Financial contagion and intra-group spillover effects

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The President

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Complete list of abbreviations

ANOVA	Analysis of Variance
ART	Artificial Risk Transfer
AT	Austria
BA-CA	Bank Austria Creditanstalt
Basel II	Second Basel Accord
BE	Belgium
BIS	Bank for International Settlement
bln.	billion
CAPM	Capital Asset Pricing Model
CAR	cumulative abnormal return
Cat bond	Catastrophe bond
CDF	Cumulative Distribution Function
CDO	collateralised debt obligation
CDS	credit default swap
CEA	Comité Européen des Assurances
CEE	Central and Eastern European
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
CEPR	Centre for Economic Policy Research
CESifo	Centre for Economic Studies Information und Forschung
cf.	confer (Lat.), compare to
CFS	Center for Financial Studies
CLN	credit linked note
Corr.	Correlation
Cov.	Covariance
CTD	cheapest to deliver
CRO-Forum	Chief Risk Officer Forum
DAB	Direktanlagebank
DD	distance to default
DE	Germany
DJ	Dow Jones
DK	Denmark
EC	European Community
ECB	European Central Bank
e.g.	exempli gratia (Lat.), for example
et al.	et alii (Lat.), and others
etc.	et cetera (Lat.), and so on
ES	Spain, expected shortfall
EU	European Union
EUR	Euro
EURIBOR	European Interbank Offer Rate
EVT	Extreme Value Theory
f.	following page
ff.	following pages

FI	Finland
FR	France
FSAP	Financial Sector Action Plan
GAAP	Generally Agreed Accounting Principles
GPD	Generalised Pareto distribution
GR	Greece
HDG	Holding
HVB	Hypo- & Vereinsbank
IAA	International Actuaries Association
IAS	International Accounting Standards
ibid.	ibidem, same source
i.e.	id est (Lat.), that is
IE	Ireland
IFRS	International Financial reporting Standards
iid.	independently and identically distributed
ISDA	International Swaps and Derivatives Association
IT	Information Technology, Italy
Lat.	Latin
LHS	left hand side
ln	natural logarithm
LoB	Line of business
LU	Luxemburg
MFI	Monetary Financial Institution
Mio.	Million
M&A	Mergers and Acquisitions
MU	Monetary Union
n.a.	not available / not applicable
NAIC	National Association of Insurance Commissioners
NBER	National Bureau of Economic Research
NL	Netherlands
No.	number
OECD	Organisation of Economic Cooperation and Development
OLS	ordinary least square
OTC	over the counter
p.	page
pp.	pages
prob.	probability
PT	Portugal
QQ plot	quantile-quantile plot
RAS	Riunione Adriatica di Sicurtà
RC	risk capital
RHS	right hand side
S&P	Standard and Poors
SCAR	standardised cumulative abnormal return
SE	Sweden
sig.	significant
SPV	Special Purpose Vehicle
TARGET	Trans-European automated real-time gross settlement express transfer system
TBTF	too big to fail
UK	United Kingdom

US	United States
Var	Variance
VaR	Value at risk
Vol.	Volume
vs.	versus

Abstract

The main intention of this thesis is the assessment of spillover effects between financial group constituents. In order to understand the relevance of this issue, we first have to delve into the economic rationale of financial intermediaries and their deficiencies with respect to contagion in particular. A general discussion of the contagion literature and a brief evaluation of potential driving forces in the current economic environment will provide first insights into the topic.

Based on these primary aspects of contagion, a more intense and more focused treatment of the research question follows. Both an analytical and an empirical analysis of intra-group spillover effects are conducted by providing different possible approaches with the same ultimate objective, i.e. the observation or proof of contagious effects among group constituents.

Finally, the practical implications for the industry are discussed and contrasted with the common argument of diversification effects within larger group portfolios. Put simply, it is discussed to what extent positive group externalities can compensate for the negative externalities that we have treated in the sections before. Eventually, this will also have a strong and important impact on the determination of potential group capital adequacy requirements and hence is both of extraordinary interest for the financial industry and theorists.

1. Introduction and objectives

1.1. Introduction into the topic

The main emphasis of this thesis is the assessment of financial contagion and intra-group spillover effects. In the current empirical and theoretical literature intra-group spillover effects are severely neglected consequences of corporate interdependences. Although it can become a decisive topic in the years following Basel II and Solvency II, i.e. the banking and insurance regulatory framework implementation, and risk capital determination there are still very few researchers with a particular focus on this important issue of intra-group externalities.

It is sometimes argued that intra-group spillover effects are a highly-overestimated theoretical creation that is difficult to measure empirically and that is possibly not as relevant in day-to-day business. It is usually argued that such effects only become relevant in extreme situations, which are already accounted for by using conservative buffers and haircuts. Others recognise the importance of spillover effects but do not show special interest in the assessment of these effects because it possibly undermines other objectives, such as the determination of group diversification effects. In fact, one may assume that current diversification assessment practices for groups sometimes lack a sufficient level of prudence.

Essentially, when diversification can be used as an argument to reduce group risk capital requirements, this may be a prominent argument for "official" negligence by corporate researchers or risk managers. Contagion and other negative spillover effects are countervailing forces for the generation of diversification.

Provocatively, one may ask the question whether the risk of the group is higher than the simple sum of risks of its stand-alone entities. Clearly, this super-additivity of risks is counter-intuitive taking into account the arguments of portfolio theory, which clearly state the advantage of a large portfolio to reduce overall risk. Additionally, the empirical evidence of consolidation in the market and theoretical arguments are other signs of the "value" of large groups. The assumption of super-additivity also contradicts the explanations of company managers that primarily emphasise the possible synergy effects and the possibility of the generation of economies of scope and scale after a merger or an acquisition of a "strategically interesting" institution. Nevertheless, the respective question may represent a starting point for deeper research and topical discussions.

Taking into account the perceived negligence of research on negative intra-group spillover effects, this thesis is intended to intensively treat this topic from a superior or neutral perspective, i.e. neither from the standpoint of the corporate risk manager nor from the perspective of the supervisor. This approach will guarantee an analysis indifferent to the results observed. However, the affiliation of the author with a supervisory authority may sometimes implicitly lead to the assumption of the supervisor’s perspective.

1.2. Contribution to current research and literature

To our knowledge there currently does not exist any substantive research project with a clear emphasis on the question of spillover effects within financial groups. Freshfields Bruckhaus Deringer (2003) is probably the only paper that makes intra-group contagion effects a subject of discussion with the intention to explain the necessity of legal firewalls between a group’s constituents although the respective discussion of contagion is conducted at a very abstract or theoretical level and does not plumb the depth of the topic. Other projects mention this issue for the sake of completeness but do not go into more details for different reasons.

This thesis is therefore intended to close this gap by discussing more intensively intra-group spillover effects and their possible consequences. Methodologies that are known from the measurement and assessment of market-wide contagion or simply from tests on the safety of corporations are borrowed and adapted where necessary for the estimation of endogenous group effects. The application of three different methodologies will provide a deeper insight into risk dissemination within financial groups or conglomerates.

Another innovation of this research project is that, for the first time, it clearly relates negative spillover effects to the generation of diversification effects in groups in order to put both effects into perspective, that is, it essentially contrasts positive group effects with effects that negatively affect the group and its constituent institutions in particular.

So far, only an isolated, one-dimensional (portfolio) perspective on diversification had been taken in the finance literature. Countervailing effects have usually not been taken account of or have only briefly been mentioned without further integration into the respective arguments on positive group effects.

1.3. Basic structure

The work is essentially divided into three main parts, i.e. a general introduction to the topic, the analytical discussion and empirical derivation of intra-group spillovers and a section on implications and conclusions derived from the earlier sections - framed by a short introduction and the final conclusion.

In the general discussion, the theoretical background or foundation for the resulting arguments are presented. It essentially reproduces the economic explanations of the financial industry and provides an overview of the current contagion literature and a description of the causes and consequences of contagion.

In a first step a basic rationale of the existence of the two most important financial intermediaries, i.e. credit institutions and insurance companies, is provided and major deficiencies are emphasised. The main differences in this respect between the two industries are given therein.

Contagion as the main deficiency is then explained in more detail in a next step. The term financial contagion is clearly defined and a broad literature discussed. The main sources and triggers in the financial environment are then regarded empirically in the European market. Strong emphasis is put on data from the European Central Bank (ECB) and the Committee of European Insurers (CEA). Concretely, consolidation and convergence in the markets, the interbank market, and outsourcing, risk transfer in its broadest sense or extreme events as major drivers of contagious effects are described more profoundly and observed empirically, provided that sufficient data were available. While the ECB provides a relatively large data pool, data on the insurance industry is more limited.

Overall, this part of the study is still very general and the main focus is still not solely placed on financial groups or intra-group spillover effects but has a broader access to the topic, where contagion may also come from an external source outside the group structure. The subsequent section then almost exclusively treats effects within groups and conglomerates. Contagion effects in the financial market already have been broadly discussed in the recent literature.

The analytical discussion and empirical derivation is intended to measure or explain spillover effects. While the first sub-section is primarily based on an analytical approach, the latter consists of several empirical assessments based on publicly available market data. The analytical discussion of group externalities is conducted on a very abstract level without the need for the inclusion of actual and current data. First, it is discussed what intra-group actually means and what possible consequences it has. Afterwards, the main determinants of these spillover effects are treated more profoundly. In principle, two factors can be ascertained: correlation of company default and physical interdependence between group affiliates. Accordingly, these determinants are then assessed more intensively.

The empirical part discusses and applies several methodologies to assess the dissemination of risks. Related literature, which mainly focuses on event studies and the assessment of general contagion, is presented. Nevertheless, it is a good starting point for the subsequent estimations. Before further estimations are conducted, return correlations of the various companies are conducted. First, intra-industry correlation is tested, and afterwards correlation within groups is put into contrast in order to get first insights on the relevance of intra-group externalities.

The main emphasis is put on the event study estimations for the simple reason of relatively easy access to and the frequency of the relevant data. Share prices are available on an almost continuous basis and are in most cases rather liquid, whereas accounting data are at best available quarterly and differ according to the accounting rules applied and the strategy pursued. Furthermore, many companies are not active on the credit market; hence, the relevant data for estimations are not issued and if issued, rather illiquid.

After the event studies alternative methods to measure the intra-group dissemination of risks are presented. More concretely, co-movements of companies' credit spreads and distances to default are assessed. Afterwards, the group results are compared with groups of arbitrarily composed companies, i.e. groups that do not exist in reality. Given that the measures applied are good predictors of group effects, the results of these estimations are assumed to diverge considerably.

The third main part discusses the possible implications of the effects discussed before. It essentially discusses the generation of diversification effects within financial groups regarding the presence of countervailing forces. Essentially, current diversification arguments and calculations of the financial industry are contrasted with potential adverse forces that are usually neglected or at least not sufficiently taken into account. In simplified term, it is discussed to what extent positive group externalities can hence compensate for the negative externalities that we have treated in the sections before.

Ultimately, the final conclusion summarises the results found and emphasises the challenges faced by both financial supervisor and corporate risk management. In the appendix several additional or more detailed tables and figures are presented.

In the appendix a comprehensive documentary on the underlying calculations of the empirical studies is provided. Furthermore, several tables with alternative parameters are presented.

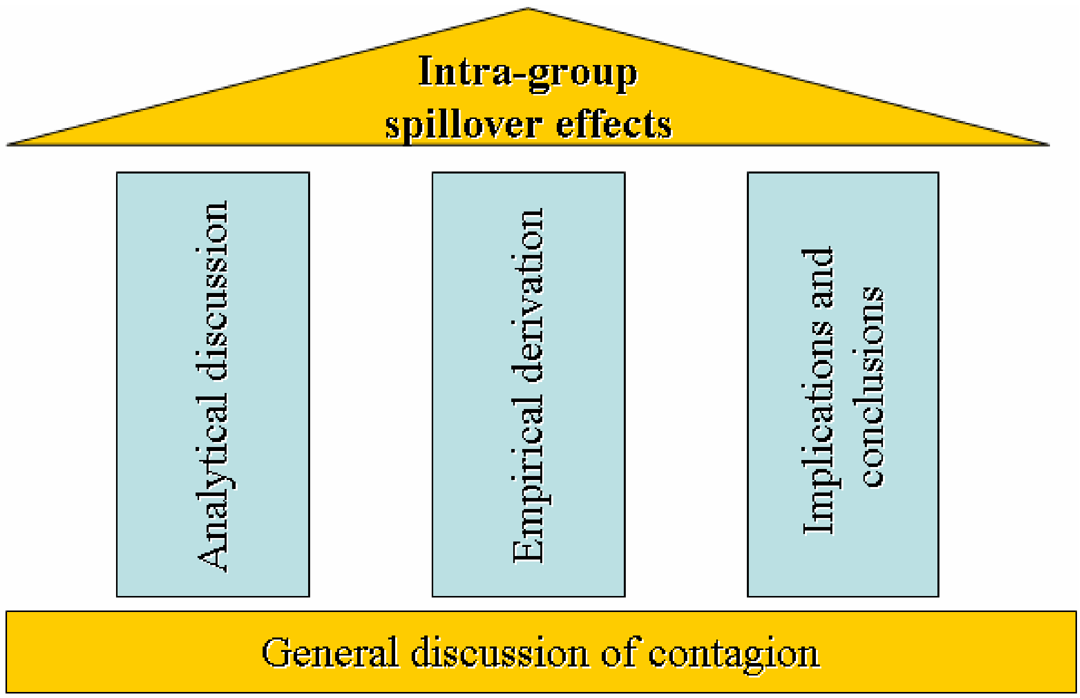

Figure 1: Illustration of principle structure of thesis

2. General discussion

This introductory part of the study is mainly intended to provide first access to the topic of financial spillover effects. Therefore, it remains quite general at the beginning. Some principle reflections on the main players in the financial market are made and how these effects may have an impact on them. The intention behind the approach taken of explaining the economic rationale of credit institutions and insurers is to show the theoretical relevance of risk dissemination and spillover effects for precisely these institutions. Furthermore, a strong emphasis is put on the main differences between banks and insurers regarding the probability of or the propensity to these effects. Finally, this section will clarify why research must have a prominent focus on these adverse consequences of financial intermediation and why it may become an issue for the determination of overall financial group risk.

This first part is written in a survey-style by focussing on the most relevant and current literature regarding this topic. Due to the divergent (historical) importance of the two financial industries, there is a strong bias towards the banking literature, which we intend to compensate for in that introduction.

After explaining the economic rationale of these financial intermediaries, the theoretical concept of contagion is explained in more detail. Due to the plethora of definitions we have to clarify what we mean by this concept and hence provide a useful definition, which becomes relevant in the subsequent chapters.

Afterwards, a literature review is provided that will show how researchers explain the emergence of contagious effects and which channels are especially prone to the dissemination of contagious risk. The literature thereon is quite extensive. Therefore, the selection of appropriate papers was primarily based on the benefit to the main topic of this paper, i.e. the analysis of intra-group spillover effects. Naturally, the most important papers on contagion are included.

The final section of this general part is the presentation of potential driving forces of contagion. Mainly six different primary sources of contagion are observed, i.e. the consolidation of the market, the convergence of financial industries, interbank market, the general concept of risk transfer, outsourcing and extreme events. These drivers are explained on a theoretical basis and supported by empirical data where available. Unfortunately, the extent and quality of available empirical data strongly varies.

2.1. Economic explanation of the financial industry and implications regarding contagion

In order to understand major causes and channels of financial contagion in the financial industry, it is a prerequisite to be fully aware of the modus operandi and structure of credit institutions and insurance firms. Moreover, one has to understand the rationale of their existence to fully recognise internal processes of financial intermediaries and their interdependences with the market.

Given an Arrow-/Debreu- world, where markets are complete and without any frictions, there is no room for financial intermediation. In this case financial intermediaries that serve as agents for both participants in the business - i.e. investors and borrowers or risk takers and risk shedders- are redundant institutions.

Furthermore, there are no transaction costs, which are eventually a result of asymmetric information. Therefore, intermediaries cannot serve particular client needs by facilitating the access to the market and providing aligned and customised products or services. Firms are, for instance, completely indifferent as to bank credits versus securities (cf. Modigliani Miller theorem, 1958). In a world of complete information, there is virtually no need for an institution that essentially channels and apportions supply and demand of financial means.

A similar argument as in the banking case is valid for insurance contracts and insurance firms. Under conditions of complete information, an insurance market would not exist. If a risk is certain, there is, on the one hand no reason to insure it; on the other hand, nobody will offer insurance. For an insurance contract to be offered, there must remain at least some uncertainty in the outcome.

Taking a more realistic picture of the world, asymmetric information and transaction costs provide a reasonable and necessary explanation for the existence of financial intermediaries, that is, the role of intermediaries is essentially characterised by rising returns to scale and scope in the finance business. In other words, the fixed costs involved in activities like executing transactions, monitoring investments, and acquiring information can be reduced by a financial intermediary that can incorporate all these functions within one single entity and thus can particularly save on transaction costs. Thus, all participating parties in the process, investor, borrower and intermediary, can gain from the intermediary's operations.

Kashyap, Rajan and Stein (2002) explain these facts by the existence of a potential for synergy between the two activities, which is based on the low correlation between deposit withdrawals and loan commitments, that is, the costly overheads in the form of cash and security holdings required by both deposits and loan commitments can be distributed among the two activities. Accordingly, banks offering both functions can get by with a smaller total volume of cash and securities on their balance sheet than would two specialised institutions.

However, nowadays, these frictions and the related costs are diminishing due to technological developments. Hence, other arguments also have to be provided to satisfactorily justify the existence and continuing strength of financial intermediaries because these changes have not coincided with a corresponding reduction in intermediation.

Several authors now emphasise risk management and risk transformation, participation costs[1] or the provision of financial advice to provide reasonable arguments for the existence of financial intermediaries (cf. Allen and Santomero, 1997, Allen and Gale, 1999 or Scholtens and Wensveen, 2000).

Principally, the function and the basic operations of the financial intermediary determine its structure, which itself has certain consequences for the company concerned. As explained in the subsequent chapters, the balance sheet structure can essentially contribute to the explanation of certain particularities or "fragilities" of financial companies - banks in particular – that have a significant impact on the dissemination of certain risks within the company or across the industry. Furthermore, it can explain the principle differences of classical banks and insurance corporations regarding those negative shocks.

The next chapters of this section will particularly focus on the two most important exponents of the financial industry, i.e. credit institutions and insurance companies. We provide the rationale for their existence and potential varying deficiencies resulting from their business model and eventually from their structure.

This introductory section will already provide a certain idea of why academic research has put such a strong emphasis on the risk of contagion and why it plays such a decisive role in the development of regulatory and supervisory rules. Moreover, it is meant to serve as the basic foundation of further arguments in subsequent sections because many results can ultimately be traced back to deficiencies based on the well-known fundamentals of financial intermediation.

Understanding the fundamentals, certain market reactions and outcomes become obvious and the necessity of regulation and supervision of the financial markets and its main protagonists becomes convincing, just as the different treatment of the market players.

Due to its extraordinary importance in the financial industry or even in the whole economy and the systemic risk argument, academic research has put a strong emphasis on the banking industry. Insurance companies have played a considerably less important role in research because systemic implications are a less imminent problem as we will find out subsequently. Therefore, we mainly explain financial intermediation on the basis of the model of credit institutions.

The chapter on insurance companies will particularly highlight the main differences in business and structure in comparison to the banking industry and will explain its increasing relevance in the study on contagion effects in financial markets, i.e. the continuous assimilation of banking operations, the convergence and integration of

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[1] Participation costs are the costs that arise due to the direct participation of the public in the financial or capital markets.

industries, etc. It also serves the purpose of showing the main differences of the two financial industries, also resulting in a divergent regulatory treatment.

2.1.1. Credit institutions:

Freixas and Rochet (1997) give a simplifying but operational definition of a bank, stating that a bank is an institution whose current operations consist in granting loans and receiving deposits from the public[2].

Abstracting from the fact that this definition does not comprise the full range of actual bank activities – in particular, off-balance sheet operations such as structured products or financial guarantees, which are steadily growing in importance, are not considered – it still provides an accurate and useful picture of a credit institution by insisting on its core activities, which stand in strong relation to the writing of loans and the provision of deposits.

The main role of banks can hence be subsumed by providing brokerage and qualitative asset transformation services. The brokerage function[3] - i.e. transaction services, financial advice, screening and certification, origination, issuance or transactions services, etc.- is explained by the intermediary's competitive (cost) advantage in information processing. In this way, credit institutions were a kind of natural monopolist[4]. However, as transaction and information costs have been shrinking, the brokerage function can no longer be used as a distinctive characteristic for a bank as financial intermediary. High costs can no longer serve as a deterrent against the market entry of non-bank institutions as empirical data show.

The latter role, qualitative asset transformation, is of imminent importance for our purposes to explain the fragility of the banking business. It concerns the processing of risks when attributes of claims are changed. By contrast, brokerage does not alter the nature of the claim being transferred.

Basically, asset transformation here means that the credit institution provides its depositors with a riskless claim on the one hand while financing risky entrepreneurs' projects on the other hand. The bank is able to transform financial contracts and securities and overcome potential indivisibilities of investments and non-convexities in transaction technologies both for investors and borrowers.

Three types of asset transformation can be identified:

1. Convenience of denomination,
2. quality transformation and

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[2] This is the traditional way of explaining the functions of a bank. However, the implications therein also hold when loans are seen as a metaphor for more complex on- or off- balance sheet positions (cf. Diamond and Rajan, 2001).

[3] The brokerage function is usually less emphasised as it is not necessarily a distinctive feature of a credit institution possibly fulfilled by more specialized firms as well.

[4] A natural monopoly is primarily characterised by positive scale economies and large sunk costs.

3. maturity or (more narrowly) liquidity transformation.

As the name implies, the former function enables the bank to break down the unit size of its products into convenient "pieces" for the customer. This is the classical argument for intermediation and financial intermediation in particular.

The bank is able to channel large investments and has them financed indirectly by many small depositors. This is one of its main advantages over direct finance where a stronger coherence of the needs of both borrower and investor is required. Intermediation is a way to overcome indivisibilities both of investment needs and the means provided.

Quality transformation means the possibility of a credit institution to enhance the risk/return characteristics, for instance, due to its competitive advantage in information acquisition or due to its capability to offer indirect participation to a small investor in large indivisible projects.

A direct investment in such projects would prevent adequate diversification of the investor's portfolio and hence would make the investment much riskier due to concentration risks, i.e. the investor might immediately be hurt by the project's default. The intermediary, on the contrary, allows the investor to participate in smaller shares and to diversify his portfolio. For the credit seeker this mechanism provides a larger market of potential investors and a higher probability to have his project financed.

The third function of asset transformation contains the transformation of securities with short maturities into securities with long maturities, that is, a bank is simultaneously able to offer short term deposits and provide long term loans to finance borrowers' projects. The theory follows the same principle as provided in the preceding arguments on asset transformation.

Basically, maturity transformation is based on the statistical law of large numbers, which implies that withdrawals of depositors will on average not exceed a certain amount, i.e. unexpected withdrawals are statistically limited[5]. Hence, the larger the institution's depositor base, the lower the risk of sudden illiquidity due to (unexpected) withdrawals of funds that are not immediately available due to their long term allocation, is. In fact, larger institutions may be safer than smaller ones.

However, the risk of illiquidity cannot be fully eliminated and also large banks may be hit, although the statistical probability is lower. This is due to the fact that the expected number of withdrawals approximates the statistical average of the total population, given the independence of those events. In a stress scenario this independence may no longer be a reasonable assumption, however[6].

While lenders pay a reward for having the interest rate risk borne, i.e. they receive a fixed interest rate discounted for intermediation services; borrowers reward the

5 The law of large numbers states that if a sample of observations drawn from a given population of independent events is sufficiently large, the average value of the sample will be close to the average value of the overall population.

6 This argument is discussed in more detail in the subsequent section on bank deficiencies.

creation of liquidity[7]. The gain of the bank is the spread in interest rates, which has long been the main (and almost unique) source of income for traditional credit institutions. As such, the bank works as a pool of both investment projects and financial means and it enables an adequate redistribution thereof for all participating agents. The bank can bridge the gap between investor and project that arises from asymmetric information. Thus, it improves the welfare of the whole market as the number of potential deals increases.

Maturity transformation can also serve as a means for the bank to overcome informational frictions. Long-lived assets are then financed with short term liabilities and that allows a frequent repricing of the institution's liabilities[8] (Bhattacharya and Thakor, 1993).

2.1.1.1. The balance sheet structure of a classical credit institution

As a result of the operations conducted, we obtain a typical balance sheet for a credit institution with strong traditional banking activities[9]; i.e. rather long term assets but short term liabilities.

This characteristic structure of the bank balance sheet provides, on the one hand, the usual justification for the existence of credit institutions and can be explained by the functions the traditional credit institution fulfils. On the other hand, it reveals the causes of its fragility.

The credit institution is quite independent in its investment decisions, i.e. how to allocate its assets, but can only marginally influence the composition and behaviour of its depositors or other investors. Difficulties may originate from the fact that assets are generally long term and therefore difficult to reallocate, whereas liabilities are short term in general. This may lead to a maturity mismatch.

The balance sheet also reveals the interdependence of credit institutions within the banking industry or even the whole market.

7 Naturally, the bank's interest income, up to now the main income component of a classic credit institution, shrinks when the interest differential declines.

8 Potential challenges for the bank resulting from this mismatch of durations are addressed in a later section.

9 That is loan provision and deposit taking. Usually, it is abstracted from investment banking.

Assets	Liabilities
Cash	
Interbank loans	Interbank deposits
Credit to the public sector, credit to households, credit to firms	Retail and other wholesale deposits
Equity holdings	Subordinated debt
Equipment and premises	Equity

Table 1: Stylised bank balance sheet

The provision of liquidity insurance - the bank enables depositors to withdraw at low cost and protects firms against unexpected liquidity needs of their investors - explains the liability side of the bank's balance sheet. The provision of monitoring services and the enhancement of the flow of credit in the economy explain the asset side of the balance sheet.

As long as the number of borrowers and lenders is large, this fact should allow for diversification at each side of the balance sheet. The diversification argument is a prominent example to explain the advantage of a financial intermediary, as a collective or bundle of investors over many single agents[10]. Moreover, as explained, the larger those groups, the more valid the law of large numbers is. This fact allows the holding of a smaller fraction of assets in liquid reserves to meet deposit withdrawals because holding capital is expensive to the bank.

Despite this fact, this characteristic balance sheet structure has always been a matter of concern to researchers and even practitioners. Many arguments for banking regulation can be deduced from the typical bank balance sheet or at least have their origin in the structure of the credit institution.

Coordination failures, i.e. withdrawals exceed the expected extent, can immediately lead to intense reactions and can ultimately cause the failure of a healthy and solid company. Interbank lending and derivative instruments can smooth this risk. However, the former measure leads to a stronger interdependence within the banking industry and therefore exposes each institution to some extent also to the risks of other banks or the industry.

This might be particularly relevant in the case where the failure of a money centre bank or the parent company of a banking group or financial conglomerate becomes imminent. Thus, the failure of one institution might trigger a chain reaction or

[10] The diversification aspect led many authors (cf. Diamond, 1984) to argue that the optimal size of a bank is infinite. It has also often been stressed as a major argument for consolidation in the financial industry, in particular mergers. Potential diseconomies or concentration effects are rarely considered.

domino effect (in the literature known as contagion[11]) and thus exposes the institutions to external, exogenous risks, not (necessarily) derivable from the company's own structure or condition. In the worst case, under such a setting risks can spread across institutions with hardly any barriers. Then, even healthy institutions may suddenly be exposed to the risk of failure.

2.1.1.2. Bank deficiencies

As explained in the preceding chapter, the balance sheet structure of a credit institution is rather prone to coordination failures, i.e. withdrawals in excess of the current expected demand for liquidity can hardly be satisfied by the bank experiencing this liquidity shortage. Thus, the institution, holding only a small fraction of assets in liquid reserves, lacks the liquid means to immediately fulfil its depositors' financial needs. As long as prices, i.e. interest rates, remain reasonable, the bank can finance the liquidity needs via the interbank market. Ultimately, it may be obliged to engage in a fire sale of longer term or less liquid assets.

This fire sale – a premature liquidation of investments - is naturally associated with a substantial loss for the bank caused by a considerable discount on the anticipated value of the investment. Moreover, such asset sales are limited because a large share of a bank's assets, i.e. loans and credits, are hardly tradable or cannot immediately be wound up[12]. In extreme cases, when even these premature sales do not suffice to satisfy all depositors, the bank may become illiquid or, in the worst case, may fail.

Due to the strong economic linkages of the financial industry, financial difficulties can possibly not be confined to the single institution. The situation may possibly affect other institutions as well, for instance, via the interbank money market, which consists of a complex network of mutual exposures of banks.

As certain institutions may suddenly not be able to serve their liabilities with their creditor banks, those institutions may also get into serious financial troubles. The creditor banks may now themselves have insufficient liquid means to fulfil their own obligations, which have been entered under different premises.

These effects may also occur indirectly, via reputation, i.e. the market's perception of interdependences within the financial industry, in particular of banking institutions. Depositors may panic and withdraw even from healthy and solid institutions that possibly do not have any physical connexion with the company originally hit. The simple market perception may suffice to trigger adverse, but individually rational, reactions by certain market players. In a bad scenario these reactions may lead to the failure of several institutions and may finally even cause a financial crisis. Under these circumstances the law of large numbers no longer holds because withdrawals cannot be assumed to be independent, anymore.

[11] Causes and consequences of contagion are discussed in greater detail in a subsequent section.

[12] An immediate dissolution of loan contracts may also severely harm the real sector because affected companies may not immediately find an alternative investor.

Abstracting from any safety measures and governmental interference, depositors aware of both this mechanism and the sequential service constraint, i.e. a first come, first served rule of service, will immediately try to withdraw as well their financial means in order to protect their fortune, when observing large withdrawals from their bank.

However, this – individually rational – reaction will even aggravate and accelerate this adverse process. The depositors are caught in a prisoner's dilemma. They will end up worse when they follow individual rationality[13] and try to withdraw their means from their credit institutions. All depositors would be better off if they could cooperate and decide to stay with their banks. However, cooperation is not a viable solution because any player can improve his position, by acting against previous announcement. Thus, any such announcement would be time-inconsistent.

Withdrawals are characterised as a dominant strategy, leading to a Nash equilibrium[14]. As a result, even more depositors begin to panic and try to get back their financial means. Hence, withdrawals of capital will soon exceed accessible means and the mechanism explained above becomes a self fulfilling prophecy: Banks have to liquidate their long term assets in order to fulfil their depositors' demands. As expected, bank runs may eventually result in the financial institution's failure.

Due to this mechanism also banks, that are assumed to be fundamentally solvent, may be driven into illiquidity and eventually into failure.

2.1.1.2.1. How can this process be explained?

One of the first explanations why bank failures occur was given by Diamond and Dybvig (1983). They explain in a 3- period model why banks are vulnerable to runs.

Diamond and Dybvig's (1983) intuition is as follows: In period 0 we have a set of ex ante identical depositors that will either consume in period 1 or period 2. As it is not clear in advance whether the depositors consume early or late, the bank has to invest a fraction of its funds in the short term technology and the counterpart in the long term technology (e.g. entrepreneurs' projects).

Nevertheless, banks do not know exactly, a priori, how many depositors will consume early. Hence, they are vulnerable to a co-ordination failure triggered by a so called preference shock of depositors, i.e. the withdrawal rate in period 1 may exceed the expected one. Then, the promised withdrawal in period 2 becomes infeasible and thus, the other depositors are induced – following individual rationality - to withdraw as well.

This process may cause a bank run under the assumption of a sequential service constraint. The resulting equilibrium provides no risk sharing and is even inferior to the allocation, agents can obtain without the bank.

[13] This concerns at least those that arrive too late to withdraw their whole fortune.

[14] Definition of a Nash equilibrium: Each player's predicted strategy must be that player's best response to the predicted strategies of the other players (cf. Gibbons, 1997).

According to Diamond and Dybvig (1983), bank runs are pure sun spot phenomena, i.e. they lack any trigger mechanism like macroeconomic shocks. Therefore, this theory provoked considerable criticism by several authors, who argue that there was some evident correlation between economic variables and bank runs in economic history. There are now also some examples with bank runs triggered by adverse information. (cf. Bhattacharya et al., 1998).

Contrary to the earlier papers that supported the self-fulfilling prophecy approach, some of the more recent research concentrates on bank runs as a phenomenon related to the state of the business cycle (e.g. Allen and Gale, 1998, Zhu, 2001)

2.1.1.2.2. Bank panics and other sources of contagion[15]

If the shocks to bank returns are correlated across banks, i.e. the banks are perceived to be similar, the run may spread to other banks, causing a panic. In this case not only one simple bank is concerned but many banks or even the whole financial system. A model of these panics must be based on (informational) contagion and can therefore not be a sunspot phenomenon. Hence, a shock, that seriously damages one bank, can easily spread to other banks, that is, initially unaffected or at least not directly affected companies may also become affected and possibly seriously harmed.

There are also other mechanisms than panics that can explain the dissemination of shocks in the banking industry. Therefore, Manz (2002) tries to classify the various explanations and points out that there are at least two potential channels through which a single firm can impact other firms.

The first channel is through direct (capital) exposure to the original shock or the failed enterprise. So, due to the failure of the debtor, creditors might be forced to write off all their claims, which may possibly result in the creditor's own failure.

The second channel is called informational contagion and refers to the perceptions and beliefs of the financial market participants. In a banking context: In order to protect their own fortune depositors decide to engage in the liquidation of their claims, when observing the collapse of another bank. They simply lack precise information on how the failure is related to their own bank.

To sum up, it can be said that a bank failure may affect both the actual and the perceived stability of the banking system, which is often referred to as the inherent instability of the financial system[16].

2.1.1.3. Safety net implications

To prevent the consequences or symptoms of the inherent deficiencies of the banking industry, in particular bank runs, diverse measures have been proposed or

[15] A detailed treatment of contagion is exercised in chapter 2.2.
[16] The inherent instability of the financial industry is discussed in a subsequent section, where contagion is explained in more detail.

been implemented[17]. Many different mechanisms have been in use in practice: suspension of convertibility, lending of last resort, narrow banking[18], etc. However, the most prominent and most discussed measure has certainly been the implementation of deposit insurance in all its varieties.

Deposit insurance is a guarantee to bank creditors, especially depositors, to receive their money back in case of a bank being in serious trouble. As such, the payment obligation of the insurance (fund) can be regarded as a put option. The intended effect is that less informed depositors are prevented from engaging in a bank run and to ensure the protection of the system.

However, this protection is achieved at a high cost. In particular, moral hazardous behaviour of both banks and depositors are assumed to increase. On the one hand, banks may operate riskier in order to raise expected returns and depositors, on the other hand, may hardly monitor their institutions – they do not price the risk taking of the bank - because irrespective of the safety of the institution, they can trust in the safety of their financial means. If a company is considered to be too big to fail (TBTF), this behaviour might be even more pronounced.

Moreover, one has to be aware that all of these methods to prevent bank runs or even panics, possibly with the exception of the concept of narrow banking, only treat the symptoms. But the source of the industry's fragility is its structure. In other words, all these measures may prevent bank runs while the institution can still be in serious troubles and the financial difficulties may still spread via the interbank market to other institutions, that is, to a certain extent, the problem is externalised to the deposit insurer that has to bear the ultimate costs of bank failures without sufficiently focussing on the safety of the company per se. Hence, contagion effects within the industry may remain, albeit perhaps differently channelled.

2.1.2. Insurance companies

The economic and regulatory literature on insurance is certainly less extensive than the banking literature. Nevertheless, insurance firms play a decisive role in financial markets and contribute to the reduction of frictions. The different treatment in the literature can mainly be traced back to historical reasons, in particular to events that had a considerable impact on the financial development, such as the Great Depression in the 1930's. Moreover, there is substantial information on banking crisis due to their frequent emergence, whereas there is hardly any data on insurance failures or even crises.

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17 Measures of the safety net have been a prominent topic in the banking literature. Here, we will only provide a very brief and focussed description. For a more detailed treatment, one may refer to the vast literature and surveys such as Bhattacharya et al. (1998).

18 Narrow banking is essentially concerned with the separation of the two core activities of traditional banks, i.e. the simultaneous provision of long term loans and short term deposits.

The rationale for the existence of insurance companies can be found in the classic explanations of financial intermediaries, as presented above for the banking industry. The main argument is again asymmetric information and all the frictions that are related to it. Thus, similar to banks, the main rationale for the existence of insurers is the reduction of transaction costs and the exploitation of economies of scale and scope.

Despite these general similarities between financial intermediaries, the business of insurers is considerably different from the banking business. Insurers borrow money (premia) by issuing debt in the form of insurance policies that pay the lender (policyholder) financial compensation if a pre-specified event occurs. Insurance is, thus, linked to future events, the occurrence of which is uncertain at the time a contract is concluded.

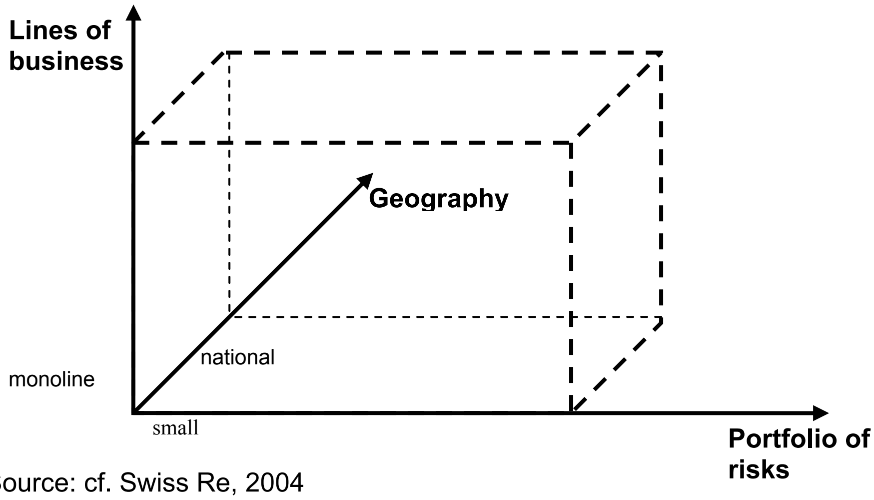
This uncertainty of occurrence is a necessary precondition for the insurability of an event[19]. For events that are certain no insurance can be provided because neither insurer nor insured have any incentive to provide, respectively demand, protection.

The nature of insurance operations is to accept risks of the institution's policyholders in exchange for a premium. Basically, the insurer transfers resources from low marginal utility of income states to those states where the marginal utility of income is high. In that way, insurance is a welfare improving measure.

Hence, in order to make profits, the insurer needs to manage the risks it accepts from its policyholders. Diversification of those risks is, therefore, a decisive element for the institution's risk management. As in banking, the greater the size of the company - in terms of the policyholder base, the range of products, the number of markets of operation, etc. - the higher the diversification effects may be. Gains in certain areas may compensate for losses in others. Moreover, the larger the institution's risk portfolio, the higher the scale effects it generates, is.

Although the pooling of contracts within one large portfolio reduces uncertainty, unexpected losses may still arise and may potentially jeopardise the insurer's ability to meet its obligations. Therefore, they are obliged to hold risk capital that serves as a cushion against unexpected losses. It also serves against other risks such as misspecification of models or changing (economic) conditions.

[19] This statement is particularly valid for general (i.e. non-life) insurers. Life insurances often primarily have the characteristics of an investment vehicle and to a lesser extent those of a "safety net" against unforeseeable events.



Source: cf. Swiss Re, 2004

Figure 2: Dimensions of diversification

The basic rationale why insurers can exist lies in the fact, that they are able to raise funds by selling policies by more than their economic cost[20]. Despite this fact, individuals are willing to pay more than it costs (the insurer) to produce the cover they buy because they themselves cannot take advantage of risk pooling arrangements, which provide an efficient means to lower costs due to the assumption of diversification effects (cf. Swiss Re, no date). The different dimensions that contribute to the overall diversification effect for the insurer's portfolio are provided in figure 2. In principle, the broader the portfolio, the greater these effects are.

Moreover, the insurer can also take advantage of risk transfer techniques, which allow the transfer of risk whenever the respective costs are lower than the costs of keeping that risk on the company's book, e.g. when the portfolio becomes excessively concentrated. Thereby, the insurer can further diversify its portfolio but has to be aware that it simply exchanges underwriting risks against counterparty risk, i.e. credit risk.

This risk transfer can be realised via the financial markets - by hedging or securitisation - or the reinsurance markets. While reinsurers still play the predominant role, the financial market with its structured products is gaining importance.

2.1.2.1. Balance sheet structure and implications for systemic risk

The balance sheet of a traditional (life) insurance[21] company is typically characterised by a particularly long duration of contracts, i.e. its liabilities, while

[20] The underlying assumption is that contracts and premia can sufficiently be individualised, such that, adverse selection, i.e. the good contracts leave the market and only the bad remain, can be prevented.

[21] Non-life insurance contracts usually cover risks over a shorter period, typically one year. The claims payable and the timing of payments are, however, unknown when the contract is written.

assets are rather short term in comparison. This characteristic is less pronounced for non-life insurers, where contracts are usually concluded for a period of up to one year. As a result, the (life) insurance company is confronted with a balance sheet that is reversed to a traditional bank balance sheet, i.e. with short term liabilities and long term assets. Additionally, the duration of these contracts is better foreseeable and follows statistical estimations.

Crudely spoken, an insurer's financial assets are balanced by insurance liabilities and the risk capital provided by shareholders. To reduce risk, both sides of the balance sheet are assumed to be strongly diversified.

Assets	**Liabilities**
Cash	
Receivables	Payables
Investments	Technical provisions
Intangible and fixed assets	equity

Table 2: Stylised insurance balance sheet

This structure, as depicted in table 2, therefore, protects the traditional insurer from most of the risks that are particularly relevant in the banking industry. This difference is, for instance, reflected in the stronger policyholder protection focus of regulators and the lower weight on financial risks and financial stability. In particular, systemic risk is assumed to be a less frequent and outstanding problem.

Systemic risks, as, for instance, defined by De Bandt and Hartmann (2001)[22], have a much lower probability and a lower destructive potential. According to these authors, systemic risk is the risk of experiencing systemic events in the strong sense, whereby an event is assumed as strong, if the institution(s) affected in the second round or later actually fail(s) as a consequence of the initial shock. Thereby, it is emphasised that those companies have been fundamentally solvent ex ante or would not have failed without the initial shock.

The causes for this difference in systemic risk propensity may theoretically be explained by the subsequent arguments. A coordination failure, i.e. an immense maturity mismatch, with the result that certain policyholders cannot be satisfied due to liquidity problems, is less likely.

Generally, due to its structure the insurer is unlikely to be forced to engage in large scale fire sales of its assets in order to satisfy withdrawing policyholders. For this reason, a run on an insurance company is less probable and virulent, i.e. it does not have the same destructive potential as a run on banks. However, a (re-) insurer may trigger a bank run if it fails to meet its obligations to banks arising out of credit derivatives, or if its bankruptcy destabilises the financial conglomerate to which it belongs due to mutual ties of group subsidiaries (Swiss Re, 2003).

To further reduce respective risks for the insurer, early policy terminations are coupled with a substantial loss for the policyholder due to cancellation deductions

[22] There is a large variety of definitions for systemic risk. However, De Bandt and Hartmann's definition seems to be the most convenient due to its generality.

and potentially increased costs for policy replacements[23]. The policyholder may have to reimburse possible tax subsidies and may be confronted with poorer contract conditions. Additionally, the surrender and cancellation repayment is not fulfilled immediately but takes some time, which may also prevent the necessity for fire sales. For all these reasons, it is assumed that policyholders may reconsider the early termination of their contracts.

Another fact, that suppresses the risk of a run on an insurance company, is the absence of a sequential service constraint. So, neither is one's own fortune determined by other policyholders' behaviour nor can one's own position be improved when policies are cancelled earlier (than those of another policyholder). The (life) insurance company has to build up sufficient (individualised) reserves for each contract, over which it has no right of disposal.

Despite all these facts, the risk of a run can still not fully be prevented, as shown by a recent example in the UK (cf. Morrison, 2003). Based on the theoretical concept, runs that precipitate a panic, however, are relatively improbable. On the one hand, this phenomenon depends on the degree to which insurance risks are correlated. On the other hand, an unexpected failure of one insurance company may not support the assumption that another one will fail as well, as is assumed in the banking industry.

Thus, given the simplified nature of the insurance industry, the risk of (indirect) contagion between unrelated firms as discussed in the banking literature is less probable, but still possible. However, direct connexions between insurers via reinsurance and cessions and retrocessions may have the same effects as in the banking industry, although one potential source of direct contagion does not exist, namely an interbank market equivalent for the insurance industry.

Another challenge, concerning company safety and systemic risk, stems from accounting. Based on the standards used, the economic condition of a company is presented differently, without any change of the underlying business. The traditional accounting perspective, as applied in continental Europe, has based valuation on historical values of assets and liabilities subject to the principle of prudence or conservatism, that is, values remain relatively stable and hidden reserves are built up[24].

In contrast IAS/IFRS[25] rules, transition to which has been obligatory for publicly listed EU companies in 2005, require a fair value approach. On the positive side, the use of market values contributes to the enhancement of transparency and allows a more accurate measurement of asset/liability mismatches. On the negative side, marking to market will increase fluctuations in the valuation of balance sheets,

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23 In extreme situations these deductions may not suffice to work as a hurdle against premature withdrawals as was noticeable in Germany in 2004. German newspapers informed about several cancellations of life insurance contracts by unemployed after it was announced that these policies would be taken account of, when determining the entitlement to governmental support.

24 We will not go into the details of accounting but try to focus on the relevant arguments.

25 International Accounting Standards, International Financial Reporting Standards

which may even reach considerable levels when volatility in the markets is high. Together with an overreaction of the market, this may add to financial stability risk (cf. Häusler, 2003). Thus, accounting may become an artificial source of contagion and systemic risk

Another effect of fair value accounting is that inter-temporal risk sharing may – depending on the market power of insurers and policyholders – be almost prevented as it is made more explicit. The insurer can, in this case, not build up buffers in better years and draw on them in an economic downturn. Additionally, IFRS 4 prevents the building up of capital reserves. In the worst scenario, the company may then be forced to sell its assets prematurely, which first worsens its own financial condition but may then also adversely affect financial market conditions.

2.1.2.2. Growing importance of systemic risk in insurance

Besides the adoption of more market based accounting principles in continental Europe, several developments made the insurance industry become more prone to systemic risk. These developments include a large spectrum from consumer protection laws, to macroeconomic arguments or (structural) changes in the financial industry (cf. Das et al., 2003; Häusler, 2003). To take more profound notice of these developments, these ongoing changes will be discussed in more detail, i.e. relieve of withdrawal costs, deregulation, convergence and integration of financial markets and reinsurance.

2.1.2.2.1. Relieve of withdrawal costs

In many countries - whether due to governmental decisions or due to pressure from fierce competition - there is a tendency to allow or facilitate premature withdrawals, i.e. withdrawal deductions are prevented and premia have to be reimbursed within a short time period. This way, a strong barrier against ill-considered sudden cancellation of policies by the policyholder is broken.

Hence, insurers may face the risk of a growing number of premature withdrawals in times of an economic downturn and this will - additionally to the weak development of assets - affect the economic situation of the insurance company. Ultimately, also the company’s asset allocation policy may suffer a serious impact by these developments. Insurers may be forced to increasingly invest in rather short term assets and to hold more liquid assets in order to cope with the requirements of a changing environment where policyholders may withdraw their means at any time and without preannouncement. Conservative asset allocation, however, is costly and results in lower returns and it still cannot be guaranteed that sufficient liquid reserves are available to serve all policyholders that prefer to cancel their contracts.

Moreover, under such circumstances, one may also assume that similar systemic effects, as recognised in the banking sector, may be provoked if we accept that insurers and reinsurers are highly interlinked via cessions and via retrocession of risks. Interdependences of insurance companies may be, to some extent, comparable to the interbank market and the credit institutions' linkages via credits and loans.

2.1.2.2.2. Deregulation

Due to the deregulation of financial markets insurers have gained access to a larger variety of products and markets. In fact, the boundaries between the insurance industry and other financial institutions have been blurring. Life insurers show a tendency to assimilate banking-type activities on both sides of their balance sheet. For instance, there has been a marked surge in financial guarantee insurances that compete directly with bank guarantees and standby letters of credit that have been a substantial area of business for credit institutions.

Due to this strong assimilation of business concepts, insurance companies with a strong affinity to banking type business, may now face the same potential maturity mismatch as argued in the banking industry, i.e. short term liabilities cannot be balanced by (short term) assets. Their new balance sheet structure, consequently, makes them accessible to the same risks as credit institutions. Put differently, due to the convergence of risk profiles and cross-shareholdings banks and insurers may increasingly be affected by similar shocks. The consequences of these shocks may, therefore, be even more pronounced than if only a few companies within one single industry were directly affected.

2.1.2.2.3. Convergence and integration of financial markets

Convergence and linkages between insurance companies and credit institutions become stronger. Especially, ownership interests are growing while direct credit exposure still seems to remain limited. The development towards convergence and integration of financial markets is particularly imminent in the case of financial conglomerates, i.e. mixed financial groups[26]. Important representatives are so called bancassurances, which are predominantly in banking but have an insurance arm as well, or assurfinance companies, as their insurance dominated counterparts.

Under such premises, the transfer of specific risks among industries is strongly facilitated, that is, typical banking risks may also spread to insurance companies. As a positive aspect one may emphasise the contribution to an increased diversification potential for both industries. As a negative consequence, these additional risks might also ultimately cause these companies' failure, which could be prevented in isolation as a stand-alone company.

[26] An exact legal definition of a financial conglomerate can be found in the European Community's Financial Conglomerates Directive 2002/87/EC (2002). For our purpose the exact definition is of minor importance and it is sufficient to know that groups, consisting of companies related to different financial industries, are treated.

This risk of contagion may also spread for reputational reasons, i.e. without any underlying physical justification such as excessive bad debt, lack of sufficient liquid means, etc., that is, the market does not (cannot) distinguish between the solvent subsidiaries of a conglomerate and the rest of the firm; as happened in the case of the Drexel Burnham Lambert Group (cf. Brouwer, 2004).

Another cause for potential contagion from banks to insurers, as a result of continuing market integration, is the development of increasingly complex methods of credit risk transfer, that is, insurance companies increasingly assume risks that have traditionally been borne by credit institutions[27]. The credit risk transfer market with its large variety of contracts and products is a growing market, albeit still in a premature situation. Therefore, it remains open how it will develop in the following years.

There are mainly two ways how insurance companies may take on credit risk from banks. First, they may insure credit risk by underwriting or guaranteeing the risk. But they may, secondly, also invest in the respective derivative products, which are designed to transfer the risk from the protection buyer to the investor. Insurers may purchase securitisation issues of banks, either directly, or through the use of special purpose vehicles (SPVs).

2.1.2.2.4. Reinsurance

An evident source of contagion for insurers – both life and non life - is reinsurance firms, by representing considerable credit risk, i.e. counterparty risk, to the primary insurer. This means that the insurer may transfer part of its insurance risk, for instance, in order to raise its capacity to underwrite business or to limit its risk exposure and to reduce the volatility and uncertainty in its financial results. But in return it then has to bear the credit risk of the reinsurer.

In fact, it swaps one risk for the other. Assuming that the reinsurer is quite stable and highly diversified, using this particular channel of risk transfer is a reasonable and (usually) cost-efficient measure to smooth the primary insurer's risks. However, premium rates may fluctuate cyclically in response to the amount of capital in the market. A negative argument is the increased liquidity risk that is related to the assumed credit risk from the reinsurer and which may lead to a sudden inability to pay.

The reinsurance industry is highly concentrated[28] and the reinsurance exposure of primary insurers has been growing during the last years. Hence, the failure of a large reinsurance company could result in rapid contagion to primary insurers.

[27] For the insurance company, credit risk is defined as the exposure to losses due to the default of an obligor of the bank – which may be a borrower, an issuer of an asset, or a counterparty of the bank (cf. Financial Services Authority, 2002).

[28] However, the increasing concentration in the reinsurance sector has improved diversification of the respective reinsurer. Globalised portfolios and different risk types contribute to the diversification of the reinsurance business (Swiss Re sigma, No.5, 2003)

Ultimately, it may provoke their failure as they have to meet higher obligations than expected or provided for in the event of a claim.

This is based on the fact that if the reinsurer defaults on its commitments, the insurer is still required to pay all claims in full. There's no legal relationship between the insured and the reinsurer. Hence, ultimately the primary insurer has to bear the whole costs if the reinsurer does not meet its obligations.

The fact, that reinsurers are often the top trading companies in a group structure, even facilitates the transmission of shocks within and across sectors (cf. Brouwer, 2004). Consequently, the failure of these companies may then potentially also spread to the banking system and the financial markets because firms increasingly tend to have mutual share holdings.

Moreover, one has to be aware that insurance risks, transferred to another group affiliate, remain within the borders of the group and can, accordingly, not fully contribute to the group's diversification efforts. It remains exposed to the (insurance) risks of its affiliates.

From this point of view it becomes questionable whether reinsurers ought to be allowed to have majority shareholding in primary insurers and whether those may be allowed to process their risk transfers with the group reinsurer. Reality shows that there are some examples on the market; take, for instance, Munich Re with its subsidiaries Ergo Versicherung and Ergo Previdenza or the Generali group and its subsidiaries.

2.1.3. Summary

This description of basic properties of the financial industry, banks and insurers in particular, and the derivation of the rationale for the existence of these financial intermediaries will represent a first introduction into the challenges of financial markets. It is intended to provide a brief overview that (at least rudimentarily) covers the essence of economic insights into the topic and will facilitate the understanding of why contagion is such an important issue in the financial market.

However, it can, by no way, (and is not intended to) give a profound and detailed description of all arguments and theoretical foundations of financial institutions. Explanations rather focus on the main facts, such that a basic understanding - as a prerequisite for the subsequent sections - is guaranteed. For a deeper insight into certain subjects, deposit insurance or lender of last resort, for instance, one may refer to the respective, extensive literature.

The main emphasis of this paper is put on arguments directly relevant for the explanation of contagion effects; and, here in particular, those externalities that spread between constituents of a financial group. But in order to understand these processes, it is indispensable to keep in mind the modus operandi of the financial market and its main constituents.

Although contagion in its economic meaning of risk spillovers is theoretically imaginable in almost every industry - and therefore not a unique characteristic of the financial market - this effect is immediately understandable in the financial industry with its strong interdependences between the participating agents and its (to a certain extent) fragile structure.

For that reason, a brief economic explanation of the rationale and of the structure of financial intermediaries is provided in this introductory chapter. Based on these arguments, potential impacts on the safety of the individual institution and the market as a whole are derived and evaluated. Differences between insurance companies and credit institutions, essentially with respect to their propensity to contagion, are evaluated.

These differences may also impact the extent of dissemination of negative externalities in financial groups or conglomerates, that is, affiliates of insurance groups may possibly react differently to certain events than affiliates of banking groups. A decisive factor may, however, also be the fact that insurance companies – general or non-life insurers in particular - are usually more diverse than credit institutions.

As we learned, borders between industries and businesses are becoming blurred and theories have to adapt to the new premises. Moreover, in highly integrated financial groups differences in industry relation may play a minor role with respect to the risk of negative (or even positive) spillovers. In such integrated companies, it is difficult to establish firewalls between the operations of each entity. In fact, if one entity is in distress, others may not be able to refrain from any support. Sometimes, financial support is even anchored in guarantees, sureties or other collaterals.

The main differences between insurance companies and credit institutions with regard to stability and safety are summarised in table 2.3.

	Bank	Insurer
economic justification:	asymmetric information and related frictions	asymmetric information and related frictions
Main function:	brokerage and asset quality transformation	acceptance of risks
balance sheet:	long term assets and short term liabilities	short term assets and longer term liabilities (esp. life)
(theoretical) cause of failure:	coordination failure, interdependency in the market capital interconnectedness	reinsurance, (retro-)cessions, relieve of withdrawal costs, assumption of banking business, direct exposure to shock, balance sheet fluctuations
measures against failure:	capital requirements, deposit insurance, suspension of convertibility, lender of last resort, narrow banking, etc.	technical provisions, withdrawal costs, no sequential service constraint
propensity to systemic risk / contagion:	high	Increasing (life insurance in particular)

Table 3: summarising comparison bank vs. insurance

2.2. Financial contagion – general assessment

In the subsequent section we essentially want to emphasise contagion effects in the financial industry[29]. Based on the information and explanations with respect to structure and modus operandi of the financial industry provided in the introductory part, the risk of (negative) spillovers is, now, more profoundly dealt with. A general description and a short survey on the relevant literature, with a focus on the causes and consequences of this phenomenon, are provided. Afterwards, in order to get further inputs for our assessments, potential drivers or channels of contagion are examined empirically by using European data.

At this stage of the analysis we still refer to the broad concept of contagion and do not solely focus on the more narrow idea of intra-group risk dissemination processes. This is the main objective treated in the subsequent sections of this thesis.

2.2.1. Definition of contagion

No precise meaning of the concept of contagion has been established in the economic literature on financial industries. Most researchers and policymakers have a rough idea what this notion stands for, but a clear and exact, i.e. unique, definition does (still) not exist[30]. De Bandt and Hartmann (2001), for instance, denote contagion as strong instances of systemic events. Systemic events are called strong, if the institution(s) affected in the second round or later actually fail as a consequence of the initial shock, although they may have been fundamentally solvent ex ante, or if the market(s) affected in later rounds also crash and would not have done so without the initial shock. Hence, simultaneous exposure to a shock does not constitute a contagious event. Forbes and Rigobon (2002) emphasise that there is a difference between contagion, which is explained by strong increases in cross-market co-movements, and (what they call) interdependence. Interdependence means that, in a period of stability, without any shock the markets already show a high degree of co-movement and hence interdependence simply provides evidence of a strong linkage.

In Hartmann et al. (2005) five main criteria are proposed to describe contagion:

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29 Albeit no phenomenon limited to the financial system, we will restrict our analysis to the financial sector. Due to the structure of the companies involved, the complex network of exposures among institutions and the inter-temporal character of financial contracts and related credibility problems, the financial industry is particularly vulnerable and contagion is hence a prominent topic in scientific discussions.

30 One can perceive an inflationary use of the word contagion in the financial literature although it is not always clear whether its adoption is commensurate. Sometimes, the dissemination of a specific shock itself is mistaken for a contagious event. At diverse fora and symposia this misunderstanding often leads to intensive discussions among researchers.

1. A problem at a financial institution adversely affects other financial institutions or a decline in an asset price leads to declines in other asset prices.
2. The relationships between failures or asset price declines must be different from those observed in normal times.
3. The relationships are in excess of what can be explained by economic fundamentals.
4. The events constituting contagion are negative extremes, so that they correspond to crisis situations.
5. The relationships are the result of propagations over time rather than being caused by the simultaneous effects of common shocks.
6. In the literature there is common agreement on the first point, while there seems to be little overall consensus on the other four remaining criteria[31]. Additionally, it may also be argued that even positive spillovers may constitute some sort of contagion.

There is common agreement that spillovers might operate asymmetrically, depending on whether news is good or bad, that is, reactions to positive events are assumed to be less strong than those to negative events or announcements. If the contagious effect is based on information, it is also decisive, whether it concerns new or different information, compared to the initial situation.

For the purpose of this paper– the analysis of intra-group spillover effects - we want to use a less restrictive definition of financial contagion. We apply contagion for any event, where a negative externality spreads from one institution to the other, irrespective of this process occurring intra-industry or across industries or even across markets and borders. Furthermore, due to the object of investigation, we also take interdependences – according to the definition of Forbes and Rigobon (2002) – into account. Strong interdependences mean that a group is simultaneously faced with shocks in several affiliates, which will lead to strong financial pressure to the group[32].

Under such a setting systemic implications is not a necessary condition for an event to be classified as contagious. This is contrary to many examples in the literature, where systemic impact is a prerequisite for events to be defined as contagious.

We follow the definition by Freshfields Bruckhaus Deringer (p.19, 2003) because the advantage of this definition is its particular applicability to intra-group effects, which we are especially interested in. It refers to financial contagion as

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[31] The often unclear and inconsistent definitions of contagion regularly provoke heavy discussions in academic circles, whether a particular event can be considered as contagious.

[32] This simultaneous exposure to a shock is one of the arguments against the acceptance of a diversification discount on capital requirements for financial group, which we discuss in chapter four.

"…the process by which liabilities, losses and events affecting a particular entity may affect another legal entity, resulting in loss or the risk of loss to that other legal entity".

As such, contagion is not a particular risk type but a consequence of a certain risk event. Generally, contagion requires some legal or factual connexion between the entities concerned, that is, contagion can even simply be triggered by some agents' perception of interdependence between the entities concerned.

2.2.2. Financial contagion in the literature

As the difficulties in deriving a unique definition of contagion, and financial contagion in particular, already make apparent, contagion is a very broad field of study, which depends on (partly) very different strands of literature. To systemise it, one may distinguish between different categories, into which the contagion literature can be classified.

1. The market or channels of financial contagion concerned,
2. the way contagion emerges,
3. theoretical versus empirical approach.

One distinction focuses on the channels of financial contagion. Huang (2000) calls them the ABC channels of financial contagion, meaning the asset market channel, the banking channel, and the currency channel[33]. A similar categorisation is made by Pritsker (2001), that studies contagion via real sector linkages, financial market linkages, and through the interaction of financial institutions and financial markets.

As a matter of these various channels through which certain risks can spread, also the mechanism that provokes the emergence of contagion will differ. Thus, another possibility to classify the contagion literature is the way the risk is transferred. A common way is to distinguish between fundamental causes, e.g. common shocks, trade linkages or financial linkages, and investors' behaviour, which is based on liquidity problems, informational asymmetries; investor reassessments, etc. (cf. Claessens and Forbes, 2004). One may also make a distinction between the literature that analyses the risk of a financial shock to cause a simultaneous failure of a set of markets or institutions and the literature that focuses on the risk that the failure of one (or more) institutions will be transmitted to others due to explicit financial linkages (cf. Furfine, 2003).

Aharony and Swary (1983) classify contagion effects into pure and signalling or information-based effects. Pure contagion contains all events that spread across institutions, irrespective of the cause of the event. Signalling contagion effects, on the other hand, contain events whose revelation is correlated across the industry or market.

[33] Currency crisis are mostly dealt with in the financial market literature on contagion.

Such a signal may be the failure of a financial institution. For instance, a failure of a credit institution may indicate a bad condition of the overall economy. Bank debtholders will, therefore, take account of this circumstance in their interaction with banks, i.e. they will require higher interest rates on their deposits and, thus, raise the borrowing costs of these institutions. On the other hand, good performance of the market players may be interpreted as a sign for a healthy economy.

A different way, to distinguish contagion effects, is to classify them into direct and indirect effects. While direct contagion concerns events that give rise to immediate loss or exposure, indirect contagion results in changes in others' behaviour, which in turn may cause consequential loss or exposure.

Hence, direct contagion is always concerned with an obligation that cannot be met by the primary entity and, this has immediate consequences for the affected entity in the form of a pecuniary loss. In particularly adverse instances those events may even trigger chain reactions (i.e. domino effects), provoking the failure of other entities. This chain reaction is then associated with contagion. The infection of these companies, however, does not have any direct relation to the initial shock, e.g. a liability that cannot be met. The exposure simply comes from the linkage between the entities[34].

In contrast, when contagion is indirect the affected entity suffers no immediate loss, as a result of liabilities or difficulties of the emanating entity, but due to the prospected change in behaviour of other agents. The consequences cannot be directly referred to the original event, even if it was the (main) trigger of these adverse reactions, that is, without the event one would not have seen any reactions. For instance, bad news from one institution leads to the conclusion that other institutions are also in trouble. Such reputation risk is manifest in risks becoming correlated and, therefore, can be seen as a matter of self fulfilling prophecy.

Lastly, the literature can also be grouped into those papers with a theoretical focus – both positive and normative – and those that intend to show contagion empirically, by using a large set of different statistical methodologies for the analysis of prominent financial crises, e.g. the Russian or Brasilian crisis, the Southeast Asian crisis, etc. or events, such as the 9-11-attacks or the failure of Long Term Capital Management (e.g. Bae et al., 2003).

In the subsequent short overview, we will follow the first approach - that determines contagion according to the markets concerned - and try to integrate the other aspects into the analysis via the selection of the corresponding papers. Due to the immense amount of literature, this short survey can only deal with a short selection of papers, which, we argue, have the greatest relevance for our purposes.

[34] Example: When a debtor cannot meet the liabilities with his creditors, we do not refer to contagion. Nonetheless, if the debtor has, for instance, a guarantee, the guarantor becomes affected as well, even if there is not any other linkage between the agents involved. Here, we have an example of a contagious event.

2.2.2.1. The financial institutions channel

Most of the papers, following this strand of literature, have their starting point in the seminal paper of Diamond and Dybvig[35] (1983). These authors explain in a three-period model why banks are vulnerable to runs and, thus, the instability of the banking sector. More recent literature, however, goes beyond the simple assumption of pure sunspot phenomena.

2.2.2.1.1. Information based contagion

An interesting example of informational contagion is provided by Chen (1999). In his model, panics are explained as the result that depositors respond to early noisy information because of the payoff externality imposed in the deposit contract. Some depositors are better informed about the bank's assets. Therefore, they enjoy an advantage in being able to withdraw earlier in states, when a bank cannot fully repay all depositors. Due to this informational disadvantage, the uninformed depositors are forced to respond to other sources of information before the value of bank assets is revealed. One such source can be the failure of other banks. If banks' returns are highly correlated, a high bank failure rate implies that the returns of the remaining banks are likely to be low. Therefore, the uninformed will respond to this noisy information and withdraws. Keeping that in mind, the informed agent has to withdraw early as well, even if more precise information will soon become available. In this respect this model follows a common concept of herding models: Later agents, inferring information from the actions of prior actions, optimally decide to ignore their own information and act alike (cf. Devenow and Welch, 1996).

Chari and Jagannathan (1988) provide another information based story, in which a panic run is the phenomenon that uninformed depositors misinterpret liquidity withdrawal shocks as shocks caused by pessimistic information. They cannot distinguish informed investors that withdraw due to a simple liquidity shock from those that received a negative signal on the bank's assets. Contrary to Chen's model, a panic is defined as the ex-post mistake, depositors make during their information updating process.

An interesting model by Acharya and Yorulmazer (2003) combines the examination of liability side contagion and asset side correlation. While the first arises when the failure of a bank leads to the failure of other banks due to a run by their depositors, the latter is the result of a similar investment strategy. They argue that depositors interpret bank failures as bad news about the overall state of the economy. Hence, they will require higher promised rates on their deposits from surviving institutions. Respectively, they are satisfied with lower returns if banks experience good performance on their loans. Accordingly, the borrowing costs of banks are lower when they survive together than when one fails; i.e. banks experience an

[35] Refer to section on bank deficiencies.

information spillover from one bank's failure on their borrowing costs, which may eventually lead to other institutions' failure.

The banks respond to this potential result by adapting their investment strategy. The greater the correlation between the loan returns of banks, the greater the likelihood that they will survive together, is. Consequently, they will lend to similar industries and increase the inter-bank correlation; i.e. banks will herd. However, greater inter-bank correlation increases the risk of simultaneous bank failure if the industries, they lend to, suffer a common shock.

An empirical study in a similar spirit is conducted by De Nicoló and Kwast (2002), which assesses the relation of systemic risk and consolidation. It argues that, due to ongoing consolidation, individual institutions become more diversified, while the banking system as a whole has become more vulnerable to systemic risk. Consolidated firms have become more similar and, hence, more vulnerable, not only due to direct interdependences but also due to indirect interdependences, which, for instance, arise from exposures to the same or similar assets.

2.2.2.1.2. Financial contagion through capital connection

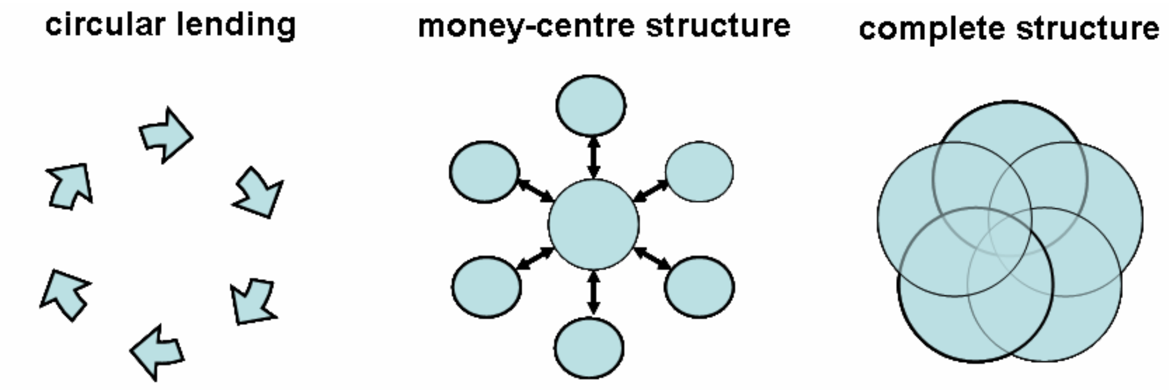
The following examples will provide a theoretical explanation of contagion via capital linkages between various institutions. Accordingly, in all these cases the transmission of a shock happens due a physical connexion, which is concerned with a trade off. On the one hand, an interbank system or a risk transfer market provides an insurance against liquidity shocks. On the other hand, it exposes a wider range of institutions to systemic risk. In a system, where illiquid institutions cannot be distinguished from insolvent ones, the interbank market is related to a lemons problem à la Akerlof (1970), such that good borrowers, i.e. banks, leave the market if the premature liquidation of their assets is cheaper than borrowing in the interbank market. Thus, the situation is even aggravated (cf. Huang and Xu, 2000). Rochet and Vives (2004) is another example based on asymmetric information, where interbank contagion emerges due to the refusal to provide liquidity to illiquid banks after an event.

Allen and Gale (2000) analyse the dissemination of liquidity shocks via the interbank market. Mutual lending and borrowing cause a physical exposure, such that a crisis in one region may easily spread to other regions because their claims on the troubled regions fall in value. Depending on the lending structure, the regions are more or less vulnerable to shocks. If the interbank market is complete, i.e. each region is connected to the other region, the initial impact of the liquidity shock in one region may be mitigated. Incomplete markets, such as a circular, i.e. a unilateral, lending structure, on the other hand, may have a more imminent effect on previously unaffected regions.

The circular lending structure in the interbank market and its possible implications, regarding the stability of participating institutions, is explicitly discussed by Eisenberg and Noe (2001).

Diamond and Rajan (2005) provide another example for contagion effects via capital connections. They show that bank failures can cause systemic illiquidity. This connexion is based on the fact that a bank's failure subtracts liquidity from the system and thereby raises the likelihood of failure of other banks due to liquidity shortages. A remedy, in the authors' opinion, could be the recapitalisation of at least a few banks, so that the system need not melt down.

A related model is presented by Freixas, Parigi and Rochet (2000). Physical interbank lending exposures are determined by uncertain consumption preferences à la Diamond and Dybvig (1983), although their focus is on the coordination of the consumers of the various locations, not on the coordination of the consumers in the same location. It is argued that a liquidity shock may make depositors run on even perfectly solvent banks, if they worry about insufficient liquid assets in the system. Based on three different scenarios - representing each a particular interbank lending structure (credit chain, diversified lending, and a money centre case) - the interbank exposures through credit lines are discussed. Failures are most likely to become contagious in the credit chain case, at least in comparison to the diversified lending case. When interbank lending is primarily organised via a money centre bank, the probability of failures becoming contagious, depends on the parameters of the model.



The figure depicts graphically the different ways the interbank market can be organised and as they are, for instance, characterised in Allen and Gale (2000) or Freixas et al. (2000).

Figure 3: Different interbank lending structures

In a model by Dasgupta (2004), it is discussed to what extent banks should be interconnected within banking systems. He shows that interbank deposits may not be a panacea against any regional liquidity shocks because they increase the bank's exposure to the risk of contagion, triggered by a run of depositor's on ailing institutions. The author concludes that, when bank runs are relatively frequent, only partial cross-holdings of deposits may be optimal and banks may prefer to increase their liquidity buffers against depositor runs. Correspondingly, unstable banking systems may be characterised by lower levels of optimal interbank linkages and higher excess liquidity buffers and vice versa. Hence, in stable banking systems, where the event of a bank failure is a rather rare event, the contagious consequences can be assumed to be much more serious due to the strong interconnectedness of the industry.

Contrary to the interbank system, there is rather scarce literature on the risk of contagion in securities settlement systems. One reason may be the virtual absence of principal risk, i.e. credit risk. However, it can be shown that large and persistent settlement failures are possible, even under sufficient liquidity provision. The reason is that securities transactions involve a cash leg and a securities leg, and liquidity – for instance, via central bank liquidity provision - can only affect the cash side. Unfortunately, during periods of market disruptions, market participants reduce their lending in securities. Devriese and Mitchell (2005) explore the potential consequences of these disruptions and find that contagion can be an issue in securities settlement systems.

2.2.2.2. The financial markets channel

Theoretical literature on contagion in financial markets is mainly about the propagation of price changes across markets and the channels through which a shock can disseminate. It is far less extensive than the contagion literature based on the banking channel.

One such – two-period asset trading - model is Kodres and Pritsker (2002) which focuses on contagion through cross-market rebalancing. Thereby, investors transmit idiosyncratic shocks, i.e. information shocks and liquidity shocks, from one market to others by adjusting their portfolios' exposures to shared macroeconomic risks[36]. Thus, the authors can show why emerging markets are especially vulnerable to contagion and why financial and exchange rate crises work as "catalysers" for contagion. The number of informed and uninformed investors plays an important role for the emergence of contagion, i.e. the higher the percentage of informed investors, the lower the risk of contagious shocks is.

Also simple portfolio rebalancing, following the rule of portfolio theory, may cause contagious effects, Schinasi and Smith (2001) argue, i.e. a shock to a single asset's return distribution may lead to a reduction in other risky asset positions. The extent of portfolio rebalancing mainly hinges on whether the portfolio is leveraged. If the return on the leveraged portfolio is less than the cost of funding, then the investor will have risky asset positions.

Another argument for the existence of contagion in financial markets is diversification of investment portfolios. Different countries' sharing of the same group of investors leads to the transmission of shocks from one country to the other. This contagious effect reduces the benefits of diversification because it generates positive correlation between the investments, even though these may be independent, in terms of their fundamentals. Goldstein and Pauzner (2004) use a self-fulfilling financial crisis model – set up in a sequential framework, in which the

[36] In order to take macroeconomic conditions as given, the model describes asset price movements over short periods of time.

events in country two take place after the outcomes in country one are realised - to draw their conclusions. Contagion is generated by a wealth effect. The model is solved through backward induction, i.e. it is analysed how agents in country two react to any outcome in country one. Based on this information, the equilibrium behaviour of agents in country one can be detected. Following a crisis, agents' wealth is reduced, which increases the tendency to run this country.

2.2.3. Driving forces of financial contagion

As defined earlier, contagion will, generally, be the result of some legal or factual connexion between the entities concerned. As such, consolidation of financial markets, in its broadest sense, may be seen as one of the main triggers for contagion, by increasing actual or assumed interdependence between market participants (cf. De Nicoló and Kwast, 2002). The drivers of this increased spillover in a consolidating financial market risk – which are also partly discussed in the theoretical literature - are hence explained in the next few sub-sections.

As consolidation is also related to improved diversification, it is not predictable if overall risks are raised under these circumstances. The business for companies with large diversified portfolios becomes smoother and, therefore, possibly less risky. The possibility to diversify the portfolio has a considerable impact. Nonetheless, the market definitely becomes more concentrated, with the result, that the failure of a key player may more easily affect other institutions.

A first foothold to judge upon the actual risk of spillovers between market players may be provided by the factors that constitute every risk. Risk is characterised by the following two determinants:

- probability of emergence and
- impact

Hence, a decline in either probability or impact does not necessarily mean that the overall risk declined, as well. As Dasgupta (2004) remarks, in stable banking systems the rare event of bank failures induces the most significant contagious consequences. While the former risk parameter probably diminishes in a highly consolidated environment, the latter may become more pronounced in a concentrated market (cf. Goldstein and Pauzner, 2004). The safety of key market players, such as money centre banks, is decisive for the overall market. The safety of these institutions has an imminent impact on the probability of risks becoming contagious (cf. Freixas et al., 2000).

The analysis of these drivers helps us in various respects for our project, although for some of these drivers the connexion to intra-group spillovers may not be immediately obvious:

- We get a rough impression, in which environment with regard to systemic risk, concentration, etc. the analysed groups are in.

- From the broader market we can derive similarities to the conditions within a financial group. The financial group may be regarded as a "fractal à la Mandelbrot" of the financial market.
- The information therein may be of importance for the question, to what extent, diversification may be considered in group capital requirements (cf. chapter 4).

2.2.3.1. Consolidation in a narrower sense

The integration of financial markets plays an important role in the assessment of externalities[37]. Interdependent financial markets are particularly exposed to systemic risks. Under these circumstances risks can spread more easily because the direct channels of contagion for disturbances to the financial system are increased.

One of these channels is cross-border establishments, which, according to Stolz (2002), is – besides the interbank market - the most probable channel of intra-country contagion. In this case, risks are no more limited to a certain market, but can spread easily across borders. These markets then become increasingly symmetric, thereby facilitating the transfer of risk. Elevated correlation increases the dependence between markets and, thus, facilitates the "import" of risks from foreign markets. The analysis of cross-border penetration and the concentration of the financial industry in the European Union (more precisely, EU-15) will provide us with first, rudimentary insights.

Contrary to common assumptions, statistics show that the level of cross border penetration of credit institutions in Europe has been quite stable during the last years and one can hardly detect strong effects from the common currency in the Monetary Union or from EU initiatives, such as the Financial Sector Action Plan (FSAP), whose main objective is to remove barriers for the financial business within the European Union. We could not observe significant changes in recent years.

Obviously, certain obstacles[38], which impede cross border business despite the endeavour of European decision-makers, still remain. Also, with regard to the recent and upcoming admissions of new EU member countries and the strong pursuit of self-interest by each single government, the process of integration may take more time than initially projected.

According to the figures reproduced in table 4, cross border penetration in the banking industry in the European Union remained relatively stable in the period from 1997 to 2003. These developments are similar in the European countries assessed, with Ireland, where the percentage of assets of branches and subsidiaries

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37 An extensive report on consolidation of the financial sector, its impact and potential policy implications is provided by the Group of Ten (2001).

38 One may put these barriers to integration in mainly five baskets: economic, regulatory, political, linguistic and cultural (cf. Heikenstein, 2004 and Padoa Schioppa, 2004). As long as strong differences remain within these areas, (full) integration of financial markets will face sometimes "insurmountable" obstacles.

from other EU countries decreased from 47 to 33 percent, as the exception to this rule.

Despite the continuously strong focus on domestic markets, we could experience some prominent mergers and acquisitions among European credit institutions in the last few years. According to statistics presented in "The Economist" (2006), seven of the ten largest cross-border bank mergers in Europe have taken place since the year 2000[39]. Several of these mergers concerned groups that were themselves the result of an earlier merger. Hence, we can observe a consolidation process in Europe with an outstanding volume, which is, however, much slower than initially expected.

country	1997	1998	1999	2000	2001	2002	2003
BE	23	21	20	22	23	22	21
DE	2	3	3	3	3	5	5
GR	n.a	n.a	n.a	n.a	n.a	18	19
ES	9	9	7	7	8	9	10
FR	6	6	9	12	11	11	10
IE	47	49	49	49	48	35	33
IT	5	7	7	6	5	5	5
LU	84	88	88	86	88	89	89
NL	5	5	4	9	10	9	10
AT	2	2	2	2	19	21	19
PT	13	19	12	21	24	24	26
FI	8	8	10	8	7	9	7
DK	n.a.	6	4	5	16	17	16
SE	2	4	3	5	5	6	7
UK	24	27	25	25	25	23	23
MU 12	9	10	10	11	12	12	12
EU 15	12	13	13	14	15	15	15

Note: n.a. = not available; MU = monetary Union

Figures are the assets of branches and subsidiaries from EU countries in terms of total assets of credit institutions.

Source: ECB, own calculations

Table 4: Cross-border penetration of banks in the EU (in %)

We experience similar results for the insurance sector. The share of foreign insurance branches in the local market is also quite weak and only accounts for about 19 percent of all companies in the EU 15 average[40]. Nonetheless, one has to take account of the fact that due to data limitations, subsidiaries could not be considered in the numerator of the ratios. The inclusion of subsidiaries may cause the higher numbers in table 5.

This similarly low level of concentration may be explained by factors such as the differences in national insurance laws, a lower potential to benefit from scale

[39] The seven mergers concerned are: HVB Group and UniCredit in 2005, Abbey National and Banco Santander Central Hispano in 2004, Banca Nazionale de Lavoro and BNP Paribas in 2006, Crédit Commercial de France and HSBC Holdings in 2000, Banca Antonveneta and ABN Amro in 2005, Bank Austria and HVB Group in 2000, and finally Unidanmark and Nordic Baltic Holdings in 2000.

[40] The two tables cannot be directly compared as the share of foreign banking institutions is expressed in terms of assets, while the share of foreign insurance branches is measured as a share of the total number of institutions. Unfortunately, we do not have any data on premia coverage for foreign insurers. Moreover, subsidiaries are not included in the ratios.

economies compared to other industries, or a small scope for product differentiation (cf. Swiss Re, 2006). However, there are strong differences between European countries.

Nevertheless, the consolidation process is expected to pick up again in the next few years, whereby M&A will play a more pronounced role than organic growth. Main drivers have, inter alia, been deregulation and increased competition, declining investment yields, globalisation, new regulatory and accounting requirements, etc. (ibid.).

country	1992	1997	2001	2002
BE	37	37	39	39
DE	10	13	14	14
GR	35	28	32	30
ES	6	6	11	11
FR	24	21	23	23
IE	47	30	27	27
IT	19	18	21	22
LU	32	21	15	15
NL	31	27	28	27
AT	14	14	18	18
PT	48	51	44	47
FI	5	18	28	31
DK	0	0	0	0
SE	3	5	7	6
UK	17	19	21	21
MU12	21	21	22	22
EU15	18	18	19	19

Figures are the number of foreign branches in terms of total companies.

Source: CEA, own calculations

Table 5: share of foreign insurance branches (in %)

The concentration of the business among some very big players and some niche players produces an ambivalent situation. As discussed at the beginning, risk is determined by the two factors, probability and impact. On the one hand, institutions become more diversified and, therefore, safer because more different products are offered, various markets are penetrated, a broader customer base is serviced etc. In other words, the diversification benefits accrued depend on the number of risk positions, the concentration of these positions and their correlation. On the other hand, the market itself becomes more concentrated, meaning that the failure of a particular market participant may affect others more severely and with a greater probability. It does not only impose losses on other institutions, but it can also create doubts about the health of other institutions (Mishkin, 1999, p. 680).

This seems to be a perverse situation: Diversification reduces the frequency of individual bank failures because smaller shocks can more easily be borne. However, from a systemic perspective, diversification makes the financial industry more prone to systemic failures in case of very large shocks (cf. De Nicoló and Kwast, 2003 or Goldstein and Pauzner, 2004). Without diversification, these shocks would only have an isolated impact. In other words, financial groups or conglomerates are better at absorbing small shocks, but, at the same time, are more exposed to shocks from anywhere in the system. Hence, systemic risk increases due to diversification (cf. De Vries, 2005).

Acharya (2001) explains this result with the help of a simple "model" considering two types of economies with two industries and two banks each.

In one economy banks are focused and each invests in a different industry. Those industries are assumed to be imperfectly correlated. As a result, both types of banks achieve hardly any diversification. The second economy represents the exact counter-example of the former one, i.e. each bank invests in both industries and can thus take advantage of diversification.

As a result, in the former economy the individual risk of each bank is higher. However, the joint failure risk is lower. While one institution may possibly be hit by a specific shock, e.g. related to the industry it is invested in, the other one might not experience any negative effects. On the other hand, in the latter economy the individual risk of each bank is lower due to its diversified portfolio, but they are more prone to fail together due to the high correlation of portfolios, that is, the joint default risk goes up. Hence, we experience a trade off between focus and diversification.

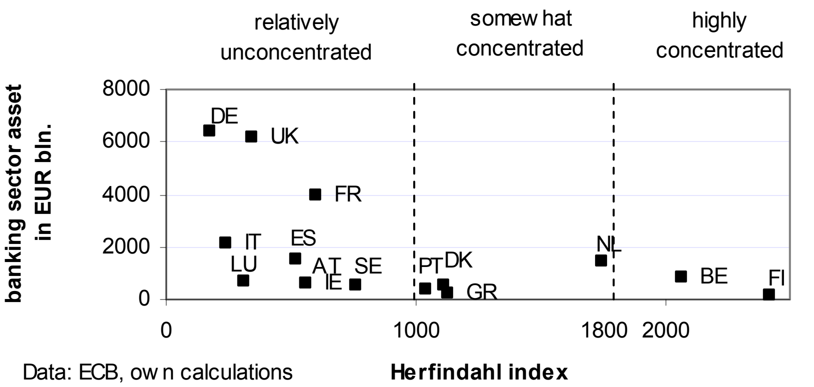
This result will certainly constitute a specific challenge for both rating agencies and supervisors. It will become indispensable to apply a broader perspective at an institution's assessment[41]. A focussed company examination may possibly not be able to reveal all risks, and may provide an incomplete picture of the actual conditions. Results may possibly diverge after the inclusion of the company's environment, meaning that different safety measures may be requested.

The data of the MFI statistics of the ECB[42] show that concentration is still quite low in European banking markets, implying lower risk of joint default. In figure 5 we plotted banking assets against market concentration and came to the following observations. While the smaller open economies are on average more highly concentrated, the large economies, such as Germany, the United Kingdom or France, are still weakly concentrated, with a Herfindahl index[43] far below 1000.

41 Rating agencies are currently adapting their assessment procedures and their ratings by taking the companies' environment into account (cf. Moody's, 2005).

42 ECB regularly provides data on monetary financial institutions of each member country (i.e. central banks, credit institutions, money market funds and other institutions) on its website.

43 The Herfindahl concentration index is calculated as the sum of the squares of each bank's market share. Its advantage is to more accurately reflect the entry of new and smaller banks, as well as the impact of a single bank with a large market share. Markets are generally assumed to be concentrated when the index exceeds 1800 and unconcentrated when it is below 1000.

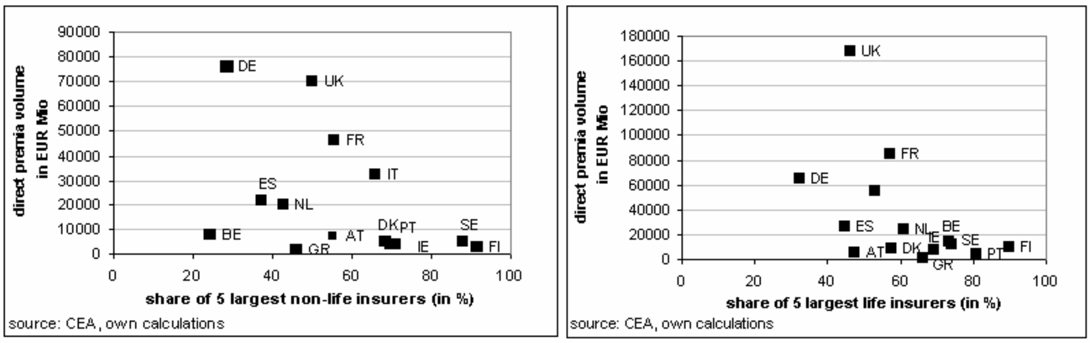


The example sets the concentration of the 15 EU banking markets in terms of the Herfindahl index in relation to the sector's assets. The borders of the concentration level are set to 1000 and 1800, respectively.

Figure 4: Market size and concentration in the banking sector in 2003

For the European insurance sector, no uniform answer can be given, as the results are neither homogeneous across countries nor across business lines as we can observe in figure 4[44]. To evaluate the numbers for the life-insurance sector and the non-life sector, separately, we provide a chart for each business line.

The share of the largest five companies lies in the range of about 24 percent to about 92 percent of the respective premia income in each country. Nevertheless, the larger economies in the EU, e.g. Germany, Spain, Great Britain or the Netherlands show a lower concentration than most smaller countries. As consolidation is taking off, these numbers are expected to change and concentration to grow.



The concentration of the 15 EU insurance markets expressed in terms of the share of the largest five life and non-life insurers respectively is related to the direct premia volume. Thereby, the size of the market is contrasted with its concentration.

Figure 5: Market size and concentration in the European insurance sector in 2002

Consolidated markets may also contribute to risk enhancement via indirect links that can still cause significant damage to other market players (cf. Trichet, 2005). A company might be forced to sell assets in an already downward-oriented market, as

44 Since no data for market shares of each company were available, the Herfindahl index for the insurance sector could not be calculated. As a proxy or reference we used the share of the five largest companies in each economy, instead.

a result of pressure from supervisors or rating agencies. This can provoke further price declines that may spill over to other agents' securities portfolios.

2.2.3.2. Financial groups and the convergence of financial industries

One main intention[45] behind the establishment of large groups is to to lower overall risk at the group level. Following portfolio theory, it is assumed that group risk is lower than the risk of the sum of the individual entities because strong variations in businesses can be averaged out. In the case of conglomerates, one may even argue, that they profit from the different risk dependence of the constituting companies and, thus, provide for the emergence of diversification potential. Slijkerman, Schoenmaker and de Vries (2005) indicate in their model that cross-sector risk dependence is lower than risk dependence between two firms within the same sector. As such, the downside risk of a group consisting of both types of institutions may be reduced, unless diseconomies of scope increased disproportionately.

However, it is also assumed that companies are most exposed to the risks of other institutions when those form part of a group or conglomerate. Albeit separate legal entities, they cannot be fully insulated from each other by establishing firewalls. On the other hand, if strict firewalls are established, these may prevent the generation of the full diversification potential at group level.

If it is not direct contagion only that affects the group, reputation effects or other forms of indirect contagion can do similar harm. Moreover, the potential diversification effects may be overestimated if the constituents of a group are in related businesses or continuously adjust to each other. In this case one may expect a rather high positive correlation between the business lines and as a result lower diversification effects (cf. Santomero and Eckles, 2000).

In conglomerates - or (even more) in highly integrated bancassurance companies - risks may also spread across industries. Moreover, the insurance part then also has to face classical banking risks[46], in other words, the affiliates are exposed to or hit by the same risks. Similar effects are to be expected when insurers assimilate banking activities (or vice versa), as this might cause assimilations in the balance sheet structure. Due to the assimilation of both markets, one may assume that the mutual influence of both sectors is considerably high, i.e. correlation should continuously converge.

Furthermore, even unrelated companies may become affected by a shock to a particular group member if companies are connected via capital relations and firewalls cannot effectively be established. Depending on the size of the shock and the importance of the primarily affected company, other affiliates may become affected as well in a second round.

[45] Other explanations are for instance the expansion of market power or the establishment of "empires" as a managerial objective per se (or as a defensive strategy), etc.

[46] Mind that an increased product range is also assumed to enhance potential diversification effects given, that products are not fully correlated.

In conglomerates, in addition to diversification, also negative incentive effects may impact the riskiness, as indicated by Freixas et al. (2006) or Boot and Schmeits (2000). Divisions may be encouraged to take on more risk as they can rely on the support of other group constituents in the case of impending bankruptcy. Moreover, contrary to stand-alone insurers, insurance divisions can implicitly take advantage of the banks safety net, in particular the deposit insurance system. Hence, depending on which effect – diversification or negative incentive effects for increased risk taking - outweighs the other, a conglomerate may be more or less risky than its stand-alone equivalents.

All these effects are not (fully) considered by portfolio theory and have to be accounted for as well to get a more prudent picture of the actual situation, that is, diversification effects, as calculated for a group portfolio[47], may be exaggerated and may need an add-on for the negative effects, not taken account of.

However, as subsequently shown, standard calculations on inter-industry linkages provide a picture, quite different to common perception, implying that adjusted interdependences between the industries in terms of correlation are still lower than expected. One argument for this result is that equity returns can be affected by developments on three levels: the overall market, a specific sector, or an individual institution (cf. Monks and Stringa, 2005). However, only the latter two factors determine the inter-linkage between two industrial sectors.

To judge upon the status quo of interdependences of industries, we measure the correlation between both markets (cf. European Central Bank, 2005), by taking both the Dow Jones Stoxx Banks Index and the Dow Jones Stoxx Insurance Index as references. Correlation is then calculated for the period January 1999 to June 2005, using a 52-week rolling window.

An adjusted correlation will filter out market-wide movements and will allow the focus on industrial developments or dynamics only. To take account of these developments, the Dow Jones Stoxx Total Markets is used as a general market index representing the market model.

The respective market returns are then regressed against this index. Then, the returns are adjusted correspondingly and the residuals correlated. The following return generating model, which is similar to the approach used for event studies (cf. Campbell et al., 1997), is estimated[48]:

$$R_{it} = \alpha + \beta R_{mt} + \varepsilon_{it}, \qquad (2.1)$$

where R_{it}[49] is the rate of return on the banks and the insurance index respectively at time t. R_{mt} is the rate of total market return, estimated from the Total Markets index, and serves as the market model. ε_{it} is the residual that determines the dynamics that

47 Cf. (Herzig and Mayr, 2005)
48 Another convenient method to estimate the market model and asset returns is CAPM.
49 Returns R_{xt} are calculated as continuous returns by subtracting the logarithmic stock prices, i.e. $R_t = \ln(P_t) - \ln(P_{t-1})$.

can be referred to industrial idiosyncrasies. The parameters α and β are OLS-estimates, calculated for each industry index.

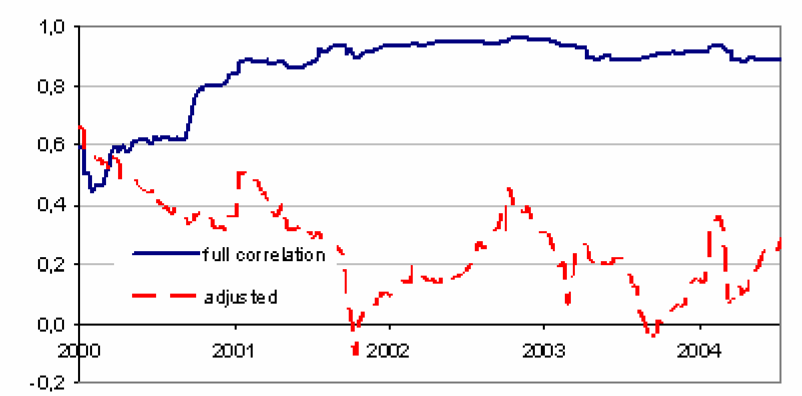
The aim is now to exclude general movements in the market in order to estimate the mutual influence of both sectors on each other. The part of the return that is not due to market-wide movements but to insurance or banking characteristics, and, thus, equal to the abnormal return ε_{it} or $\hat{R}_{it}$, is, hence, estimated as:

$$\hat{R}_{it} = \varepsilon_{it} = R_{it} - \alpha - \beta R_{mt} \tag{2.2}$$

(Pearson) correlation with a one-year rolling window is then calculated according to the following standard formula:

$$\rho = \frac{\sum_{i=1}^{n}(x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2} \cdot \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{2.3}$$

n is the number of observations, i.e. weekly data from January 1999 to July 2005; x and y are the respective banking and insurance index data, whereby $\bar{x}$ and $\bar{y}$ are the respective means.



full correlation: shows the development of Pearson's rho over time between DJ Stoxx Banks and DJ Stoxx Insurance index returns

adjusted correlation: excludes general market movements as represented by the DJ Stoxx Total Markets index

Figure 6: Correlation between European bank and insurance stock price indices

As shown in the preceding figure, unadjusted correlation between insurance and banking is particularly high. However, taking account of market-wide movements, correlation tends to be much lower, indicating that sector specific developments play a minor role for the other sector.

The strong influence of general market movements can also be shown by time-varying betas, which gauge the sensitivity of sector to market-wide returns. In other words, a beta converging towards one implies that markets experience strong integration, as returns then move simultaneously. This association is immediately obvious, when the estimate for the beta is recalled, which is:

$$\beta_{i,t} = \frac{Cov_{t-1}(\Delta R_{i,t}, \Delta R_{b,t})}{Var_{t-1}(\Delta R_{b,t})} = \rho_{i,b,t} \frac{\sigma_{i,t}}{\sigma_{b,t}} \tag{2.4}$$

where $\rho_{i,b,t}$ is the conditional correlation between the industry and the benchmark asset (in this case the general market), and $\sigma_{i,t}$ and $\sigma_{b,t}$ are the respective standard deviations of the price changes. Hence, $\beta_{i,t}$ depends on both the correlation between the yield changes and the ratio between yield volatilities.

Hence, when integration grows, yield changes should increasingly be driven by common factors, and the correlation should increase towards one. At the same time, volatilities should reach the same level. In the full integration case beta is therefore one, i.e. the share exactly follows the market.

As shown in figure 7, a high degree of commonality in the sectors' reactions to market-wide changes is evident, although sensitivities to general market developments vary between the two industries, i.e. banking and insurance. Banking seems to be more aligned with common market movements (cf. European Central Bank, 2005).

The high commonality in reactions to the market was already expected when assessing the correlation between European bank and insurance stock price indices. Otherwise, such a huge gap between full and adjusted correlation would not be observable.

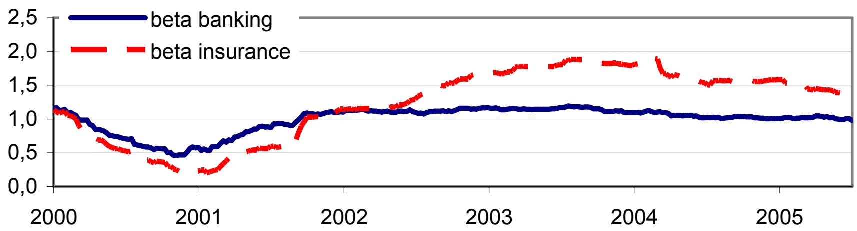


Figure 7: Betas of European bank and insurance stock price indices

2.2.3.3. Interbank market

Besides cross-border establishments, the interbank market – a network of mutual exposures of credit institutions - is another important direct channel for contagion in the banking market. On the one hand, interbank deposits enable the hedging against regional liquidity risk; on the other hand, the interbank market is a channel that exposes the participating banks to the risk of contagion (cf. Dasgupta, 2004).

If the industry consolidates, the same process could be expected in the interbank market. The market will become more concentrated and most of the deals will be transacted with so called "money centre banks". In such an increasingly complex network a shock on one of the more important players may easily provoke liquidity shortage for many other market participants and, in the worst case, contagious (i.e. a cascade of) failures (cf. Freixas et al., 2000).

The arguments are similar to the ones made for financial groups and conglomerates, only that more companies are involved, that is, the interbank network results in more institutions bearing certain risks together, thereby smoothing the risk for the individual institution. On the other hand, such a network is more prone to systemic risk than a number of unconnected institutions. However, as Franklin and Allen (2000) and Freixas et al. (2000) show, the exposure to contagion also heavily depends on the way interbank lending is organised, e.g. between money centre banks and other institutions, in a circular (or credit chain) lending structure or with many different counterparts.

Due to their size, money centre banks are better diversified and – abstracting from any potential moral hazard effects due to their too big to fail (TBTF) status[50] - therefore assumed to be safer than small institutions. But the failure of such an institution has a far-reaching impact. The insolvency, or even the illiquidity of such an institution, may trigger a domino effect in the banking landscape. Other banks may suddenly also face the risk of default due to strong financial linkages with primarily affected enterprises. As a result, we might see systemic effects as described in economic theory (cf. Allen and Gale, ibid., or Freixas et al, ibid.).

The assessment of current data on the European interbank market provides interesting results regarding the potential risk of contagion and its risk channels:

According to ECB payment statistics, cross-border payments make up for about 20 percent in volume and 40 percent in value. In the period from 1999 to 2004 these numbers have been quite stable. In absolute terms, both volume and value of transactions continuously surged every year and, thus, (over)compensated for the decline in the number of credit institutions in all European Union countries and, thus, the decrease in the number of market participants.

A more intensive view at the TARGET[51] statistics of the European Central Bank reveals further interesting implications for the assessment of interbank markets: Cross-border interbank transfers are, on average, significantly larger than domestic payments. However, the number of transactions is substantially smaller.

This result may be explained by the large number of small banks that are assumed to operate primarily within national borders. Large interbank payments, however, are essentially conducted by larger banks with few money centre banks as their counterparts. Hence, the values of these transactions are noticeably higher. The decline in the cross-border value per transaction - as seen in the figure – can be explained by a faster growth of volumes, compared to transaction values (126 percent surge compared to 56 percent). This relation is reversed for domestic interbank payments (50 versus 103 percent growth). Following Allen and Gale (2000), this form of interbank linkages is particularly prone to contagion.

Obviously, the interconnectedness between credit institutions via the interbank market is gaining in importance. Especially, cross-border payments represent a non-

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50 For financial stability and political reasons the government cannot afford to let such an institution go bankrupt.

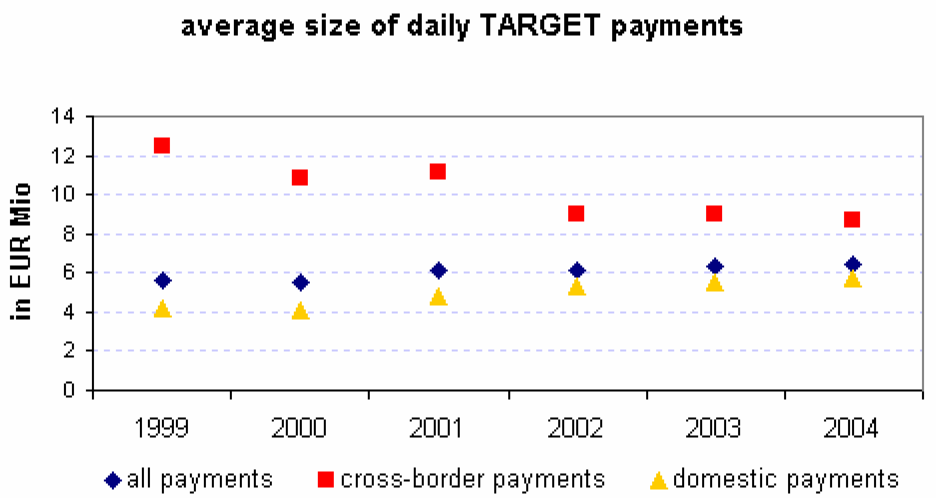
51 Trans-European automated real-time gross settlement express transfer system

negligible and decisive factor in the banking markets. Nonetheless, also the risk of contagion, together with a deeper integration of markets, increases due to a stronger connection with and interdependences between institutions and the large values concerned. Estimations of Gropp et al. (2006) indicate, that the introduction of the Euro and the ongoing integration of the European money market have increased cross-border contagion. According to them, after the introduction of the Euro, contagion has increased in multitude, while the effects seem to have remained stable.

Unfortunately, a more profound assessment of interbank linkages is hardly feasible due to public data limitations. Since the European Central Bank (ECB) and its member central banks can only provide data at an aggregate level, it is not possible to evaluate mutual interbank relations between participating credit institutions and to discover money centre banks and the true organisation of interbank lending.

Given that one had access to disaggregated data, it would be relatively simple to conduct scenario analyses and stress tests that enable the judgement upon the consequences of particular adverse developments, e.g. aggregate liquidity shortages, the failure of a money centre bank, etc.

In figure 9, we see the development of the average daily TARGET transactions in the six-year period from 1999 to 2004. As is immediately observable, average cross-border payments are considerably higher than domestic payments. Nevertheless, regarding the data points of the "all payments" averages, in addition, we recognise that the volume of domestic payments must still be higher. Otherwise, the average size of all payments could not be that close to the average domestic payment size. Put differently, the volume of cross-border payments is still lower than the volume of domestic payments, although the figures seem to be converging. Overall, these results imply that large banks start to act as money centre banks (Stolz, 2002).



ECB data, own calculations

The chart compares the development of the average size of European interbank payments in the period between 1999 and 2004. It is differentiated between domestic and cross-border payments. The results for all payments are derived from the respective sizes and the total amount of capital flows.

Figure 8: Average daily TARGET transactions

2.2.3.4. Risk transfer and reinsurance

Both (financial) risk transfer and reinsurance - as its counterpart in the insurance sector - are vehicles to limit the exposure to a certain risk and to promote liquidity in the market. While reinsurance is only available for (primary) insurers, other forms of risk transfer are traded on the capital markets. But the negative side, however, these markets do not only serve as a means to reduce credit risk exposure and as a vehicle of portfolio management but also open a new channel for contagion (cf. Allen and Carletti, 2005).

2.2.3.4.1. Risk transfer

Risk transfer is a transaction, where mainly credit institutions and insurers are involved in selling or assuming (e.g. credit) protection[52]. This process is both used to confine the risk of the protection buyer and to further diversify the protection seller's portfolio. Credit risk transfer products have become attractive due to their ability to separate credit risks off from the original credit transactions and to render them tradable in the market. Moreover, they can contribute to an improvement of liquidity of bank assets. The impact on overall company risk, one can expect from such transactions, depends critically on how the proceeds are invested. Thus, the resulting effect can be in both directions. But it is comprehensible that an institution that heavily participates in this market and reinvests the proceeds will have a

[52] Hedge funds are another group of financial institutions that play an increasing role in the transfer of credit.

completely changed portfolio risk position afterwards (cf. Krahnen and Wilde, 2006).

In the subsequent figure, the manifold options to transfer risk are outlined in a tree diagram, whereby a first differentiation is made between reinsurance – which is discussed thereafter - and other risk transfer methods that are available over the counter (OTC). A further differentiation concerns traditional and capital market products. For the latter category a large variety of respective products is available in the financial markets.

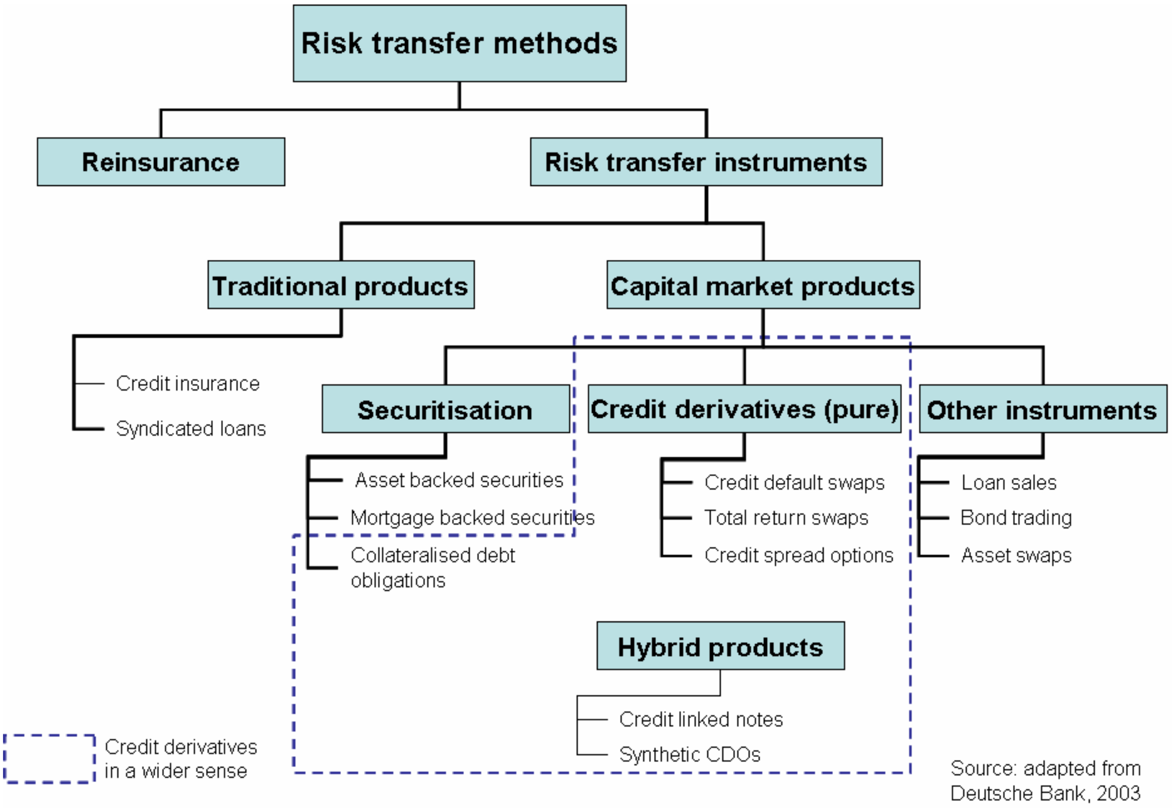


Figure 9: Risk transfer methods in the financial market

One may classify these products into three different branches, i.e. securitisation, pure credit derivatives and other instruments, or hybrid products thereof. The dashed line combines all products that can be subsumed under the umbrella of credit derivatives in a wider sense, but are not considered as such in a strict sense. Prominent examples are credit linked notes (CLN) and collateralised debt obligations (CDO), which also play an important role in the risk transfer market.

The most prominent example – due to its outstanding market share within the credit derivative market - is the credit default swap (CDS)[53]. Following its definition, in a CDS transaction the risk taker (i.e. the investor) makes a contingent payment to the risk seller if a predefined credit event – modelled according to the standards of the International Swaps and Derivatives Association (ISDA) - occurs. In return, it receives a periodic fee. Transactions take place on the OTC market, which allows

53 CDS make up for about 89 percent of the positions in the German market according to a Bundesbank survey in autumn 2003 (Deutsche Bundesbank, 2004a).

customising the product to the needs of both buyer and seller within the limit of ISDA standards, however, at the cost of liquidity.

Their outstanding importance can also be explained by the fact that CDS form the basis for more complex structured credit products, such as securitised products, e.g. collateral debt obligations, which, however, only cover a very small share of the market. Their advantage is that they include a substantial retention level by the risk shedder, i.e. risk is only partially, i.e. in tranches, transferred (cf. European Commission, 2002a). The most junior tranche is usually kept by the issuer, whereby its retention works as a signalling device in order to overcome informational problems[54] (cf. DeMarzo, 2005).

The use of special purpose vehicles (SPV) as intermediaries in the transaction may even limit the credit risk exposure of the protection seller to the protection buyer. The immediate deal, in this case, is not processed with the entity that requires the cover.

The Bundesbank survey 2003 also revealed that more than eighty percent of credit derivatives trade takes place in the interbank market, whereby a small share of large, internationally active banks dominate the market, due to their sophisticated infrastructure and their higher financial capacity. The remainder is shared equally between insurance companies, hedge funds and other enterprises. (Deutsche Bundesbank, p.34f, 2004a).

The attractiveness of (credit) risk transfer products is manifold. From an individual company's point of view these products can contribute to the diversification of the portfolio and play an important role in management's risk-return-decisions due to the separation of default risk and interest rate risk. Furthermore, it may be a convenient means to take advantage of capital or regulatory arbitrage possibilities, by transferring highly rated credit risk to non-banks, because Basel II capital adequacy requirements are based only on the default risk of the contracting party without differentiating between the companies. EU solvency requirements, for instance, do not depend on credit risk.

Additionally, also arbitrage opportunities with the bond market may be an incentive for transactions in credit risk transfer products. From a broader, stability-oriented, perspective an imminent advantage of this market is its contribution to a broader dissemination of risks on different market players. Thereby, shocks may considerably be smoothed as they are borne by a larger group of market players (cf. Deutsche Bundesbank, 2004b).

On the other hand, the risk transfer market may also contribute to instabilities in the financial system due to the emergence of new channels of contagion, the increasing inter-linkages between financial industries and the strong concentration among very

[54] This argument follows closely the signalling assumptions for entrepreneurs to attract investors, as outlined in the seminal paper of Leland and Pyle (1977). Adverse selection and moral hazard in credit derivatives are, on the other hand, an argument for the illiquidity of the market (Minton et al., 2005).

few large companies[55]. Thus, a certain credit event in the derivatives market could result in contagion due to reputation risk (cf. Chan-Lau and Ong, 2006).

Furthermore, an insurer that assumes risks of a bank does not only diversify its portfolio but it also incurs a credit risk. Via its assumption of credit risk it may become exposed to (banking) risks, it is possibly not familiar with. As long as this risk transfer remains within reasonable limits, this is not a prevalent issue.

Unfortunately, the assessment of the actual risk, transferred via credit risk transfer instruments, is a quite sophisticated task. While the notional amount of single-name transactions (e.g. CDS) accurately reflects the risk transferred, this is not the case for products that are sold in tranches (cf. IMF, 2006). Most of the credit risk in these products resides in the equity tranche which is traditionally kept by the protection buyer.

If a market is very concentrated, the withdrawal of one greatly exposed participant may have an immediate impact on the liquidity in the market, at least in the short term. In the medium term this risk may be compensated. In the worst scenario, however, this liquidity shortfall may result in the insolvency of other market participants.

The possibility to take advantage of capital arbitrage via the risk transfer market is another potential risk for stability (Allen and Gale, 2006). Market players' main objective may be primarily directed to circumvent capital requirements, thereby neglecting efficiency in the allocation of risks. Furthermore, credit risks may move away from highly to less-regulated financial players[56] (Deutsche Bundesbank, 2004a). Another worry concerning financial stability is the decrease in transparency in the financial markets due to credit risk transfer processes. Effective credit risk positions are more difficult to estimate and the risks incurred are more difficult to assess.

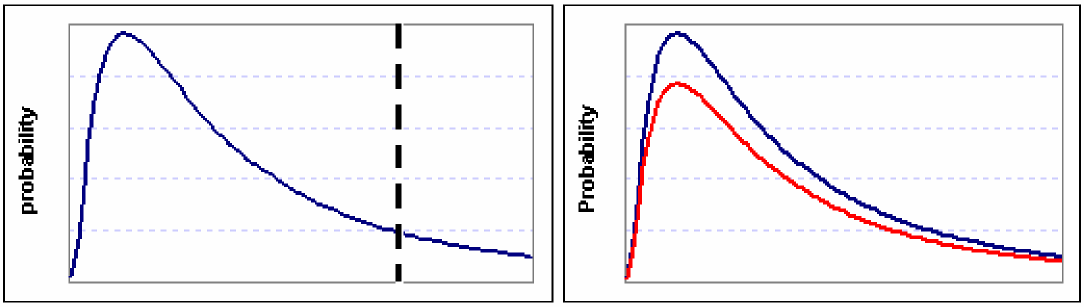
2.2.3.4.2. Reinsurance

Reinsurance is a similar and convenient method for the primary insurer to limit its risk exposure, for instance, the peak exposures, i.e. reinsurers inherit all the risks the primary insurer cannot bear. Furthermore, the reinsurance market serves in some way a similar purpose as the interbank market for credit institutions.

Principally, there exist different types of reinsurance. The reinsurer may cover one particular risk, which is called a facultative arrangement. These contracts are commonly used for risks beyond the capacity of usual business arrangements. Treaty arrangements, on the other hand, apply to a group of risks, i.e. the reinsurer agrees to accept all business written by the cedant, which falls within the specific terms of the contract. Individual risks do not have to be negotiated.

[55] Compare to arguments on contagion risk in the interbank market.
[56] If risk is transferred to hedge funds even a non-regulated institution is concerned.

The cover can be proportionate or non-proportionate or represent a mixed form. While the former contract compresses the risk profile of the primary insurer, the latter truncates the loss distribution of the ceding insurer, implying that any loss amount exceeding the priority will be assumed by the reinsurer. When insuring the market's peak exposures, reinsurers inherit all the risks primary insurers cannot or do not want to bear.

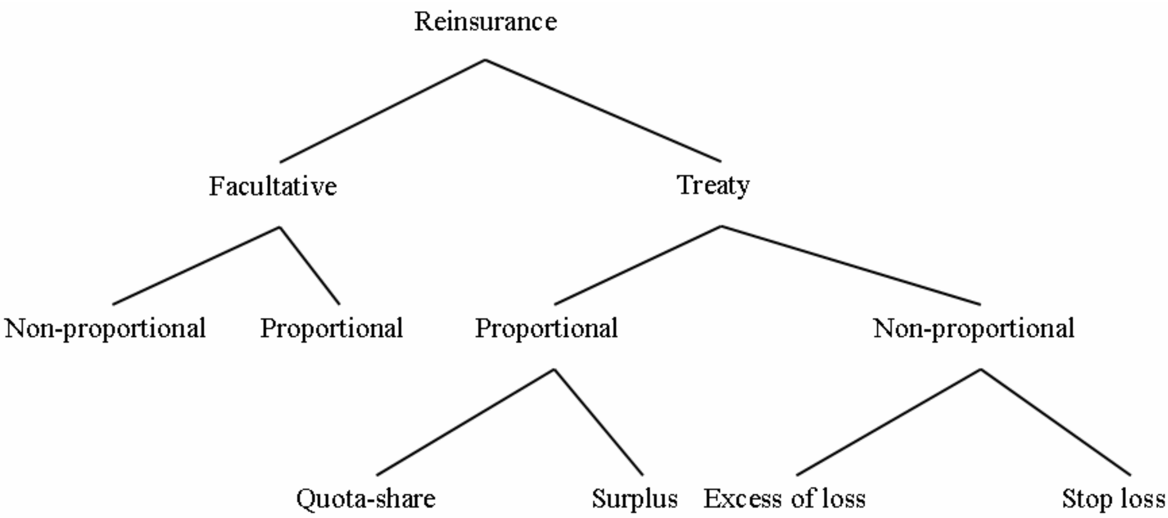


The left diagramme shows the density of a highly skewed risk that is reinsured unproportionately. The vertical dashed line represents the treshold of reinsurance.
The right diagramme shows the change in risk for the primary insurer when proportionate reinsurance is purchased.

Figure 10: example for densities of unproportional vs. proportional reinsurance

Proportional and non-proportional reinsurance contracts, as shown in figure 10, can be subdivided further. The former may be classified into quota-share and surplus arrangements. In a quota-share contract the reinsurer simply reinsures a fixed proportion of every risk accepted, while under a surplus contract only the portion that exceeds the retention limit of the primary insurer is (proportionally) covered. Non-proportional contracts are either excess of loss treaties or stop loss contracts. In an excess of loss treaty, the reinsurer agrees to accept all claims exceeding the retention limit up to a stipulated limit, the so-called excess point. A stop loss treaty is a form of reinsurance that limits the primary insurer's loss ratio[57].

57 The loss ratio is calculated as the ratio claims incurred to premium income.



Source: European Commission (2002)

Figure 11: reinsurance arrangements

Since the reinsurer highly depends on the primary insurer's underwriting ability, special additional contract clauses may be agreed upon in order to reduce moral hazard and to make reinsurance contracts incentive-compatible. These clauses may consist of profit commissions; loss participation clauses, profit sharing, etc. (cf. European Commission, pp.44f, 2002a).

In contrast to artificial financial market products, the potential impact of reinsurance is immediately apparent, albeit partly dependent on the type of arrangement. Reinsurers, accepting a certain amount of the primary insurer's underwriting risk, pose an immediate credit risk to this enterprise[58]. This risk can become contagious when the reinsurer is unable or unwilling to perform because in this case the primary insurer has to bear the full risk. There is no legal relationship between the reinsurer and the policyholder.

Therefore, a reinsurer that does not perform may provoke the primary institution's failure if the costs of fulfilling the contract are far higher than previously expected. Some experts even argue that the financial failure of a large reinsurance player may have consequences to the overall insurance sector and even across markets because a small number of reinsurers dominate the whole industry.

2.2.3.5. Outsourcing

Outsourcing concerns the use of a third party to perform activities on a continuing basis that would normally be undertaken by the entity itself and is increasingly sought as a means for both reducing costs and achieving strategic aims (Joint Forum, 2004). It is a popular vehicle for financial groups that, for instance, set up a

58 Diverse methods exist to swap this credit risk against another risk (e.g. market risk). However, from a business standpoint, it might not always be economically reasonable to evade a certain risk.

centralised resourcing entity for administrative or other functions shared by the group as a whole.

The advantage is that outsourcing allows the exploitation of economies of scale and the focus on the enterprise's core business and hence the company's competitive advantage. Free resources can then be used more effectively, i.e. more aligned to the core business.

Extreme examples are virtual companies, e.g. online banks, insurers and financial services that even outsource operations to the ultimate customer. Several companies may take advantage of the outsourced facility and may also share the costs for its utilisation. So, it is increasingly common to have IT-centres for several financial institutions.

As a drawback, immoderate outsourcing may possibly result in considerable concentration risk. Company portfolios may become too focussed and diversification effects may shrink accordingly. In the final analysis one may realise higher overall portfolio risk. Therefore, ultimately costs, as originally intended, may not shrink to the extent expected.

Moreover, outsourcing gives rise to operational risk for those group members, for whom functions are performed[59], since any failure of or interruption in the performance will be likely to result in loss to them (cf. Freshfields Bruckhaus Deringer, 2003). Shared data warehouses or IT-centres represent classic examples for outsourced and jointly organised entities, which, however, may also give rise to the risk of contagion. The outsourcing institution remains, to a certain extent, exposed to the risks of the outsourced entities. If outsourced entities also interact directly with clients, even reputation risk – a special form of contagion - may become an issue for the outsourcing enterprise.

2.2.3.6. Extreme events

Extreme events – characterised by their infrequent occurrence and the high impact involved[60] - are of particular interest at least for two reasons. They are usually assumed to be unpredictable and infrequent but may lead to sizeable losses. Due to the low frequency of catastrophes, risk estimates based on statistical evidence of a short historical period only cannot be conducted, as catastrophe risk might then be ignored[61]. Second, they have the characteristic that risks become highly correlated during the event, even if these risks might look almost independent in "normal"

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59 Diverse contractual agreements may allow the mitigation of the outsourcing risk in this particular respect.

60 More technically, extreme events can be described as one-time shocks from the extreme, adverse tail of the probability distribution that are not adequately represented by extrapolation from more common events.

61 On the other hand, if an extreme event is included in the experience data, estimating risk and expected liabilities on the basis of that experience may produce overestimations. Therefore, extreme events should be recognised in a separate category (IAA Insurance Regulation Committee, 2002).

times and, as such, cannot be measured by simple (linear) correlations that do not sufficiently take account of the tails of the distribution.

Under such extreme circumstances risks may easily spread across businesses or even across markets and may hurt more agents than initially expected. For instance, the credit risk[62] a primary insurer has assumed via its contract with a reinsurer may suddenly become imminent due to an impending default of the reinsurer that has, for instance, accepted to bear all the excess losses in a catastrophe but did not commensurately provide for the ceded risk. Increasing dependence during extreme events may confront the reinsurer with a relatively concentrated risk portfolio.

For a group such an extreme event can represent an enormous burden because several affiliates may suffer simultaneously. Moreover, usually strong linkages between group constituents exist. This may oblige them to support financially ailing companies although this support might ultimately also harm companies that were not affected directly. Thus, the group is hurt in two ways: several affiliates are affected simultaneously by the event and the intra-group linkages also contribute to a further transmission of the risk, or, more precisely, of its consequences.

Therefore, those risks can hardly be offset. The usual diversification arguments for a group are hardly valid under extreme conditions and capital adequacy requirements, based on normality assumptions, do only insufficiently take account of these situations.

Traditional models do not sufficiently consider the tails of distributions, i.e. those areas that are relevant for extreme events. Simple extrapolation from "normal", more common events cannot adequately reflect those events. Extreme value theory (EVT) that covers the distribution of the maximum value of a sequence of random observations and the distribution of the excesses over a high threshold has only recently become of more public interest (cf. European Commission, 2002b).

Due to the long-term nature of many contracts, insurers must have a particular interest in the consideration of extreme events. The time horizon of the assessment has to be long enough to capture the impact of those extreme events and the associated tail dependence.

Nonetheless, empirical data may still not be able to commensurately cover the full extent of such a "one in x-years" event, i.e. empirical (historical) data may considerably deviate from real data.

Principally two different kinds of models have been established to model catastrophes or other extreme events: (a) block maxima models, which are models for the largest observations collected from samples of identically distributed

[62] Theoretically, this credit risk can be circumvented by the issuance of catastrophe bonds because the issuer cannot be affected by a default by the risk taker. The investor has to provide the money up-front. Nevertheless, the market for cat bonds is still relatively immature, i.e. bid-offer spreads are high as the number of investors is small and, therefore, the liquidity of the products low. Given that investors accept these products and the market becomes mature, risk shedding via the capital market should become less costly because a reinsurer can never be as diversified as a liquid capital market. Another advantage is that there is no time delay in payment of the damage compensation.

observations and (b) threshold exceedances, which describe the behaviour of all observations that exceed a predefined high level. For practical applications, the latter are, however, assumed to be more useful models. They address the question: given an observation is extreme, how extreme might it be (McNeil, 1996)?

The main distributional model for exceedances over thresholds is the generalised Pareto distribution (GPD)[63]. It is defined by the following cumulative distribution function:

$$CDF: \quad G_{\xi,\beta}(x) = \begin{cases} 1-\exp(-x/\beta) & \xi = 0, \\ 1-(1+\xi x/\beta)^{-1/\xi} & \xi \neq 0, \end{cases} \tag{2.5}$$

where $\beta > 0,$ and $x \geq 0$ when $\xi \geq 0$ and $0 \leq x \leq -\beta/\xi$ when $\xi < 0$. The parameters ξ and β are referred to as the shape and scale parameters, respectively. The GPD is called generalised because it subsumes other distributions under its parameterisation. When $\xi > 0$, we obtain a reparametrised version of the ordinary Pareto distribution[64] with $a = 1/\xi$ and $k = \beta/\xi$; when $\xi = 0$ we have a exponential distribution and when $\xi < 0$ it is a short tailed Pareto II distribution.

The role of the GPD, as mentioned, is to model the excess distribution over a high threshold, whereby this excess distribution is simply defined as:

$$F_u(x) = P(X-u \leq x \mid X > u) = \frac{F(x+u)-F(u)}{1-F(u)}, 0 \leq x < x_0 - u, \tag{2.6}$$

where u is the threshold and X is a random variable with distribution function F. The Pickands-Balkema-de-Haan-theorem (cf. Embrechts et al, 2005) proves that in the limit the excess distribution converges to the GPD and, hence, provides a convenient distribution for modelling excess losses over high thresholds. As such, the GPD is a good measure for extreme events if a high enough threshold is chosen:

$$\lim_{u \to x_F} \sup_{o \leq x < x_F - u} \left| F_u(x) - G_{\xi,\beta(u)}(x) \right| = 0 \tag{2.7}$$

In the following graph, we illustrate the generalised Pareto distribution with a constant β-coefficient of 1 and three different values for ξ, i.e. -0.5, 0 and 0.5 as parameters for the Pareto II, the exponential and the Pareto distribution respectively.

[63] For a detailed description of extreme value theory and, GPD in particular, refer to Embrechts et al. (2005).

[64] CDF of Pareto distribution: $CDF: F(x \mid a,k) = 1-\left(\frac{k}{x}\right)^a; k \leq x < \infty; a,k > 0$

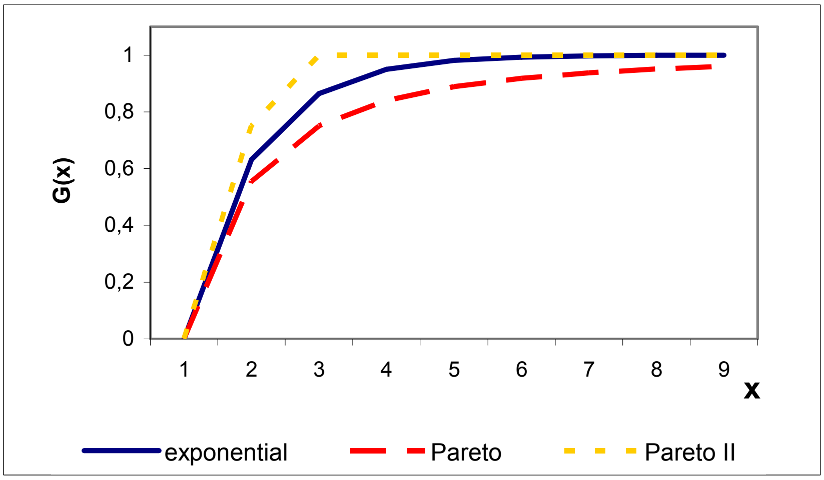

Figure 12: Distribution functions of GPD in three cases (illustration)

3. Analytical discussion and empirical derivation

While in the preceding sections the topical reflection on contagion and other risk spillovers was more general, we now intend to take a more intensive focus on intra-group spillover effects and the consequences, thereof.

First, we analytically derive the main factors and determinants of risk dissemination in financial groups and analyse the consequences of strong physical or publicly perceived interdependences between group constituents on a theoretical basis. The former concept borrows from research on the interbank market and the bank linkages therein and the latter aspect is a common issue in the explanation of domino effects or contagion in the banking industry. The strong difference to this research, however, is the assessed market. Here, we regard the financial group as a kind of "micro-cosmos" within the financial markets. We argue that equivalent or even identical rules and "laws" apply, only that fewer entities are concerned. One may, for instance, compare the parent company with that of the government or the central bank in the financial markets. It may also fulfil the function of a lender of last resort and will have to weigh up, whether to support its ailing subsidiaries. The subsidiaries constitute the "market" within the group. In conglomerates, both the banking and the insurance market are represented.

In this sense, the theoretical or analytical part is related to diverse papers on default correlation and the interbank market. The concepts therein are, however, often considerably adapted and extended to our special purposes, i.e. the analysis of intra-group dependences.

Secondly, we test empirically how those company interdependences become manifest, by analysing various public data, such as share prices, credit spreads, accounting data or combinations of these. Various methodologies are applied to test potential negative consequences of strong physical linkages or perceived interdependences of group constituents.

To our knowledge, there has not been any similar empirical research on intra-group spillover effects and contagion. The particularity of this work is its intensive focus on the sequence of internal group events and its intent to derive any conclusions on group risks that are frequently overseen. In contrast to common research, it is not intended to judge upon the consequences of external shocks on the financial market in total. We look at (intra-group) events that play a decisive role in the assessment of the overall safety of the financial group but that need not necessarily have systemic implications.

3.1. Assessment of group contagion – analytical approach

After having introduced the basic economic rationale of financial institutions with regard to their deficiencies and having provided a short glance at potential triggers and sources of contagion in the market, we will explain, analytically, the relevant aspects of contagion in the financial industry. Contrary to most research papers that regard spillover effects within the whole economy (or at least in the industry), the emphasis will now be put on the dissemination of risks within a narrower environment, i.e. the financial group or conglomerate[65]. In section 4, we will then also include the aspect of diversification for our final analysis of group risk.

This approach stands in strong contrast to the literature on financial groups that primarily emphasises the potential diversification effects that are due to the wider portfolio of groups, in comparison to independent, stand-alone companies. These (industry) papers are strongly based on portfolio theory, but possible countervailing effects are not commensurately accounted for.

As long as regulatory rules are not finally implemented, as in Basel II, or completely designed, as in Solvency II, the industry is lobbying for a group capital discount for diversification, accrued in a larger group portfolio. Supervisors, on the other hand, are emphasising on negative externalities in financial groups, whose impact they can only explain theoretically, but for which they have no empirical evidence due to clear data limitations. Eventually, both counterparts have to reach a conclusion that takes account of both effects, such that the level of risk capital to be held remains sufficiently prudent.

The simple assessment of the individual company - without taking account of the wider system the institution is belonging to - may ignore certain aspects of safety that could be considered by taking a more holistic approach, that is, supervisors have to assess the individual institution with respect to its environment and the mutual effects the interrelations thereof may have. Enterprises, however, will only consider effects, by which they are directly affected themselves. They do not have to bother about the consequences on other institutions or entities.

Contagion, as a countervailing force, has to be taken into account by regulators, if accepting a diversification discount on capital adequacy requirements. The challenge, however, is the assessment of these risks, which is related to a higher data requirement.

While contagion between large internationally active organisations may also be assessable with the help of publicly available data, e.g. share prices, the situation is different for groups where several constituent companies may not be listed, their shares may not be liquid or they may belong to another industry, etc. Therefore, other methods than those commonly used for the assessment of contagion may

[65] For the sake of simplicity, no distinction is made between financial conglomerates and groups covering only companies of one single industry, although one may assume that differences in the propensity to contagion can be expected due to the difference in structure and modus operandi of banks, insurers and companies of the real economy.

become necessary. A clear understanding of capital linkages will become indispensable.

3.1.1. Contagion within groups

The nature of contagion in groups is based on the same principle as provided in the general contagion literature and as outlined in a preceding chapter. The same definition of this concept is valid, that is, contagion is still "…*the process by which liabilities, losses and events affecting a particular entity may affect another legal entity, resulting in loss or the risk of loss to that other legal entity"* (Freshfields Bruckhaus Deringer, p.19, 2003).

Despite this fact, there are certain restrictions. Only spillovers of group constituents can be regarded as intra-group contagious effects. External shocks are only relevant if certain group affiliates are indirectly affected, i.e. via (capital) linkages with an affected group company.

As such, for this research project the group is a kind of "micro-cosmos" within the financial industry, whose borders can be clearly defined. All companies of the group are regarded, irrespective of their industry affiliation, i.e. even non-financial affiliated companies may be regarded because those may also affect the safety of the group.

Despite this clear separation, one has to keep in mind that the impact from outside the group may be particularly strong and hence may dilute the assessment of intra-group effects. This may be the case when, for instance, industry or regional effects are stronger than group effects or group interdependences. It is therefore required to be aware of these potential effects and take them with caution.

For that reason, it is indispensable to distinguish direct effects from indirect or second round effects. For instance, the failure of a big stand-alone company that triggers a domino effect in the industry can be subsumed under the notion of contagious effects. It is even the classic example of contagion. Despite this fact, it is not necessarily part of this research project, due to the aforementioned arguments.

If the failure of this big stand-alone enterprise, on the other hand, provokes particular stress for a certain group affiliate, which than in a second instance causes the tumbling of another not directly affected group affiliate, one is again concerned with the case of intra-group contagion.

The particularity of this ("second order") contagion is, that it would not have taken place without the group interdependence. The capital interdependence of the respective affiliated entities may cause a sudden illiquidity of the entities, not directly affected by the shock. In other words, the group is regarded as a potential source of contagion effects as it allows easy dissemination of risks across companies.

3.1.2. Main determinants of contagion

Basically, two factors are highlighted that are assumed to be the main determinants or drivers of contagious effects, that is, both simple negative spillover effects - for instance due to physical interdependences - and correlation-based effects within groups are taken into account[66]. Positive spillover effects are usually not regarded further because they do not represent a risk to the group. Similarities are most likely to be found in the financial contagion literature, e.g. regarding the interbank market as channel for spillovers and the literature on information based contagion.

The physical linkage between the group constituents, i.e. between subsidiaries and between parent company and subsidiaries, is a source of pure contagion and may even concern affiliates that have no other relation but the capital linkage. The externality spills over, regardless of the cause of the company's difficulties. The probability of infection is not dependent on industry affiliation or any other arguments besides the capital relation.

The second argument, we emphasise, is the correlation of portfolios, whose determinants are manifold as illustrated in the subsequent figure. If company portfolios are strongly correlated, they may be affected by information-based contagion. An affiliate's failure may be caused by problems, whose revelation is correlated across the group, and the correlated affiliates experience a negative impact.

Figure 14 briefly illustrates the arguments above and shows how contagion is triggered. For both main factors of contagion numerous examples can be found in the literature, as provided in the short review in section 2.2.2. Contrary to those examples, however, we do not take these factors as "ingredients" for a model but analyse them as such, in order to explain the institution's propensity to all kinds of spillovers.

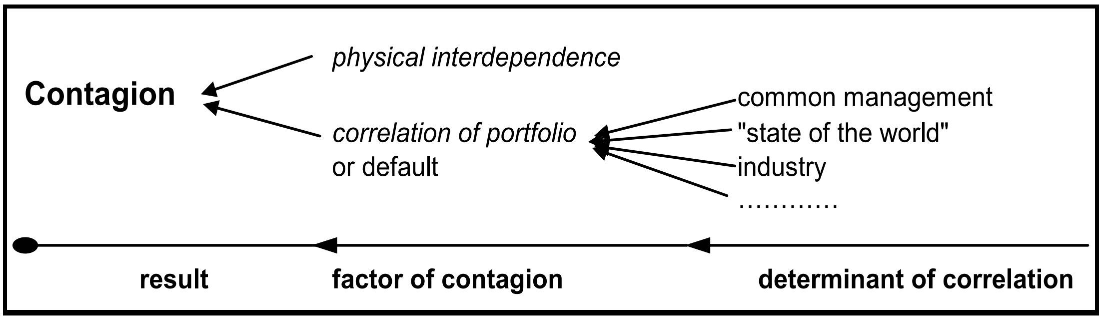

Figure 13: Triggers of contagion

Mainly for the sake of tractability, the analytical assessments of intra-group spillovers are constrained to groups with a decentralised structure. Those companies, belonging to a (decentralised) group, have to be sufficiently independent to have their own capital base and portfolio, although they may be

[66] Both determinants are discussed in different strands of literature, whereby the correlation based literature is much more extensive (cf. Furfine, 2003).

controlled by the same management or a holding company without any operational activities.

Following the categorisation in figure 15, only the first three models are considered, whereas integrated groups are excluded on purpose. The strong integration does not allow a meaningful separation of the respective entities in order to measure any risk dissemination and, hence, prevents the assessment of intra-group contagion.

Nevertheless, one may assume that any effects would disseminate more easily and more quickly within fully centralised groups. These groups, basically, have one single portfolio and the affiliates are similar to profit centres that depend on the capital allocation by the top management.

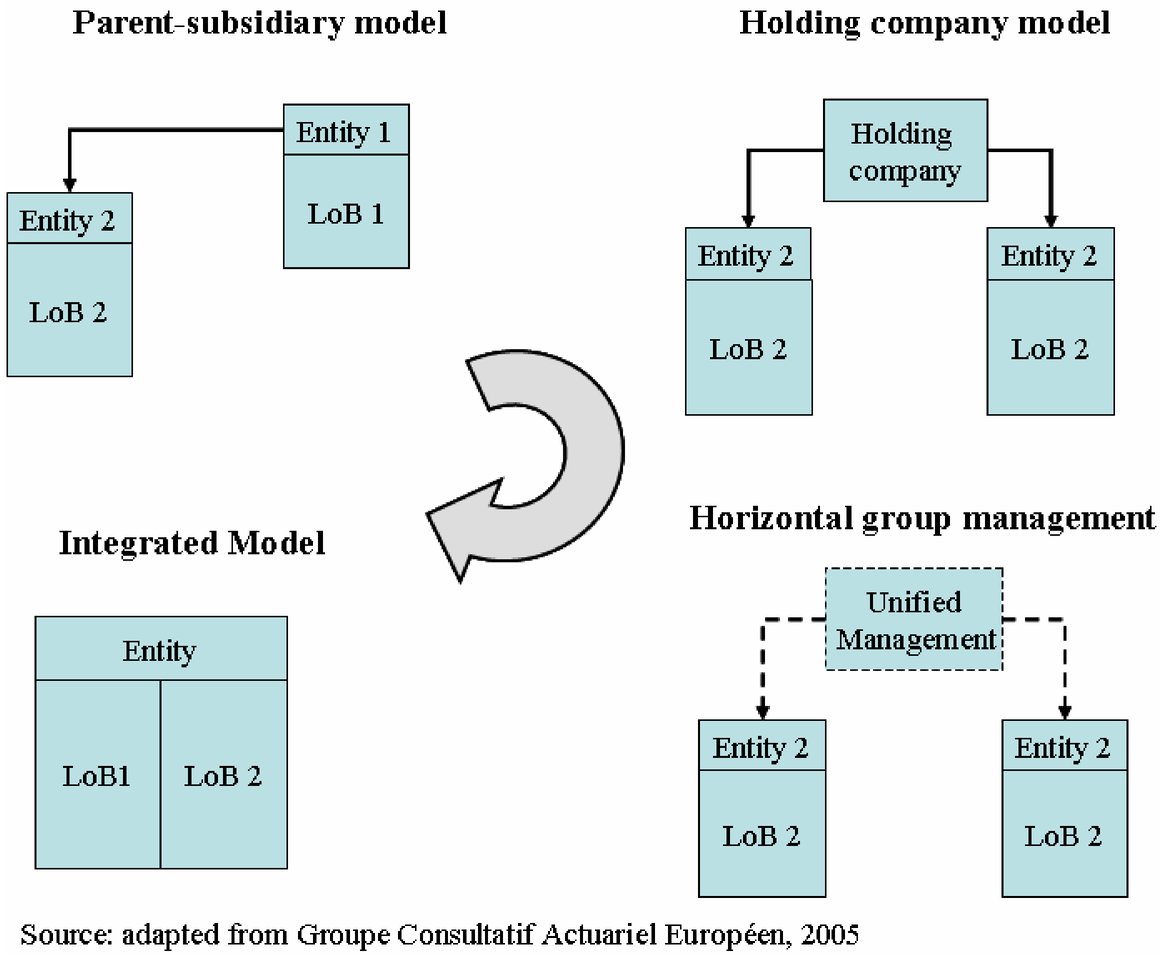

Figure 14: Level of centralisation

The degree of integration and the group structure will have a considerable impact on both physical linkage and portfolio correlation and, eventually, on overall group risk. This argument is also supported by Freixas et al. (2006) or Dewatripont and Mitchell[67] (2005), who emphasise that the constituents of an integrated conglomerate may take on excessive risk in comparison to its stand-alone counterparts. Since the deposit insurance scheme is implicitly extended to the

[67] While Freixas et al. (2006) primarily focus on capital requirements for conglomerates, Dewatripont and Mitchell (2005) essentially consider the rationale for building conglomerates.

insurance part of the conglomerate, integration may additionally encourage risk taking.

Each of these corporate structures has its advantages and inconveniences regarding group risk and contagion. Implications from the corporate structure are similar to those derived by Allen and Gale (2000), who examine potential contagion effects via the interbank market. If the group structure is complete, i.e. each constituent institution is symmetrically linked to all other companies, then the initial impact of any spillover may be mitigated. Incomplete, unilateral lending structures – e.g. with the holding company[68] as the main lender - will have a more imminent effect on the group as a whole.

The analytical approach used is conducted at a rather abstract level, albeit being well aware that most data on interdependences of group affiliates are not publicly available. A satisfying, empirical justification of theoretical ideas cannot be provided. Moreover, public data such as share prices or credit spreads (if available), are usually strongly biased and the informative content of these data have to be taken with caution.

3.1.2.1. Correlation of company defaults[69]

The use of standard default time series in order to measure probabilities of default and correlation of default between two companies is not a valuable or sufficient means for group companies. As Ashcraft (2004) shows, the group structure, or the parent company in particular, may be a source of strength to the various member institutions. Ailing companies can expect to receive capital infusions, e.g. in the form of intra-group transactions, which stand-alone companies cannot. Therefore, assuming similar data characteristics for stand-alone companies and group affiliates may be at least misleading. Due to data limitations, it may also be difficult to apply historical (default) time series.

For a similar reason, it is also not practicable to use available ratings for the assessment because these individual ratings usually incorporate the financial situation of the whole group. In other words, a bad rating for the parent company will have an impact on the rating of the subsidiary company and vice versa. On the other hand, rating agencies also incorporate any form of explicit support, e.g. capital infusions, guarantees, different collaterals or pooling arrangements, and implicit support - i.e. the anticipated future support likely to be available due to a subsidiary’s strategic or financial importance within the group - in their company ratings (cf. A.M. Best, 2005).

[68] Compare with money-centre structure in Freixas et al. (2000).
[69] Default is taken as a synonym or proxy for any severe negative event, with considerable impact on the financial condition of the company. However, ultimately, it need not necessarily end in the institution’s winding up.

Rating agencies, such as Moody's (cf. Moody's, 2005), now also start to take account of country or government impact. In particular, the country rating and the probability of governmental support in extreme situations, which depends on several influential factors, is considered. These factors may be the risk of contagion effects, the market share of the institution, and the strategic or political importance of a certain company, the safety of the financial system per se, etc.

Additionally, one has to be aware that rating changes do not highly fluctuate. They only take place when it is assumed that they are profound and stable, such that they do not have to be revised after a very short period. In short, rating agencies react slowly and take notice only of longer-lasting effects, when it can be assumed that the company (or the group) will recover easily to its initial state of safety after a short period of time.

Subsequently, we will analyse analytically and in a stylised way, the impact and probability of company default correlation on a (financial) group. The impact is not explicitly analysed, although it is assumed to be particularly high in groups, due to the small number of entities that have to assume it. Thus, the results may still give evidence on the potential risk.

One may assume the analysis of a decentralised group, consisting of at least two constituent companies (i=2,…n). Examples 1 and 2 in figure 15 may represent possible group structures considered. In these cases affiliated entities are sufficiently independent to allow for a separate consideration of each institution's default risk.

For the sake of simplicity, it is assumed that all companies do business in the financial industry, such that default correlation is also intuitively understandable. The pair-wise default correlations within the group may be defined as the correlation of an indicator function (cf. Wahrenburg and Niethen, 2000 and Zhou, 1997).

$$V_i = \begin{cases} 1 \; if \; i \; defaults \\ 0 \; otherwise \end{cases}, \forall i = 2,...n \text{, whereby } V_i \text{ is the value of company i.} \tag{3.8}$$

$$prob(V_i = 1) = p_i \quad \text{and hence}$$
$$prob(V_i = 0) = 1 - p_i \quad \text{as its counter} - \text{probability}$$

In words, the probability that company i defaults is equal to p_i and, that it survives, is $1\text{-}p_i$. Based on this information mean and variance can be calculated, which are – due to assumed homogeneity of the units - supposed to be the same for each affiliate.

$$\begin{aligned} E(I) &= \sum V_i f(V_i) = 1p_i + 0(1-p_i) = p_i \\ VAR(I) &= \sigma_i^2 = \sum V_i^2 f(V_i) - [E(V_i)]^2 = p_i - p_i^2 = p_i(1-p_i) \end{aligned} \tag{3.9}$$

From these results covariance and ultimately correlation of default can be easily calculated.

$$Cov(I,J) = \sigma_{ij} = E(IJ) - E(I) \cdot E(J), whereby$$
$$E(IJ) = \sum_i \sum_j V_i V_j f(V_i, V_j) \tag{3.10}$$
$$Corr(I,J) = \rho = \frac{Cov(I,J)}{\sqrt{Var(I)} \cdot \sqrt{Var(J)}} = \frac{\sigma_{ij}}{\sigma_i \sigma_j}$$

E(IJ) is the expected value when both companies default. The values for the variance and the mean have to be inserted in order to obtain the pair-wise default correlations..

$$\rho = \frac{p(I \cap J) - p_i p_j}{\sqrt{p_i(1-p_i)}\sqrt{p_j(1-p_j)}} \; and$$
$$p(I \cap J) = p_i p_j + \rho\sqrt{p_i(1-p_i)}\sqrt{p_j(1-p_j)} \tag{3.11}$$

Depending on the number of group constituents, we receive $\sum_{i=1}^{n-1} i$ pair-wise correlations. p(I∩J) is defined as the joint default probability, i.e. the probability that both companies default, simultaneously.

It can also be presented graphically, in a lattice or tree diagram, as provided for in figure 15.

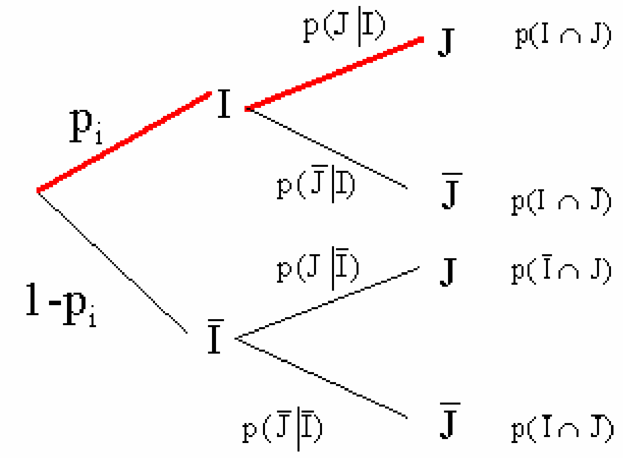

Figure 15: lattice model for company defaults

$\bar{I}$ is the complementary event to I, i.e. no default of company 1, and $p(J|I)$ is the conditional probability of J, given that I has taken place, i.e. the probability that company 2 defaults, given that company 1 defaulted. The bold red lines show the unique "path" for the joint default probability. It is calculated following the formula for the joint probability, as p_i*p(J/I)[70]. Similarly, the remaining three events can be derived, i.e. both companies survive, company 1 survives but 2 does not, and vice versa.

[70] Formula for conditional probability: p(J/I)=p(I∩J)/p_i

Taking again the formulae for the joint default probability, we recognise the impact of correlation. The lower it is, the lower the probability of joint default is. Negative correlations of company defaults are fairly improbable, i.e. company 1 defaults, provided that company 2 does not default. Therefore, they are usually ignored. The correlation is positive when the probability of joint default is higher than in the independence case.

Slijkerman et al. (2005) use an alternative measure to estimate joint default probabilities of institutions, by introducing the linkage measure. This measure has the advantage that it does not make use of the correlation measure, by analysing tail dependences only. Thus, also non-normal distributions can be analysed appropriately. This linkage measure is defined the following way:

$$E[\kappa|\kappa \geq 1]-1=\frac{p(I>t,J>t)}{1-p(I\leq t,J\leq t)} \tag{3.12}$$

This is the conditional probability that both affiliates fail, given that there is a failure of at least one of them, whereby t is a well defined loss threshold that defines failure and κ is the number of institutions that crash[71].

3.1.2.1.1. Bayes' Theorem

Bayes' theorem yields the conditional probability distribution of a random variable A, assuming we know:

- information about another variable B in terms of the conditional probability distribution of B given A, and
- the marginal probability distribution of A alone.

Hence, with the help of Bayes' theorem, one can estimate ex post the probability that an event occurred simultaneously with another event. Given that one event occurred, what is the probability of the other event to have occurred as well? In practice Bayes' theorem is, therefore, used to estimate the probability of hypotheses.

Bayesian updating is in many models the strategy investors apply, in order to judge upon bank failures and the impact on their own investment or their deposits. Chen (1999), for instance, explicitly uses this methodology to explain the emergence of bank panics. Other examples of models applying Bayesian updating are surveyed in Devenow and Welch (1996). In principle, most theories on herding regard this aspect of information processing.

For our purpose, by solving the equation we get to know the probability of another affiliate to fail, given the actual failure of another group company. Since we expect that events are not independent in financial groups, the probability of default should

[71] For a detailed derivation of this measure of dependence, refer to Hartmann et al. (2004).

surge after the failure of another affiliate was recognised[72]. The higher the correlation between those institutions, the higher the probability of joint default is. If the events were fully independent, the failure of one institution would not have any impact on the other companies' probability of default. Thus, we could not draw any conclusions regarding the impact of a particular company's failure.

$$p(I/J) = \frac{p_i \cdot p(J/I)}{p_i \cdot p(J/I) + (1-p_i) \cdot p(J/\bar{I})}, \textit{ where}$$
$$p(J/I) = \frac{p(I \cap J)}{p_i} \tag{3.13}$$
$$p(J/\bar{I}) = \frac{p(\bar{I} \cap J)}{1-p_i}$$

These equations necessitate a further transformation because the inclusion of any (conditional) probability containing $\bar{I}$, the non-event, complicates further estimations and the understanding of the model.

Regarding the Venn diagram, presented in figure 16, we can easily transform $p(\bar{I} \cap J)$, i.e. the probability that only one company fails, to facilitate equations and to allow further derivations.

The interdependence of two events is shown by their intersection. If the two sets – presented as an ellipse for event I, i.e. the first company defaults, and a rectangle for event J, i.e. any other institution defaults - do not intersect, the events are independent. In this case the intersection is an empty (or null) set. Based on this information, every event J can simultaneously be explained as the sum of the intersection $I \cap J$ plus the remaining $\bar{I} \cap J$. This is simply the sum of all possible cases, with the premise that the second institution defaults, that is, joint default plus survival of the former (expressed by $\bar{I}$). In the lattice diagram this association is expressed by branches one and three or, alternatively, branches two and four for a decomposition of event I.

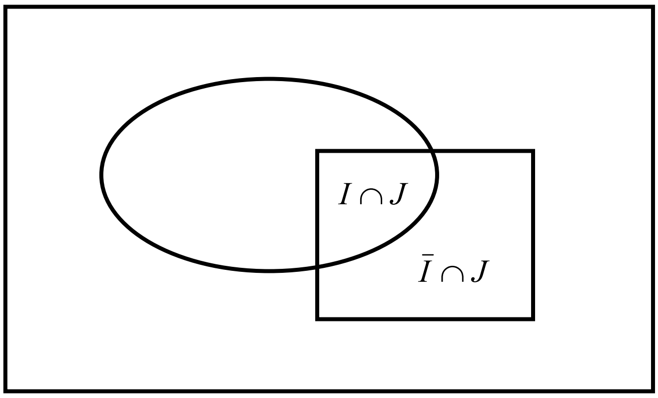

Figure 16: Venn diagram for events I and J

[72] Many papers (following the seminal example od Diamond and Dybvig, 2003) explaining the behaviour of agents regard reputational contagion, i.e. it is sufficient that investors believe that companies are someway interrelated to trigger corresponding reactions. These perceptions need not necessarily reflect actual circumstances.

$$J = (I \cap J) \cup (\bar{I} \cap J), \textit{ hence}$$
$$p_j = p(I \cap J) + p(\bar{I} \cap J) \textit{ and} \tag{3.14}$$
$$p(\bar{I} \cap J) = p_j - p(I \cap J)$$

Both terms are now well defined and can be used for further estimations. The equations are facilitated and made understandable, by inserting the results from (3.11).

$$p(I/J) = \frac{p_i \dfrac{p(I \cap J)}{p_i}}{p_i \dfrac{p(I \cap J)}{p_i} + (1-p_i)\dfrac{p_j - p(I \cap J)}{(1-p_i)}} = \frac{p(I \cap J)}{p_j}$$
$$(3.15)$$
$$p(I/J) = \frac{p_i p_j + \rho\sqrt{p_i(1-p_i)}\sqrt{p_j(1-p_j)}}{p_j}$$

We see that the correlation ρ between I and J has a significant impact on the probability p(I/J)[73]; i.e. one company's default, given that another defaulted as well. If correlation is zero (ρ=0), the events are independent and the probability of default is simply p_i, which is the probability of company default as defined in (3.8).

For our purpose that means that the default of a group affiliate is (strongly) influenced by the probability of another affiliate's default. The extent of this interdependence is connected with the correlation of the businesses themselves. For instance, Acharya and Yorulmazer (2003) show in their model on interbank correlation and information contagion that greater interbank correlation increases the risk of simultaneous bank failure if the industries, they lend to suffer a common shock. Hence, we argue that return correlations and default correlation may be to some extent be used interchangeably to analyse the impact of a particular shock.

3.1.2.2. Correlation of business activities

As Wahrenburg and Niethen (2000) explain, empirical default probabilities are relatively low and, thus, empirical default correlation is only slightly above zero. An alternative method to take attention of increasing risk due to correlation, and, which follows the same procedure as the estimation of default correlations, is to look at the various business activities of the individual group constituents. All these activities together are regarded as the group's overall portfolio.

Instead of looking at default correlations, in this case the emphasis is put on the correlation of business activities, i.e. return correlations of the companies' operations. As Hanson et al. (2005) rightly explain, these different forms of

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[73] By changing the sub-indices, we can easily estimate p(J/I) as well.

correlation – default correlation and correlation of business activities - need not necessarily be the same, that is, the same return correlation may imply different default correlations across firms due to differences in default thresholds, which are usually modelled as a function of the firm's balance sheet.

Nonetheless, Zhou (1997) shows that ceteris paribus default correlation increases with the size of asset correlation. If one firm defaults because of the drop in its value, the probability is high that the value of the other firm has also declined, if asset return correlation is positive. This may be an argument why group affiliates, which are assumed to show a higher correlation, also have a higher default correlation than less interlinked companies.

However, accounting data is not necessarily consistent across companies, businesses or countries. This may even challenge the comparison of subsidiaries' data within a particular group. Inconsistencies can be traced back to different accounting rules but also to different strategies of companies' management. They can take advantage of various waivers, which may ultimately lead to the building up of hidden reserves[74]. For the sake of simplicity and as it does not severely change the results, we assume the default and return correlations to be equal.

Santomero and Eckles (2000, p.8) argue that correlations are likely to be high for the simple reason that activities are added to the firm because of a management perception that the firm has a comparative advantage in producing the underlying product or assessing the underlying risk[75].

According to this assumption, we may derive that also group risk, e.g. in terms of portfolio variance or value at risk (VaR), is relatively high in comparison to a more diversified group.

In general, for a portfolio with G business activities and ω_g as their weights, the portfolio variance is:

$$\operatorname{var}(R_p) = \sum_{g=1}^{G} \omega_g^2 \operatorname{var}(R_g) + \sum_{g=1}^{G} \sum_{h=1}^{G} \omega_g \omega_h \operatorname{cov}(R_g, R_h),\ for\ g \neq h \tag{3.16}$$

Using the second moment of the marginal returns – as expressed in the preceding formula – and the inverse distribution function of the standardised portfolio returns, i.e. the quantile of the distribution at a well defined level α, we can derive the VaR[76] as it is, for instance, presented by Bradley and Taqqu (2003).

$$VaR_p(\alpha) = \mu_p + \sigma_p \Phi^{-1}(\alpha) = \mu_p + \sqrt{\operatorname{var}(R_p)}\Phi^{-1}(\alpha) \tag{3.17}$$

74 The establishment of IAS/IFRS rules is, among other things, intended to reduce exactly these hidden reserves and ultimately make companies more comparable.

75 One may indicate that this assumption requires the existence of a rather centralised group structure leaving the group management sufficient room to intervene in the subsidiaries' business strategies.

76 The VaR is a standard risk measure in financial markets. Although it does not fulfil all requirements for a coherent risk measure as defined by Artzner et al. (1999), it is commonly used due to its easy derivation. For (highly) skewed data, it however provides relatively biased results.

As is immediately evident from both formulae above, the portfolio risk is strongly influenced by the covariance (or correlation) of the business lines. The higher the covariance, the higher the portfolio variance is. Thus, ultimately, also the portfolio VaR is higher than in the case of very distinctive business lines.

This fact also has implications for the group's business strategy. Roughly stated, the more diversified the business areas, the lower the overall group risk is. For the reasons explained in Santomero and Eckles (2000), one may assume that a strategy that supports this diversity is unlikely. Groups are usually focussed and outsource activities where they do not see a competitive advantage or where scale or scope economies are low.

As explained earlier, though, in these formulae concentration or contagion effects of any kind are still not taken into account. A precise judgement on the overall group risk still necessitates the consideration of these "dangers".

3.1.2.3. Physical interdependence between group affiliates

Physical linkage between group constituents is another important factor that influences the propensity to contagion in the group. A company in distress may trigger payment obligations by other affiliates due to mutual guarantees, pledges or other collaterals, due to public pressure, etc. The assumption of other affiliates' risks and losses may provoke in a second round the distress of these companies as well. This process is, for instance, immediately understandable when we assume that the parent company is the ailing institution. Strong similarities may be found in the interbank market, and, therefore, also the literature on contagion via the interbank channel is of special interest.

As explained, the financial interdependences may originate from various sources: mutual guarantees, letters of comfort, intra-group transactions, mutual lending and borrowing, etc. In principle, one may regard the group as an interbank market at a very small scale. One may, however, also assume that affiliates receive support at better financial conditions than in the market, which is especially true for ailing companies. Transactions may be carried out at arm's length and may not be based on commercial prudence. The higher the centralisation of the group, the more intensive the financial interdependences are.

In order to prevent or limit contagion of this kind, groups may build up firewalls between the individual affiliates, for example, by restricting intra-group transactions[77]. It is doubtable though whether these firewalls really work in cases of distress. For instance, the group also has to keep in mind the reputational damage when a subsidiary "drowns". Market participants may assume a connection between the failure of a group company and the financial condition of the rest of the group. The holding company may therefore not dare withhold any capital infusions to the ailing affiliate without provoking consequences for the remaining group. They may,

[77] Due to their imminent impact on a financial group's safety, a considerable supervisory focus is therefore placed on intra-group transactions.

for instance, be punished by a large drop in share prices, reflecting the lost confidence of investors. Thus, strong physical relations also have an informational dimension with respect to contagion.

Due to data limitations, it is almost impossible for an outsider to assess financial interdependences of group constituents. Annual and quarterly accounts are hardly revealing or may even give a wrong impression of actual interdependences.

Moreover, these data only provide a "snapshot" and cannot give current and updated insights. Supervisors are informed on intra-group transactions but these data only provide a rough overview over the actual circumstances and dependences.

Following Eisenberg and Noe (2001), who analyse a clearing problem, and Elsinger et al. (2002) who estimate risk from interbank loans, we may use network models to estimate physical interdependences of group members. More precisely, we assess the potential effects of these linkages with respect to contagion.

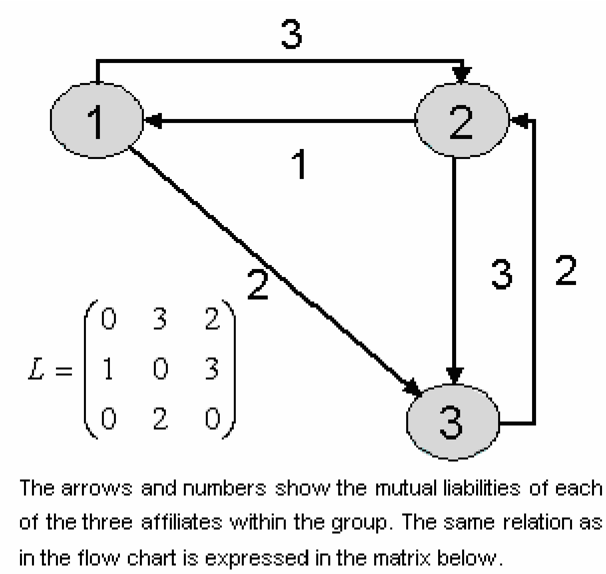

Figure 17: Group capital linkage (illustration)

For illustrative purposes the mutual liabilities are presented in a flow chart as shown in the figure above. The liability structure of the group may alternatively be reproduced in a simple matrix, which has the advantage over the flow chart of conveniently allowing further calculations. The row vectors of the matrix show the respective liabilities of company I with its affiliates and consistently, the columns represent the claims. As company I cannot have liabilities against itself, the diagonal matrix must consist of zeros.

Hence, a_{1n} is company 1's liabilities with company N and $a_{1.}$, which is defined as $\sum_{i=1}^{n} a_{1i}$, represents company 1's total liabilities with other affiliates of the group.

$$\mathbf{L} = \begin{pmatrix} 0 & a_{12} & \dots & a_{1n} \\ a_{21} & 0 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 0 \end{pmatrix}$$, the vector of total liabilities for the group is hence: $\vec{d} = \begin{pmatrix} a_{1.} & a_{2.} & \dots & a_{n.} \end{pmatrix}$[78]

Clearly, from this information alone we cannot derive sufficient information on the financial condition of each affiliated institution, that is, large liabilities with other companies do not necessarily imply that the company is in financial difficulties. The group is not a closed system and interacts with its environment, i.e. its stakeholders.

To gauge the financial safety of the individual company for each business line, the income streams i net of any liabilities need to be considered. Similar to the vector of total liabilities $\vec{d}$, the income streams, generated outside the group, can also be presented as a vector, i.e. $\vec{i}$. Healthy and highly liquid institutions can therefore accept higher liabilities than companies under distress or with a limited income stream.

In order to estimate the net value of each institution, some minor matrix transformations are unavoidable. In a first step the liability matrix **L** is normalised by each company's total liabilities with affiliated companies to a matrix **Π**. Each matrix element then corresponds to the relative share of liabilities with an affiliate relative to the total liabilities of the company, which is naturally always 1, i.e. 100 percent.

In a next step all incomes are added and liabilities subtracted to ultimately obtain the net value. If this net value has a negative sign we regard the company as having failed. In this case, it cannot contribute to the group's results but the remaining costs have to be distributed to the others. To achieve this summation, the matrix **Π** first has to be transposed, such that each row vector corresponds to the respective company's relative intra-group income streams. Multiplied by the transposed liability vector $\vec{d}$, this yields the vector of absolute intra-group income for all group affiliates. The addition of the net external income stream and the subtraction of intra-group liabilities, ultimately, delivers the vector of net values. The subsequent equality provides the following implication. Subtracting all intra-group liabilities from the sum of all income sources, i.e. external plus intra-group income, we obtain the net value of each institution.

$$\begin{pmatrix} 0 & a_{12}/a_{1.} & \dots & a_{1n}/a_{1.} \\ a_{21}/a_{2.} & 0 & \dots & a_{2n}/a_{2} \\ \dots & \dots & \dots & \dots \\ a_{n1}/a_{n.} & a_{n2}/a_{n.} & \dots & 0 \end{pmatrix}^T \cdot \vec{d}^T + \vec{i}^T - \vec{d}^T = \begin{pmatrix} \dots \\ \dots \\ \dots \\ \dots \end{pmatrix} \tag{3.18}$$

78 In order to better differentiate between matrices and vectors, we use the arrow for vectors; matrices are still printed in bold.

A company becomes illiquid if $\pi_{i.}\vec{d}^T + i_i \leq d_i$, i.e. all income streams are less then total liabilities[79]. To calculate this inequality, each row vector of the normalised and transposed liabilities matrix is multiplied by the total liabilities vector[80]. Then, the net external income of company I is added. If this sum is less than the liabilities of company I, then the institution is still in a healthy position. The threshold for illiquidity is the point, where $\pi_{i.}\vec{d}^T + i_i = d_i$, which means that all promises can still be fulfilled. Naturally, this process is to be conducted for each institution, which is immediately done by using matrix calculation, instead of calculating each state separately.

3.1.2.3.1. Contagion effects

When a group affiliate is in a severe liquidity shortage, i.e. its net value is negative, it is assumed that the other group members will interfere and cover these losses. In other words, the income streams for the remaining companies are reduced. For the sake of simplicity, it may be assumed that the failing institution contributes its total income, whereas all remaining institutions proportionately cover the loss, i.e. the gap between income and liabilities. Moreover, it is assumed that the illiquid company, ultimately, fails and does not recover in a later period.

Theoretically, this process can be repeated until the last company of the group fails, i.e. n iterations of the calculation procedure are possible. Eisenberg and Noe (2001) call this procedure the “fictitious default algorithm”.

The fact that the other group constituents have to cover the losses is already a sign of contagion. The contagious effect is even more obvious and strong, when another affiliate drowns, because it had to bear additional costs due to the failure of a group member. An institution, that has a positive value in an earlier iteration, may now have a negative value and thus fails as well.

The process is conducted as in the first iteration. However, the vector of intra-group liabilities $\vec{d}$ is adapted to cover the fact that the company can only bear costs up to its total income, i.e. the negative net value of the company is subtracted from the relevant component of $\vec{d}$. This modification of the factor leads to a proportionate division of costs among the remaining group affiliates.

If one or more companies fail during this second round, this failure can be traced back to contagion because the companies would not have failed without the capital linkage with other affiliated companies. A stand-alone institution might even not have noticed the shock. This procedure can be continued until there is no company left with a negative net value or until the whole group has failed.

Mathematically, this redistribution of liabilities is exercised by using the standard Gauß elimination procedure or the simplex algorithm. In order to redistribute excess

[79] Mind that the components of $\vec{i}$ may be negative when liabilities are higher than income, such that the net result becomes negative.

[80] This is equivalent to the intra-group income.

liabilities, the negative net value is set to zero, i.e. the institution covers no more than is available from diverse income streams.

Solving this equation system, we obtain the new vector $\vec{d}^T$, which, on the one hand, determines the intra-group income affected by the illiquidity of (an)other affiliate(s) and, on the other hand, shows the liabilities of each company. If this new payment vector induces new failures, the procedure is repeated.

In the following tree diagram in figure 19, the group default algorithm is displayed. It shows how the process of contagion in an integrated system is assumed to work. The procedure stops when a company survives the strong risk of illiquidity due to mutual liabilities. In the worst scenario, however, the process is repeated until the last entity has to be wound up.

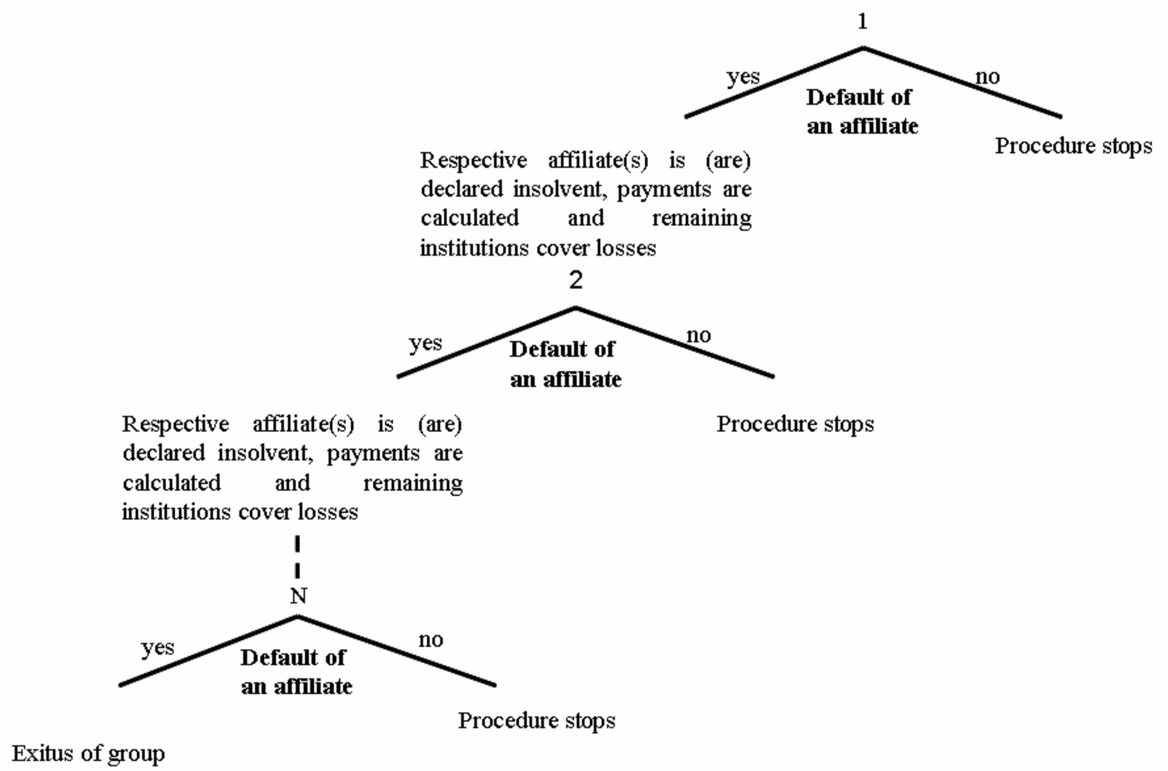

Figure 18: group default algorithm

3.2. Measuring contagion in financial industry – empirical approach

In earlier sections, we have – at a more abstract or theoretical level - discussed sources of contagion in financial industries and their possible impact on the market's and individual entity's safety.

First, a general overview on the structure of financial institutions and the implications with respect to contagion are provided. The idea of contagion is then described in more detail and an extensive (theoretical) literature review is provided. The implications for the financial sector and its main "protagonists", i.e. the insurers and credit institutions, are highlighted. Possible drivers of contagious effects and their potential impact are discussed, as well.

Afterwards, this concept is evaluated at a fairly abstract and theoretical level, showing the basic mechanisms of these spillover effects in financial groups and their impact on the respective institutions. One important intention of this section is, inter alia, to highlight risks that are usually ignored or, at least, underestimated because they are hard to grasp and difficult to measure. Hence, they are difficult to implement in corporate risk models.

The subsequent section is, therefore, intended to measure these intra-group contagion effects in practice, by observing historical returns of listed banks and insurance companies. We are, thus, interested in potential interdependences in the time series of these returns.

As aforementioned, the main focus is on intra-group risk dissemination effects and, hence, primarily on financial groups, consisting of several listed subsidiaries. Interdependences of non-listed companies cannot be measured with publicly available data. Besides the lack of publicly traded shares, also accounting information is usually not disclosed at the same level of comprehensiveness.

Unfortunately, this approach fails to reach a large number of institutions as it restricts the assessment to a fairly small sample of European financial groups. Most groups in Europe have only one company listed at a stock exchange, i.e. the parent company. Subsidiaries are often delisted after acquisition and integrated into the group.

In a first step, we regard interdependences of major European market participants, by measuring pair-wise correlation, without taking particular notice of affiliation. In order to abstract from general market movements, also partial correlations are calculated. Thereby, we hope to infer the actual impact of the financial industry on share price movements. Rank correlations will finally take account of highly skewed and fat tailed distributions because linear correlation fails to do so, commensurately.

Afterwards, the same procedure is applied to a set of financial groups and conglomerates, consisting of at least one subsidiary and its parent or holding company that are listed at a European stock exchange. Since share prices essentially carry market opinions and expectations, a comparison of the results of our calculations will provide "prima facie evidence" of whether the market perceives a stronger interdependence between group affiliates in comparison to non-affiliated companies in the industry. This procedure will also give us some first impression regarding the importance of industry affiliation in contrast to group affiliation.

Furthermore, we hope to discover, whether there are differences in interdependence, with respect to the industry the groups are in, i.e. whether bank structures and operations provoke stronger interdependences than those of insurance institutions. Based on the theoretical foundations, one may expect to discover higher interdependences between credit institutions than between insurance companies. As explained earlier, investors may interpret bad developments in another credit institution as a negative sign for their own institution. This association is generally not made in the insurance industry, i.e. the failure of a company does not necessarily imply a negative development in other insurance institutions.

In a next step, we will abstract from the whole market and confine our focus to financial groups, as was stated as our primary objective. Event studies are conducted for those financial groups or conglomerates that consist of at least two listed financial companies[81]. We intend to find out, whether certain group company specific events have any impact on other affiliates' stock return developments, i.e. whether a group event can trigger a negative or positive reaction in stocks of affiliated companies, that are not directly affected by the event.

Strong emphasis is put on the requirement that the other affiliates are not directly affected by the event. Otherwise, the reactions, we are looking at, cannot be traced back to contagion or spillover effects, that is, we would simply be confronted with direct reactions to shocks, which are not an issue of this project.

Using this methodology of event studies, we hope for indications on potential contagion effects within such financial groups, because they are, otherwise, difficult to identify from an external perspective due to the lack of access to relevant data. For instance, it is not possible to develop network models as in analyses of interbank relations (cf. Elsinger et al., 2002). Nevertheless, interbank data are usually not sufficiently detailed, either and are, generally, available at an aggregate level only.

Unfortunately, methods using stock market returns bear several weaknesses in the observation of contagion effects of integrated groups. The more integrated groups are, the higher the chance that only the top holding company is listed, is. At the moment, we can observe a strong tendency towards full integration of companies within a group.

Prominent examples in the European financial markets are, for instance, ING, Fortis, Dexia or Allianz. The latter is currently fully integrating RAS, an Italian insurer. Generali shows similar tendencies, according to announcements from

[81] Groups or conglomerates are not necessarily restricted to the legal definition as for instance found in the European financial conglomerates directive. Instead, we gear on the factual connexion and the economic (and influencing) control of another company. This control is often already enforceable with a minority stake, say 20 percent.

beginning of March 2006. The Italian parent company that already holds 93 percent of the stake is going to delist the Generali Holding Vienna and to buy back the seven percent free float.

Under such circumstances, with the methodology of event studies, we are unable to measure any interdependence between affiliates, although one may assume that in highly integrated groups, bancassurances and assurfinances interdependences are particularly high.

Abstracting from any diversification aspects and their potential to enhance the stability of a company, negative externalities might spread more easily through diverse channels and infect other entities or even profit centres. The complexity or opacity of certain groups may even make it difficult for the own management to judge upon the impact of certain business "lines" or functional units on others[82]. This opacity of banks or insurers is also reflected by the frequent disagreement of rating institutions, in contrast to other industries, as observed by Morgan (2002).

Another inconvenience of event studies is the fact that return developments mainly reflect public, i.e. investors' or analysts' perceptions. They may, therefore, not serve as a representation of a company's actual risks. A negative event might even lead to positive price developments if analysts expected an even worse scenario. On the other hand, positive (annual) results might provoke negative reactions if (high) annual targets were not achieved. The actual risk may, therefore, not directly correspond to the market reaction perceived, as reflected in the share price.

Ultimately, due to the aforementioned weaknesses, alternative methods to detect potential contagion effects are presented, i.e. corporate bond spreads, credit default swap (CDS) spreads and distances to default.

The main advantage of credit spreads is that companies do not have to be listed on a stock exchange to issue bonds or CDS. Consequently, also fully integrated groups could be analysed, provided that at least two companies are represented on the capital market. A prominent example is the ING group, with its insurance and banking arm. Furthermore, the risk perspective of the debtholder, which may strongly deviate from the attitude of the equityholder, can be taken into consideration. It is assumed that debtholders are more sensitive to risks as they cannot participate equally in the gains but have to bear the full downside risk.

Distances to default have the advantage to incorporate several data in one single figure. They are derived from both accounting and stock information and, hence, incorporate insider (accounting) and outsider (share prices) information and knowledge. Therefore, it is hoped that the explanatory power of the ratio increases.

However, also these measures suffer from diverse shortcomings. Availability of data, responsiveness to intra-group events and broad usage are relevant requirements, which are not always fulfilled. While corporate bond spreads[83] and

82 The establishment of an integrated risk management system is, therefore, a great challenge for several companies under Basel II or Solvency II.

83 For corporate bond spreads it may, however, be decisive to select the adequate riskless return (e.g. 3-year government bond) to discover the spread.

CDS spreads are directly available from data providers, such as Datastream or Bloomberg, distances to default are measures constructed on the basis of several accounting and market data. The use of balance sheet information, however, is related to several shortcomings and to the fact that accounting rules may (still) differ across borders.

The results of all models applied will improve the judgement upon the dissemination of risks within financial groups in Europe. As such, the combination of all models together may improve the insights on potential contagion effects. Furthermore, they may provide suggestions for future research, when common accounting principles are applied, risk transfer markets are more highly developed and established and longer time series of data are available.

3.2.1. Related literature

Most papers on contagion, using event study analyses focus on bank failures and their implications for rival firms. A seminal paper for this field of study is Aharony and Swary (1983) that analyses the impact of three large banking failures on other rival institutions or on the economy as a whole. Thereby, the authors differentiate signalling based and pure contagion effects. The former can be interpreted as the investors' response to a common type of unfavourable signal, i.e. a problem, whose revelation is correlated across the industry. The latter represents a spillover effect that is independent of the actual cause of the bank failure.

Subsequent papers extended this approach, by focussing more intensively on the effects of bankruptcy announcements and their possible causes. Lang and Stulz (1992) argue that these announcements can both have a contagion effect or a competitive effect[84]. Depending on which effect dominates, the announcement will be positive or negative for the rival company. According to their study, competitors tend to benefit from a rival's failure in highly concentrated industries with low leverage due to the redistribution of wealth to the remaining entities and a perceived improvement in the competitive conditions. Effects tend to be negative in highly levered industries, where the unconditional stock returns of the non-bankrupt and bankrupt firms show high correlation. In this case the failure of one market participant is interpreted as a negative sign for any other institution. It is feared that other companies might be affected as well.

Aharony and Swary (1996) and Akhigbe and Madura (2001) emphasise the factors that influence the degree of contagion effects for rival companies. The former examines the impact of three observable bank characteristics that are postulated as the cause of bank runs. As proxy measures, they use the distance of the solvent bank's headquarters from the headquarters of the failed banks, the size of the solvent banks, and the capital ratio. Distance and size serve as a proxy for similarity

84 The competitive effect may be translated by positive revaluation effect. In our study on intra-group effects we assume these effects to be of minor relevance.

and the third characteristic is used to identify the nature of the contagion effect, i.e. information based or pure contagion. The latter study examines 99 bank failures in the period from 1980 to 1996, to evaluate what factors influence the degree of contagion and the degree of risk shifts among the surviving banks.

Brewer and Jackson (2002) extend the existing literature by a focus on inter-industry contagion effects, i.e. effects of life insurance company related financial distress announcements on commercial banks, and vice versa. In particular, adverse information about commercial real estate portfolios from three separate sets of announcements are examined.

In contrast to other contagion studies, they also attempt to evaluate the proportion of the contagion effect that is informational relative to that proportion that is purely contagious.

Finally, Bessler and Nohel (2000) test for the presence of contagion effects in stock returns, associated with announcements of dividend cuts by money centre banks. These effects are based on the assumption that outsiders may interpret changes in a bank's financial policy as signals about the quality of the inherent loan portfolio. If different banks are regarded as similar, such announcements will be interpreted to pertain to non-announcing firms, as well.

More recent papers propose a new methodology, which examines interdependences in the tails of the distribution. Since the distance to default is a convenient measure to analyse the risk of a (financial) institution, by incorporating information on stock price returns, asset volatility and leverage, their probability distributions are commonly used for an assessment.

We are particularly interested in the far tails of the density functions and in potential co-movements in the figures analysed. The basic assumption behind this methodology is that stock returns are usually skewed, i.e. extreme events are more likely than the assumption of normal distribution implies. Therefore, extreme co-movements, i.e. companies' stock returns or first differences in distance to default are extreme in the same direction, are assessed. A common proposal for this tail event is the 5^{th} percentile positive or negative tail of the distributions used. Examples for this procedure are Minderhoud (2003) or Gropp and Moerman (2004a).

To our knowledge, there have not been any assessments on credit spreads with regard to contagion effects up to this moment, although, prima facie, it appears to be an obvious procedure to evaluate such effects. Nevertheless, one may take advantage of the literature that intents to evaluate subordinated debt as potential early warning indicator for regulators (e.g. Evanoff and Wall, 2001 and 2002; Hancock and Kwast, 2001 or Calomiris, 1997 and 1999).

The argument to use debt instruments is based on the assumption that debtholders are much more risk sensitive than equityholders in case of any adverse developments. In contrast to equityholders, debtholders have to bear the downside risk and can only moderately participate in gains of risky operations. Nevertheless, the immaturity of this particular market may have prevented any profound assessment of this kind, so far.

Additionally, currently any existing studies on co-exceedances were confined to the assessment of intra- and inter-industry effects. But no event studies, or assessments of tail events, have been conducted on group constituents with the objective to measure intra-group contagion effects so far.

The objective of this research project is, however, to measure exactly these effects. The main difficulty for such assessments is the fact, that in many cases only the holding company is listed or data are not publicly available. The low transparency of data and the short time series complicate any further analysis. Furthermore, focussed supervisory analyses as commonly applied by financial supervisors, instead of a more holistic approach, taking into account the whole industry during a company assessment, may fail to take account of any risk dissemination.

3.2.2. Correlation between companies' returns

De Nicoló and Kwast (2002) argue that interdependences between institutions provide an indicator of systemic risk potential. In order to get a first impression of interdependences between financial market companies we, therefore, estimate (continuous) weekly stock return correlations over the period from beginning of January 1999 to end of June 2005 in a first step[85]. Correlations can give us a first impression of the linkage of companies via capital market reactions. Nevertheless, we know from Rigobon (2001) or Forbes and Rigobon (2002) that correlations have to be taken with caution because they are conditional on market volatility, which is particularly high during crises. Models are, therefore, biased in the presence of heteroskedasticity. Hence, we will primarily use them to get a first impression of company interdependences, without interpreting the results as full evidence of spillover potential. Although the results may be distorted, they still allow comparisons of inter-group and intra-group correlations.

In order to abstract from general industry developments, as incorporated in a representative industry index, also partial correlations between two companies' stock returns are calculated. One is interested in the pure correlation between institutions, by filtering out general market movements, which are expected to have a strong explanatory power of a company's stock developments.

$$\rho_{X,Y/Z} = \frac{\rho_{XY} - \rho_{XZ}\rho_{YZ}}{\sqrt{(1-\rho_{XZ}^2)(1-\rho_{YZ}^2)}}, \tag{3.19}$$

where ρ_{XY} is Pearson's correlation coefficient between the two stock returns X and Y. Z represents the effects related to general market developments as incorporated in a market or industry index. Z is filtered out in this partial correlation $\rho_{X,Y\backslash Z}$.

85 The calculations are based on the data taken from Thomson's Datastream.

Although the partial correlations of companies' returns are fairly low, this observation does not necessarily imply weak dependences between companies. As emphasised by Embrechts et al. (2002), correlation is only one concept of dependence among many and is built on the assumption of multivariate normal distributions.

However, return distributions are generally not normal but heavily tailed and skewed. Uncorrelated returns may not necessarily be independent. In fact, independence of two random variables implies that they are uncorrelated but zero correlation does not necessarily imply that they are independent. In fact, in cases of heavily tailed distributions using linear correlation may, to a large extent, underestimate actual dependences and lead to wrong conclusions[86].

This aspect may be explained by the possibility that correlation increases in the tails, i.e. during episodes of stress, entities may be(come) correlated, while in "normal", tranquil circumstances, they may look almost independent[87]. It is a fact that stock returns appear to be more highly correlated during market downturns than during market upturns. In our analysis we are particularly interested in market downturns or, at least, in negative scenarios. Tail dependence, however, cannot be measured by a simple unconditional correlation measure.

Alternative measures for dependence (concordance) in a non-normal world are rank correlations, such as Spearman's rho or Kendall's tau. These measures may provide insight in dependences, where linear correlation is an insufficient measure[88].

Accepting these rank correlations to be equally powerful, we apply Spearman's rho in our analysis[89], which is defined as:

$$r_s = \frac{\sum_{i=1}^{n}(R(x_i)-\overline{R(x)})(R(y_i)-\overline{R(y)})}{\sqrt{\sum_{i=1}^{n}(R(x_i)-\overline{R(x)})^2 \cdot \sum_{i=1}^{n}(R(y_i)-\overline{R(y)})^2}} = 1-\frac{6\cdot\sum_{i=1}^{n}(R(x_i)-R(y_i))^2}{n(n^2-1)}, \tag{3.20}$$

where $R(x_i)$ and $R(y_i)$ are ranks for each of the n realisations of the random variables X and Y. Developments, net of general market movements, are estimated, using the same approach as before, i.e. partial rank correlations.

86 De Vries (2004) provides an illustrative example to show that zero correlation does not necessarily mean independence: He considers an example with discrete uniform distribution on eight points $(\pm 1, \pm 1)$, $(\pm 2, \pm 2)$. Due to the symmetry of data, it is evident that the correlation factor ρ is zero, although the data are not independent. For instance, if x = 1, y cannot be equal to 2, and the conditional probability P{Y>1|X>1} = 0.5, while unconditionally P{Y>1} = 0.25 only. Thus, ρ does not capture the dependence that is in the data.

87 One has to be careful with the interpretation of the results obtained. In periods of high stock return volatility the correlation measured can be higher although the underlying correlation may be constant. Hence, observed increases in return correlations may then be a simple statistical artefact.

88 For a more detailed description and a mathematical derivation, refer to Embrechts et al. (2003).

89 The use of Spearman's rho was arbitrary and does not underlie any specific objectives.

Test for significance

Finally, we test, whether banking correlation significantly differs from insurance correlation, by using the results of the (full) correlation estimates as input. The analysis of variance (ANOVA) is the method applied, i.e. more concisely, the F-test. The F-test is used for the comparison of mean values, under the assumption of normally distributed data series with unknown mean μ_i and unknown, but homoscedastic[90], variance $\sigma^2>0$. The advantage of the F-test is its robustness against small deviations from normality.

The basic idea is that, if the subgroups have the same mean, then the variability between the sample means (between groups) should be the same as the variability within any subgroup (within groups). The null hypothesis is hence:

$$H_0 : \mu_1 = \mu_2 ,$$

which is rejected; i.e. there is a significant difference in the means, if the F-value is greater than the critical value[91]:

$$F = \frac{sum\,of\ squares\,between\,groups / p-1}{sum\,of\ squares\ within\,groups / N-p} > F_{p-1,N-p;1-\alpha}$$

N is the number of observations, p the number of subgroups and F_x represents the critical factor, that is the threshold for the rejection or the acceptance of the null hypothesis.

3.2.3. Results in the test for dependences in stock returns

3.2.3.1. Intra-industry correlation

In our correlation estimates we concentrated on the companies belonging to the DJ Euro Stoxx Banking index and DJ Euro Stoxx Insurance Index, respectively. This procedure allows taking companies with a high market capitalisation and dropping, in advance, low liquidity stocks and those stocks with a low percentage of free float because their inclusion may considerably bias our estimation results.

Calculations are conducted for the largest financial markets, i.e. particularly those countries with a large number of companies in the sample. Concretely, we look at listed institutions from France, Germany, Italy, Spain, Switzerland and the United Kingdom. Separate estimations for the insurance and banking markets were conducted. Due to the low number of relevant, i.e. listed, credit institutions in Switzerland and listed insurance companies in Spain, no correlations were calculated for these particular markets and industries.

90 The assumption of homoscedasticity may be rather strong, however is not assumed to heavily impact the results.

91 That is, the percentile given the degrees of freedom and the chosen significance level.

In the appendix, both rank and linear correlations for each country and industry are provided. Furthermore, it is differentiated between partial and full correlation. All the companies considered can be found in the subsequent table. As is immediately observable, the number of companies analysed strongly varies between each country.

Data source:	Thomson Datastream	
Data used:	Weekly returns	
Time period:	January, 4th 1999 – July, 4th 2005	
Country	**Banking institution**	**Insurance institution**
France (four banks, six insurers)	• BNP Paribas, • Societé Générale, • Natexis Banque Populaire, • Crédit Agricole	• AGF, • AXA, • CNP Assurances, • Finaxa, • SCOR, • Euler Hermes
Germany (five banks, four insurers)	• HVB, • Commerzbank, • Deutsche Bank, • Depfa Bank, • Deutsche Postbank	• Allianz, • AMB Generali Holding, • Hannover Re, • Munich Re

Italy (15 banks, eight insurers)	• Banco BPI, • Banca Lombarda, • Banca Intesa, • Banca Populare Milano, • Banco Espiritu Santo, • Banca Populare di Verona Novara, • Banca Nazionale Lavoro, • Capitalia, • Mediobanca, • San Paolo IMI, • Unicredito Italiano, • Banca Monte Dei Paschi di Siena, • Cassa di Risparmio di Firenze, • Banca Antonveneta, • Banche Populare Unite	• Alleanza, • Generali • Fondiaria, • Mediolanum, • Milano Assicurazioni, • RAS, • Unipol, • Cattolica Assicurazioni
Spain (four banks)	• Bankinter, • Banco Bilbao Vizcaya Argentaria, • Banco Santander Central Hispano, • Banco de Sabadell	
Switzerland (seven insurers)		• Baloise, • Helvetia Patria, • National Insurance, • Swiss Life Holding, • Swiss Re, • Zurich Financial Services, • Converium Holding

United Kingdom (eight banks, 12 insurers)	• Alliance & Leicester, • Barclays, • Close Brothers Group, • Halifax Bank of Scotland, • HSBC, • Royal Bank of Scotland, • Standard Chartered, • Investec	• Amlin, • Aviva, • Brit Insurance Holdings, • Britannic Group, • Hiscox, • Jardine Lloyd Thompson, • Legal & General, • Prudential, • Royal & Sun Alliance Insurance, • St. James's Place Capital, • Wellington Underwriting, • Old Mutual

Table 6: Correlations data

Since these estimations provide us with fairly low correlation values, we refrained from testing inter-industry dependences. Therefore, we confine this analysis to intra-industry developments and refer to groups and conglomerates, when we consider intra-group dependences in the event study.

Banking	mean linear correlation (full)	mean linear correlation (partial)	mean rank correlation (full)	mean rank correlation (partial	number of institutions
France	0,50	0,16	0,46	0,18	4
Germany	0,53	0,26	0,48	0,47	5
Italy	0,38	0,21	0,36	0,18	15
Spain	0,33	0,08	0,32	0,14	6
United Kingdom	0,45	0,10	0,43	0,12	9

Insurance	mean linear correlation (full)	mean linear correlation (partial)	mean rank correlation (full)	mean rank correlation (partial	number of institutions
France	0,32	0,13	0,27	0,12	6
Germany	0,48	0,06	0,39	0,06	4
Italy	0,34	0,19	0,33	0,16	8
Switzerland	0,38	0,10	0,37	0,10	7
United Kingdom	0,30	0,13	0,27	0,13	12

The correlation figures are based on the mean of pair-wise corrrelations of all institution considered. The Pearson coefficient was taken for linear correlations, Spearman's rho was used for calculating rank correlations. In order to derive partial correlations, DJ Stoxx Banks and DJ Stoxx insurances were assumed to reflect general market movements. The relevant time frame was January 1999 to July 2005.

Table 7: linear and rank correlation in financial industry

When calculating rank correlation, Spearman's rho was used, for linear correlations the classical Pearson coefficient is used. In table 7, one can find the mean correlations for each country and across both industries, i.e. banking and insurance. The data period was beginning of 1999 to July 2005. Both mean linear correlation figures and mean rank correlations are shown. In both cases full and partial correlations were calculated, whereby the first two columns represent mean linear correlation coefficients and the second two the mean rank correlations

The complete tables, showing all pair-wise correlations between national banks and national insurance companies, respectively, can be found in the appendix. As expected from economic theory, the correlations of credit institutions seem to be higher than those of insurance companies, although they are still rather low, with values mostly below fifty percent in the full correlation case. Partial correlation is almost negligible in both industries.

Another argument for low correlation within the insurance industry is, however, the fact that European insurers – in contrast to American (monoline) insurance companies - are less homogeneous than the (universal) banking industry, which is generally fairly uniform[92].

While in the United States insurance is usually a monoline business, the insurance business – essentially the non-life or general insurance business - in Europe is more diversified. The insurance business consists of many different business lines, usually classified into three main areas, i.e. life-, non-life, and reinsurance. Non-life insurance can be further broken down to a broad variety of business lines, e.g. household, motor, liability or fire insurance.

These business lines share considerably different characteristics, e.g. materialising in the balance sheet structure, and imply fairly low correlation figures. Tillinghast provides an outstanding claims correlation matrix, which, for instance, assumes a linear correlation of 0.2 between motor and household or fire, forty percent correlation between household and fire or no correlation between liability and fire (cf. Tang and Valdez, 2004).

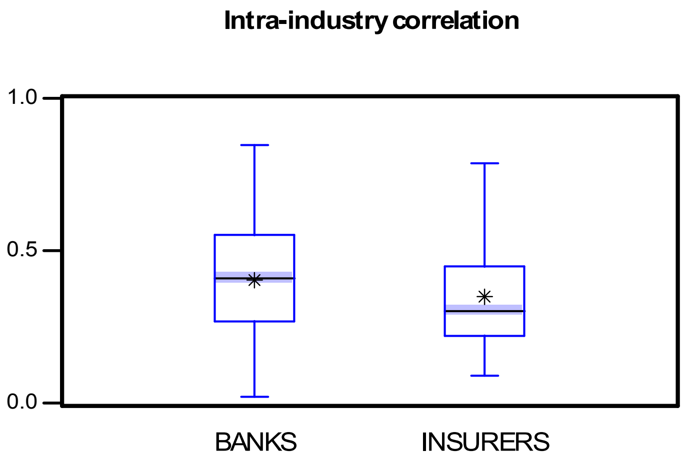

Figure 19: Box plot of intra-industry correlation (of sample)

The box plot is a short summary of the most essential results of our intra-industry correlation calculations. The box itself represents the first and third quartiles, i.e. the middle fifty percent of the data. The difference between these values is the interquartile range. The horizontal line in the box is the median or second quartile; the asterisk represents the mean. Data outside the box are represented by the whiskers and staples.

In the banking case data are highly symmetrically distributed, as can be derived by the fact that the mean is almost equal to the median, i.e. about 0.4, and that the median is placed in the middle of the box. Intra-industry correlation of European insurers is not symmetric. The mean is higher than the median – which implies positive skewness - and both values are below the values of the banking market. Obviously, there are stronger outliers than in the banking case as the mean is higher

92 Here, we explicitly abstract from the fact that there are differences in the investment focus of banks. It is obvious that cooperative banks have another focus than, for instance, commercial banks (cf. Pfingsten and Rudolph, 2002).

than fifty percent of the data observed. The upper fifty percent show a higher spread than the lower fifty percent.

According to the F-test conducted[93], there is a significant difference between the series' means ($F>F_{p-1,\ N-p;\ 1-\alpha}$), that is, the hypothesis, that mean intra-industry correlation values are equal, has to be rejected. To some extent, this result is already observable in the box plot as provided in figure 20. However, according to a separate estimation for the German and Italian sample, the null hypothesis cannot be rejected, i.e. no significant difference in the means can be observed.

No obvious difference between rank correlation and linear correlation was found. This fact may indicate that stock return densities are not heavily skewed. Furthermore, this result confirms us in using procedures (implicitly or explicitly) based on linear correlation, such as the event study methodology in the next section. Thus, the risk of underestimating dependences is, at least, confined. Moreover, since observation periods are rather short, heteroskedasticity will be a minor problem.

The quantile-quantile (QQ) plot, which estimates the deviation from linearity, confirms this observation for the returns of the European financial market indices. As we can observe, data points do hardly deviate from the forty-five-degree line, which defines an exact correspondence, that is, banking data (more precisely, their weighted aggregate as represented by the DJ Stoxx TM Banks or Insurance index) are almost normally distributed because the distributions on the horizontal and vertical axes almost match. The deviation of the insurance data from the normal distribution is higher. In both cases, it is the more extreme values that deviate from the normal distribution.

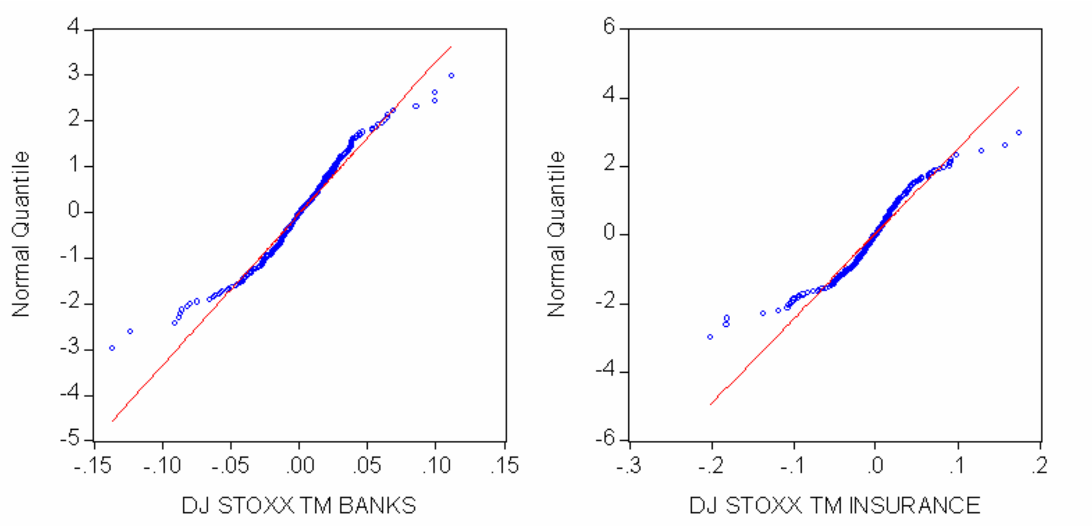

Figure 20: Quantile-quantile plot of DJ Euro Stoxx TM Banks and Insurance

93 For test statistics refer to table 31 in the appendix.

3.2.3.2. Correlation within groups

In a next step, we will estimate intra-group correlation, which is – prior any calculations - assumed to be noticeably higher than correlation between independent companies. This assumption is primarily based on the perception that groups are strongly integrated and, therefore, are more exposed to any positive or adverse externalities of the group, e.g. via capital linkages, than to common shocks. The correlation of independent companies is supposed to be strongly based on common shocks[94].

The intra-group correlation is especially interesting as it provides a first crude impression of how stock returns may react after the announcement of an affiliated company's event. Strong stock return reactions of the affected entity and its affiliate(s) are assumed to be consistent with high correlation. Low correlation may be an indication of weak or no reaction in the event case. Negative correlation might even imply opposite movements in share prices.

It is assumed that a high correlation of stock returns reflects a strong interrelation of group constituents. If one company is affected by a negative[95] event, the investor expects an impact on other affiliates, which is expressed in those companies' return developments during the event period or shortly after. As explained earlier, a high asset correlation, ceteris paribus, implies a higher default correlation. Hence, the failure of one particular group affiliate may be related to a drop in value of other affiliated companies.

It is important, though, that the other group constituents are not directly affected by the shock because we are only interested in contagion or second round effects. Failures, which occur simultaneously and, which are caused by the same factors or causes are generally not covered in this research project, although simple correlations cannot provide a clear distinction. As such, correlation estimations only serve the purpose of a first crude impression of potential interdependences.

As explained in a preceding section, under extreme situations correlation may considerably differ from normal times. While "normal" correlation may be low, (extreme) tail correlation may be excessively high. As such, poor correlation under normal circumstances does not necessarily imply that affiliated companies will not show any reactions to a noticeable event of another group member, although the probability of a reaction may be lower.

In stress situations we then may recognise strong interdependences. Catastrophic events are typical examples where dependences become obvious. In such extreme events, we may suddenly experience that risks become imminent simultaneously.

The number of financial groups with several listed subsidiaries is quite low in Europe. This fact may be interpreted as an indicator for increasing integration of

94 For that reason also partial correlation, abstracting from those common industry movements, are calculated. In order to abstract from overall market movements, one may use total market indices.

95 A positive event may trigger similar reactions. Intuitively, these are assumed to be less distinct than negative reactions.

financial groups. The Netherlands with large conglomerates such as Fortis, ING or ABN Amro is a prominent example. However, a similar tendency is also observable in other European countries, e.g. Great Britain, the Scandinavian countries or Belgium. The selected companies can, therefore, only represent a rather small sample of all European financial groups that would be worth analysing.

Furthermore, the analysis is restricted to companies with a clear group structure, while loose majority stakes in another company, which constitute financial investments only, are not considered. Examples are Munich Re that has a stake in Commerzbank or Allianz, French Crédit Agricole which has a majority stake in Italy's Banca Intesa, etc.

Probably, in a few years the list will become noticeably larger if we can trust the rumours in the daily economic press on mergers, acquisitions, hostile takeovers and the denials thereof. Potential candidates are diverse credit institutions in Italy's highly fragmented market or British insurers. The future will show, which of these rumours will actually come into effect. Nevertheless, it makes obvious that the market is very dynamic at the moment.

The groups finally considered are provided in table 9. Table 30 in the appendix provides the respective subsidiaries of all the groups analysed.

(predominantly) insurance	***(predominantly) banking***
Munich Re	Hypo- & Vereinsbank
Allianz	Commerzbank
Axa	Group Santander
Fondiaria-SAI	KBC Group
Aviva	Capitalia
Generali	San Paolo IMI

Table 8: Banking and insurance groups considered

Prima facie, no significant differences in correlation between affiliated and non-affiliated companies can be identified, both in the banking and the insurance case. For certain companies, correlation is even negative, which may be explained by the illiquidity of these stocks, predominantly belonging to group subsidiaries. Naturally, in these cases the explanatory power of the market model is also noticeably weak.

With the exception of Dresdner Bank and Allianz, companies that have been fully integrated recently (e.g. Almanij into KBC Group), or are going to be integrated soon (e.g. Finaxa into Axa), show particularly strong correlation, well above 0.9. In our view this fact is an obvious sign that interdependence increases, the more integrated companies are. Unfortunately, we do not have the means to observe interdependences of fully integrated companies, unless some of them issue bonds or credit default swaps[96].

However, full integration may not necessarily mean strong (perceived!) interdependence as shown by the pre-integration correlation figures of Dresdner Bank and Allianz or even Allianz and RAS, which is of the same industry and is being integrated in spring 2006.

Nevertheless, thereby, the shortcomings of publicly available data, such as share prices, which to a large part express public perceptions, become obvious. They cannot express interdependences that are beyond mere "reputational" links. Integrated companies are more interdependent than stand-alone institutions. They often share the same management; have strong capital and physical linkages, show mutual support in times of stress, etc.

While correlation of Bank BPH with its holding company is even negative (r = -0.5), it is especially high with Bank Austria Creditanstalt (0.95), an institution that is very active in Central and Eastern European (CEE) countries. That may also explain why its correlation with BRE Bank is the highest within the sample; higher than intra-group correlation of BRE Bank. The strong correlation between DAB and Comdirect or Fineco provide a first indication that also the sector (here: internet banking) may play a significant role in investors perception; possibly more significant than affiliation. Moreover, holding companies of the same industry show considerable correlations in many cases.

Overall, correlations do not provide much more than mere indications of certain relations but they can serve as a starting point for further investigations. Therefore, we will, subsequently, focus on more sophisticated methodologies to assess potential spillovers, bearing in mind the information already gained.

3.2.4. Event studies

In a next step, we focus on company events that are assumed to have an impact on other industry entities, and group affiliates, in particular. This kind of study is a standard methodology in the literature when the effect of specific events on companies is analysed (cf. MacKinley, 1997). Basically, reactions on these events are measured by comparison of pre-event stock price movements with those during the event. Following Goldstein and Pauzner (2004), contagion generates positive correlation between the returns. Hence, we argue that we should experience corresponding reactions of affiliates' returns to an intra-group shock, because affiliates' returns are assumed to converge.

In fact, one can observe strong similarities in the assumptions to the large literature on information-based contagion, as described in chapter 2.2. As such, event studies represent a prominent way to test the theoretical models' results empirically, even

[96] Subsequently, we discuss the possibility of using credit spreads to analyse company interdependences.

though, in our case, a different focus is taken, when analysing intra-group spillovers.

To abstract from general market movements, and to attain the pure reactions of a company's share to a certain event, one is interested in abnormal or idiosyncratic returns, which are, afterwards, tested for statistical significance. A significant abnormal return movement, after a certain positive or negative event, concerning another affiliate or the parent company, is interpreted as contagion effect.

3.2.4.1. General description of the methodology

A market model – a statistical model which relates the return of any given security to the return of a representative market portfolio - is used to estimate normal returns[97]. The return of security i in period t is estimated by using the following equation of the market portfolio[98]:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}; \quad E(\varepsilon_{it}) = 0, \operatorname{var}(\varepsilon_{it}) = \sigma^2_{\varepsilon_i} \tag{3.21}$$

R_{it} and R_{mt} are the period-t returns on security i and the market portfolio m, respectively. The model parameters, α_i and β_i, are OLS-estimates and the residuals ε_{it} are the abnormal returns. The advantage of OLS-estimates is their property of being unbiased and efficient. However, they assume that assets follow a multivariate normal distribution and are independently and identically distributed (iid) through time, which need not necessarily be the case, as we have already argued earlier.

The methodology further assumes that parameters, i.e. the regression coefficients, remain constant during the whole period, which may particularly affect the quality of the results during periods of changing business cycles. Therefore, parameters are estimated, by analysing a sufficiently long period in order to observe a general trend in time series.

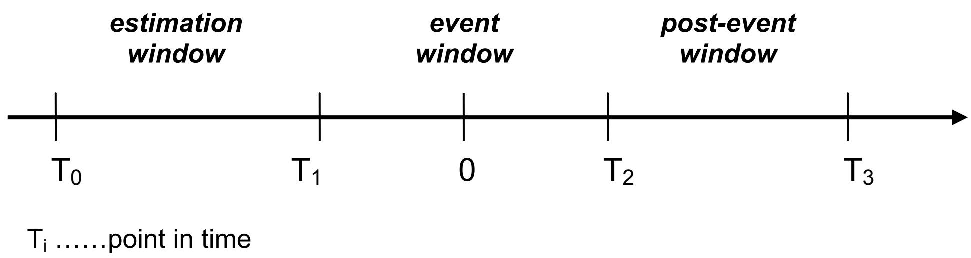

Figure 21: Time line for the event study

As shown by the time line in figure 21, the time frame is divided into three main sub-periods, i.e. the estimation period, the event period and the post-event period,

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97 A drawback of this approach is that – as shown by Campbell et al. (2001) – the firm-level volatility, relative to market volatility has noticeably increased, thus reducing the explanatory power of the market model for a typical stock.

98 In our notation, we follow the example of MacKinlay (1997) and Campbell et al. (1997).

whereby the former two are used for calculations and the latter can serve as reference.

The period prior to the event, $T_0 – T_1$, is used as estimation window, such that the event itself cannot impact the parameters of the model. We take an estimation window of one year, so that other events, which occur during this period, cannot bias the estimation. These events are assumed to be averaged out in a sufficiently long period and, therefore, do not adversely impact the market model.

The event window, $T_1 – T_2$, is set around the event at time 0. In order to take account of potential time lags in other market participants' reactions, the event window in our model comprises ten days before and after the event, in total 21 days.

The inclusion of a larger number of pre-event days for the event window[99] will consider early knowledge of the event by market participants, e.g. insiders or simple expectations by the market, prior to the event. The effect of early reactions can, frequently, be studied around the announcement of quarterly or annual reports.

The inclusion of post-event days in the event period takes account of the fact that other companies' shares may not immediately react. It may take some time until investors have fully assessed the possible implications of the event for the (indirectly affected) company. Nevertheless, the distribution of pre-event and post-event days around the actual event need not necessarily be symmetric. This choice was quite arbitrary. Moreover, test-estimations with a shorter event window showed that results did not severely deviate and thereby distort our conclusions.

Given the market model estimates above, abnormal returns $AR_{i\tau}$ – where $\tau = T_1+1,\ldots, T_2$ – for company i are measured for the event window.

$$AR_{i\tau} = \hat{\varepsilon}_{i\tau} = R_{i\tau} - (\hat{\alpha}_i + \hat{\beta}_i R_{m\tau}) \tag{3.22}$$

In a next step, the abnormal returns have to be aggregated across the whole event window in order to take account of contagion effects, affecting other (affiliated) companies.

The cumulative abnormal return for security i over the event window (T_1 to $T_2>T_1$) is:

$$CAR_i(\tau_1,\tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau} \tag{3.23}$$

We test the results under the null hypothesis H_0, which implies that the event has no impact on company i's assets, i.e. in technical terms the event has no impact on the mean and the variance of its returns. To test the null hypothesis for security I, the standardised abnormal return is calculated, which, for a sufficiently long estimation period, can be approximated by standard normal distribution:

99 A common choice for the event window is one day before and after the event. However, the intention of most studies deviates from the purposes of this analysis, such that a longer event window is justified.

$$SCAR_i = \frac{CAR_i}{\sigma^2_{CAR_i}} \tag{3.24}$$

$\sigma^2_{CAR_i}$ is the variance of the cumulative abnormal returns and is calculated as follows:

$$\sigma^2_{CAR_i} = (\tau_2 - \tau_1 + 1)\sigma^2_{\varepsilon_i} = \iota' \mathbf{V}_i \iota \tag{3.25}$$

$\mathbf{V}_i$ is the covariance matrix of asset i's abnormal returns, conditional on the market return over the event window. ι is a column vector of ones, defined by the length of the event window (τ_2-τ_2+1), and ι' its transpose, i.e. the corresponding row vector. $\mathbf{V}_i$ is calculated as:

$$\mathbf{V}_i = \mathbf{I}\sigma^2_{\varepsilon_i} + \mathbf{X}^*_i(\mathbf{X}'_i\mathbf{X}_i)^{-1}\mathbf{X}^{*\prime}_i\sigma^2_{\varepsilon_i} \tag{3.26}$$

where $\mathbf{X}_i$ = [ιR_m] is a [τ_1-τ_0+1)x2]-matrix[100], with R_m as the vector of market return observations for the estimation window, $\mathbf{X}^*_i$ = [ιR^*_m] contains the market return for the event window, **I** is the [(τ_2-τ_1+1)x(τ_2-τ_1+1)]- identity matrix and $\sigma^2_{\varepsilon_i} = \frac{1}{(\tau_2 - \tau_1 + 1) - 2}\varepsilon'_i\varepsilon_i$ is the variance of the abnormal returns or residuals[101].

For the interpretation of our event study results, there is one important caveat. Event-induced variance, which usually exceeds the variance over the estimation window, may lead to excessive rejection of the null hypothesis of zero abnormal returns (Seiler, 2000). In other words, as correlation coefficients are conditional on market volatility, estimates of correlation coefficients tend to grow and to be biased up during crises, which, by definition, are periods of higher volatility (cf. Forbes and Rigobon, 2002). Hence, our results on contagion have to be taken with caution, as regards the aforementioned aspect. The true relationship between two returns may have remained constant, while the estimated correlation increases when the variance increased[102], i.e. results may be biased by heteroskedasticity.

3.2.4.2. Our approach to test potential spillover effects

In our approach[103] to find significant events, we take ad hoc announcements, taken from the respective companies' homepages, the stock exchanges, where the companies are listed or from organisations that collect ad hoc publication data, such as "Deutsche Gesellschaft für Ad-hoc Publizität mbH." This approach enables the analysis of events that are based on internal shocks. The chance of erroneously assessing the reactions to exogenous shocks, which is not the main aim of this

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100 X' is the transpose of X. Matrices are presented in bold print such that they can be distinguished from scalars.

101 Mind that (τ_2-τ_1+1) covers the number of days in the event window and (τ_1-τ_0+1) is applied for the estimation window.

102 A reply to this very important caveat can be the argument that we are primarily interested in the risk one affiliate poses on the others. Under this condition, it is of minor importance what cause this can be referred to.

103 Considerable input for this analysis was received from a CEIOPS project by Bernhard Herzig.

research project, is reduced, even though these shocks may still appear simultaneously.

After having found relevant company events, i.e. ad hoc announcements, reactions of other enterprises on this (new) company-specific information are investigated and analysed in the way explained, by applying event study methodologies.

The relevance of the events is based on the fulfilment of the subsequent criteria:

1. The event must be company specific and may not concern a market or industry wide incidence, as we try to detect contagion effects provoked by companies only.
2. The events' impact on the company's return has to be considerable, to be able to influence other companies' stock prices.
3. The events will concern new information for the investors, i.e. they are not anticipated in the stock price, a priori.
4. During the event period the interference with other events must be prevented, such that developments of abnormal returns can be assigned more clearly to the investigated event.

For ad hoc announcements, the first requirement is usually fulfilled, which makes them so attractive for our analyses. The impact of criterion two can only be judged upon, after the analysis of time series data. For instance, fully anticipated events will not show any excessive reactions (cf. requirement 3). Such events are, therefore, not assessed further. The last requirement mentioned is very important because it will prevent that share prices from being biased by several simultaneous events. Under such circumstances, it is almost impossible to isolate the reactions to a particular event. So, whenever the reactions on an ad hoc announcement are analysed, it has to be ascertained that no other affiliated company, simultaneously (or during the event window), issued any economically relevant announcements.

The estimation window for the model is the year prior to the event window. To estimate the market model parameters Dow Jones Euro Stoxx price indices are used as proxies for the market portfolio[104]. These indices have the advantage that they essentially cover - by including the most important European listed companies – developments in the whole European financial market.

Moreover, the correlation between the applied industry indices is particularly high as is shown in table 10. For that reason the inaccuracy is rather low, when using DJ Euro Stoxx Financials for conglomerates instead of the respective index for each subsidiary[105]. A switch in the underlying market model for the different subsidiaries distorts the results of the event study. Hence, we choose the market model that best suits the individual group's circumstances.

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104 Basically, the following three industry indices are used: DJ Stoxx Insurance, DJ Stoxx Banks and DJ Stoxx Financials, depending on the company sample that is investigated, insurance groups, banking groups, conglomerates.

105 Note, that the use of several market models within one event study might lead to inaccuracies that hamper the comparability of reactions.

	BANKS	INSURANCE	FINANCIALS
BANKS	1	0,88	0,98
INSURANCE	0,88	1	0,94
FINANCIALS	0,98	0,94	1

Table 9: Correlation between DJ Stoxx industry indices

3.2.4.3. Factors hypothesised to explain abnormal return movements

The valuation effects on companies' stock returns, induced by ad hoc announcements, may vary, depending on various factors. Certain factors seem to support the release of similar reactions to events', the company is not directly affected by. Building both on economic theory - as described in preceding sections - and simple perceptions we identify the subsequent factors and construct the corresponding hypotheses:

Companies with similar characteristics: As argued by Fama (1998), firms with characteristics, more similar to those of the announcing firm, should respond differently to those with less similar exposures, i.e. we assume contagion effects to be more probable for similar companies.

The decisive question is whether group affiliation has a sufficiently strong impact on the institutions' characteristics, such that it is stronger than other forces like industry affiliation. Under these circumstances group affiliation may provoke share price movements in the same direction as the rest of the group.

Perceived relation with / proximity to announcing institution: Irrespective of any factual relationship, the chance to be affected is assumed to be higher when the public perceives the companies to be interdependent. This is an argument, a large strand of literature on bank runs or financial contagion - starting with the seminal paper of Diamond and Dybvig (1983) - is based on.

On the contrary, publicly perceived and credible firewalls between the group entities may mitigate contagion effects, i.e. investors and, hence, share prices will not excessively react to a specific (announced) event of the other entity. Nonetheless, existing collaterals of holding companies or other affiliated institutions may thwart the firewalls, built up between the institutions. The position of the guarantor may, therefore, be negatively influenced by an adverse announcement.

Industry affiliation: Due to well known systemic impact and strong interbank relations, banks are supposed to show a higher propensity to contagion than insurance companies. This relation should also hold in the case of conglomerates. Hence, we expect banks to be more likely to follow negative announcements of other banks than insurers would do. Traditionally strong interrelations between a group reinsurer, which often serves as the holding or parent company, and the group's primary insurers are also expected to provoke particularly strong reactions after an announcement. This effect may be based on the credit risk (i.e. the counterparty risk) the insurer incurs, when transferring insurance risks to the reinsurer[106].

Furthermore, we believe inter-industry effects to be weaker than intra-industry effects and, therefore, contagion effects between banking affiliates to be more imminent than those between insurers or banks and insurers (cf. Slijkerman et al., 2005). On the other hand, the higher the impact of industry affiliation on a company's returns, the lower the importance of the group the company is belonging to, is. Generally, large companies are expected to follow and determine common market trends and are only weakly – or to a lower extent - affected by group internal events. Put another way, large companies are primarily influenced by industry competitors of similar size. Moreover, capital linkages via the interbank market may also be higher than those between group companies.

Size: It is assumed that announcements of holding companies or large affiliates have more significant effects than those of small or less important subsidiaries. This argument is based on the stronger factual connexions with larger affiliates and on the public perception to have a stronger impact. It is comparable to the argument on money centre banks and their linkages with other institutions in the interbank market (Freixas et al, 2000).

Positive versus negative events: It is assumed that negative events have a higher probability to trigger reactions by investors - ultimately reflected in affiliates' share prices - than announcements containing positive information. This may be due to the perception that investors are particularly risk-averse under adverse (economic) conditions and, therefore, put a stronger weight on negative events than on positive ones. The traditional, conservative and risk-averse investor prefers the prevention of losses to the gain of extraordinary returns.

Financial condition: Companies, already facing financial difficulties, are assumed to have a higher propensity to contagion than healthy or successful institutions. First, investors are much more nervous under these circumstances and may, therefore, react to any announcement that could possibly impact the institution they are invested in. Furthermore, even minor negative developments may have an immediate impact on the stability of the financially ailing company.

Penetrated markets: Companies, operating in different, rather asymmetric countries or markets, may certainly react less (or not at all) to other company-specific events. For instance, a subsidiary, operating in an emerging market, may react differently to a shock than group entities, domiciled in a saturated market.

Nevertheless, as we observed from data of the interbank market, interrelations across countries are gaining in importance and markets may, thus, show a strong assimilation and become increasingly symmetric. National borders cannot serve as a

106 The potential credit risk, primary insurers are exposed to, is broadly discussed in a Swiss re sigma study of 2003.

firewall against any adverse (or even positive) developments in companies domiciled in a different country. Mergers across countries even accelerate this process.

Investor base: Basically, one may assume that the higher the share of informed investors, the lower the exposure to contagion is because investors can clearly estimate the true risk of their company. This is a result gained by models of Chen (1999) or Kodres and Pritsker (2002) and serves as the main argument for certain researchers to introduce obligatory subordinated debt as a regulatory measure or disciplining device (cf. Calomiris, 1999). A company with a very low amount of floating shares will, therefore, show less reaction to events, it is not directly exposed to.

The following figure presents the previous statements on factors that are assumed to have a strong explanatory power for the abnormal return movement of the share prices of companies that have not been directly affected by the (announced) event.

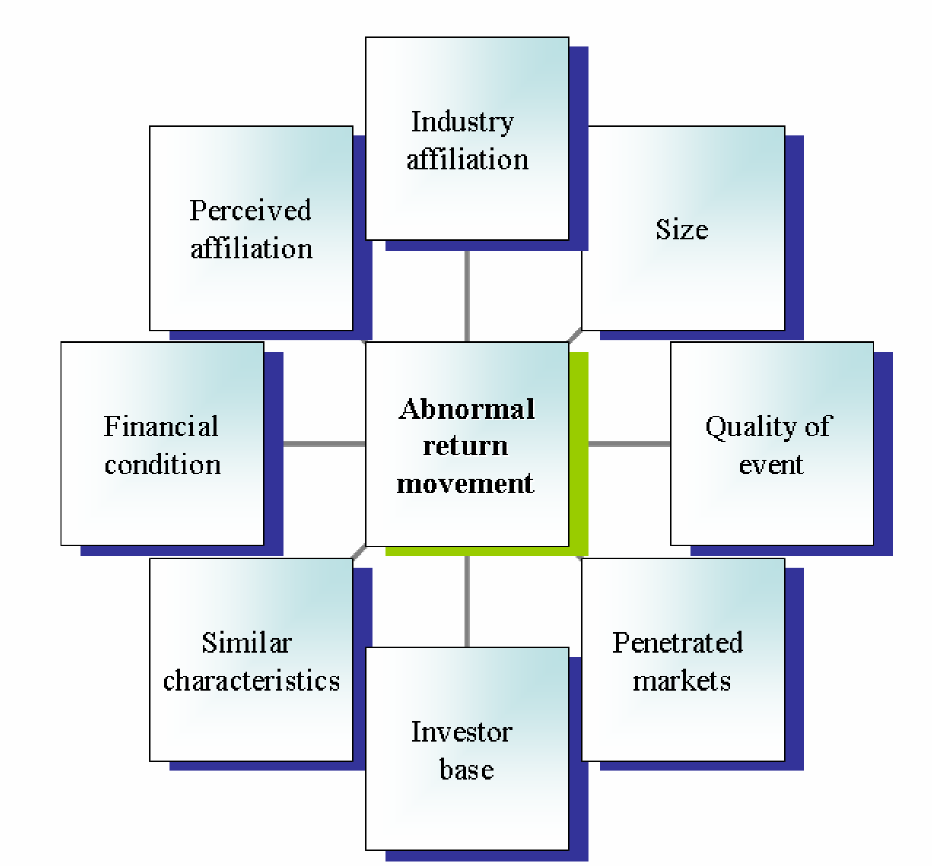

Figure 22: Factors explaining abnormal return movements

3.2.4.4. Empirical results of the event studies conducted

Event studies have been conducted for nine European groups, of which five are pure banking groups, two groups consist of insurance institutions only and the remaining two are mixed groups or conglomerates[107]. Most of these groups are not restricted to one single national market but have affiliations and operations in several European countries, although the degree of internationalisation is fairly distinct. The number of (listed) affiliates lies in the range of two to six institutions. To that extent, we treat quite heterogeneous groups of companies.

As mentioned earlier, the choice of groups was essentially restricted by the existence of affiliates listed at any stock exchange, which enormously limited the number of relevant groups. Due to the already small sample, no further selection criteria were utilised. In figure 23 the selected nine financial groups with all their (listed) affiliates are depicted.

Allianz	Allianz Leben	AGF	Euler Hermes
	Allianz	RAS	Dresdner Bank
HVB	Bank Austria	DAB	Vereins- & Westbank
	HVB	Bank BPH	
Generali	Generali Vienna	AMB	
	Generali	Generali Switzerland	
Munich Re	Ergo	Ergo Previdenza	
	Munich Re		
Commerzbank	comdirect	BRE Bank	
	Commerzbank		
AXA	AXA Insurance	Finaxa	
	AXA		
KBC	Almanij		
	KBC		
Capitalia	Fineco		
	Capitalia		
San Paolo IMI	Banca Fideuram		
	San Paolo IMI		

Figure 23: Group affiliations

Both event studies for group holding events and those of their affiliates are conducted, recognising that subsidiary events may possibly produce weaker reactions than announcements of holding company events.

Since two thirds of the selected groups only have one or two listed subsidiaries, and, therefore, possibly produce rather arbitrary results, a strong emphasis is put on Hypo- & Vereinsbank (HVB), Allianz and the Munich Re group. For these groups also most ad hoc announcements were available, which should allow for a more

[107] If Hypo & Vereinsbank and its affiliates are exempted from being part of the Munich Re group (18 percent ownership only), then Munich Re is also a pure insurance group. According to the European Financial Conglomerates Directive, however, Munich Re constitutes a conglomerate as it fulfils the necessary thresholds for the constitution of a financial conglomerate.

representative sample for event study analyses. Nevertheless, due to the small number of relevant groups, we essentially conduct case studies.

Table 10 shows summary statistics of the event studies conducted[108]. The numbers in the table refer to the group-specific average of how many affiliated companies have abnormal returns with the same sign, i.e. how many affiliates, in relative terms, show the same reaction to an event, by which they are not directly affected but possibly indirectly via another group member.

HVB	Munich Re[109]	Allianz	Commerz bank	Generali	KBC	Capitalia	San Paolo IMI	Axa
0.63 (0.87)	0.60 (0.42)	0.58 (0.43)	0.58 (0.75)	0.51	0.75	0.57	0.75 (1.0)	0.68

The numbers represent the percentage of affiliates with the same reaction as the company that was directly affected, i.e. the company the ad-hoc announcement can be referred to. The numbers in parentheses provide information on the reactions to significant events only, i.e. ad-hoc announcements that were based on events with a p-value $\leq$ 0.1.

Table 10: Percentage of affiliates with same reaction as directly affected company

In parentheses, we provide the average percentage of affiliates that is (indirectly) affected by significant events, i.e. events significant at the ninety percent confidence level (p-value$\leq$ 0.1). For Generali, KBC and Capitalia, we do not provide results as there has been only one significant event each.

In three cases, i.e. HVB, Commerzbank and San Paolo IMI, these numbers are higher but in the remaining two cases, i.e. Munich Re and Allianz, similar reactions of affiliates to a significant primary event are even less frequent than on average. The significance of a primary event does not necessarily mean that investors of other affiliates react similarly. This is a quite disappointing result as it might be an indication that affiliates' stock price movements are only marginally related to events of other group members, or that, at least, other environmental influences are noticeably stronger.

One may emphasise that Allianz group consists of rather weakly integrated subsidiaries, operating in different business areas and geographic regions. In the case of Munich Re, we recognise two different business models with a different risk structure: a globally active reinsurer and two primary insurers with a strong local focus.

All other groups are primarily active in similar businesses and the same industries. This might explain why affiliates seem to be more likely to react to other group

108 The spreadsheets with all event studies conducted for each financial group are displayed in the appendix.

109 Munich Re without HVB group.

members' (significant) events, although this observation is not tested statistically, due to the lack of sufficient data points.

The numbers in the table are averages over all event studies conducted for each group and, hence, contain both events of subsidiaries and the parent company. One may not make the mistake to compare these numbers directly with those of other groups because the number of constituents for each group, the number of events, etc. may significantly differ and, thus, may distort any derivations.

In the appendix the descriptive statistics on events for each analysed group is provided. Tables 32 to 40 show the consequences of ad-hoc announcements on the share prices of a group's constituents. The number of ad-hoc announcements for each group considerably varies, also depending on the number of group constituents.

Figure 24 displays an illustrative example, which shows well the development of cumulative abnormal returns around the event date. The event was the announcement of a profit warning for Allianz on the 31st of July 2002. The null hypothesis implies that those values do not significantly deviate from the abscissa, i.e. one should not recognise any strong deviations from the x-axis, if the null hypothesis is entirely fulfilled. In other words, the subsidiaries' shares do not show any reaction to the parent company's announcement. Nevertheless, the CARs of Allianz, Allianz Leben and Euler Hermes in this example are significant at the 0-, 2.7- and 8.3- percent level, respectively, which means that the null hypothesis has to be rejected in these cases. Obviously, the event has a significant impact, both on the directly affected Allianz and two of its subsidiaries. In the other examples, i.e. RAS and AGF, cumulative abnormal return movements are not strong enough to be assumed significant.

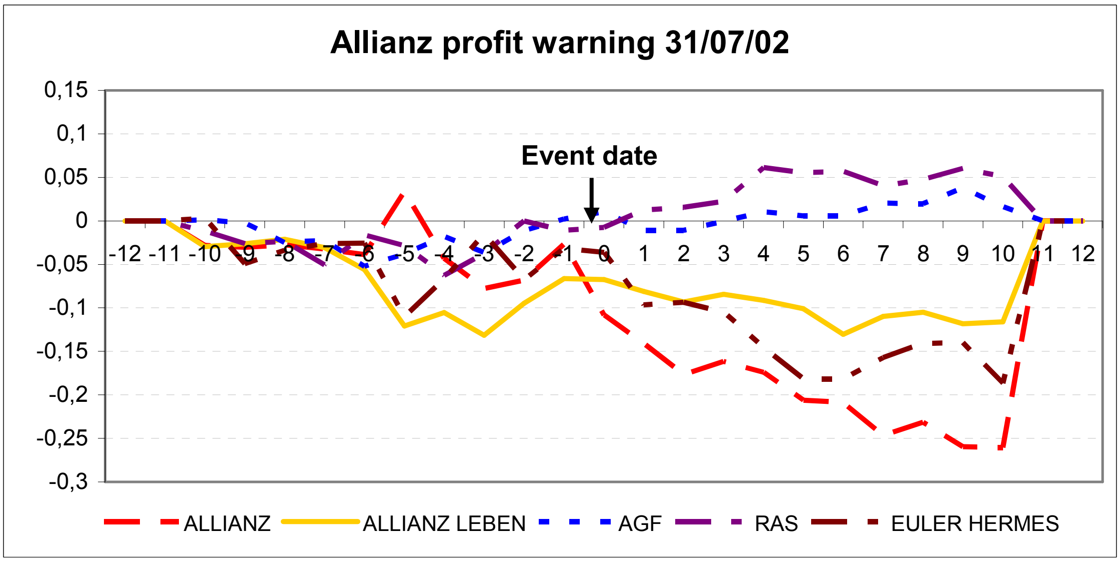

Figure 24: Cumulative abnormal returns (illustration)

3.2.4.4.1. Detailed analysis of obtained results

The following section provides details on the event studies conducted. It is a summary of our estimations of reactions to ad-hoc announcements during the last few years. The spreadsheets, these analyses are based on, are provided in the appendix.

Hypo- & Vereinsbank: After correcting the ad-hoc announcements for overlapping events, 36 events in total were analysed and the impact on the five group companies, i.e. Hypo- & Vereinsbank, DAB, Bank Austria Creditanstalt, Bank BPH and Vereins- & Westbank, were assessed[110]. Of these 36 events, only six were significant at the ten percent level. In four of these cases, there was also one affiliate that simultaneously showed significant cumulative abnormal returns. The other affiliates did not show any significant changes or even moved in the opposite direction.

In four events CARs of one affiliate and in two events CARs of two affiliates were significant (ten percent) although the CAR of the directly affected company did not show any significance. One event even showed a significant negative CAR at the 95 percent confidence level for an affiliated company (Bank BPH), although the CAR for the affected company was positive.

Two companies are obviously unaffected by others' announcements, namely Bank BPH and Vereins- & Westbank. For Bank BPH, every other event shows a cumulative abnormal return that moves in the opposite direction than the CAR of the affected company. One interpretation of this result may be the fact that Bank BPH operates in a different, still not saturated, but growing market, and is, therefore, only marginally affected by events of the other affiliates that – with the exemption of Bank Austria Creditanstalt – predominantly operate in Germany. For Vereins- & Westbank, CARs show opposite signs in nine of 28 cases. This may be due to the stock's low liquidity and the low percentage of free float.

Overall, most events did not have a significant impact on affiliated companies' CARs. Also, the average share of affiliates' CARs, showing the same sign as the affected company's CAR is – albeit above fifty percent – rather low.

The null hypothesis states that cumulative returns will be zero on average, i.e. if the CAR for the affected company is negative, the probability of an affiliated company to have a negative CAR will not be higher than to have a positive CAR. If this hypothesis can be rejected, one is concerned with a contagious event.

Munich Re: Six events of Munich Re produced significant CARs, but none of them results in significant CARs (with the same sign) for its subsidiaries, i.e. the primary insurers Ergo Versicherung and Ergo Previdenza. In one event study one affiliate even had a cumulative abnormal return with opposite sign that was significant at the 99 percent confidence level.

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[110] It has to be remarked that Bank Austria Creditanstalt has been listed since July 2003, and Vereins- und Westbank was delisted end of October 2004. Therefore, data for these particular institutions was not available over the whole observed period.

Interestingly, the percentage of companies, showing the same reaction as the affected affiliate in the case of a significant event, was even lower than the average over the whole sample of 17 ad hoc announcements. Obviously, the probability to perceive a significant CAR of a subsidiary is not related to the significance of a directly affected company's event.

This is a counter-intuitive result, given the assumption that affiliates would predominantly react to events, which have a strong impact on the directly affected company. Obviously, company events play a minor role for share price developments of affiliated companies in the Munich Re case. The results of the study on the Munich Re group may also be influenced by the fact, that the companies concerned operate in different industries and, thus, are exposed to different shocks.

Nevertheless, in severe circumstances, reactions are expected to be more pronounced because Munich Re in distress would provoke immediate inconveniences for the affiliated institutions (under the premise that they have strong reinsurance relations with each other).

Allianz: The Allianz group is the only true conglomerate in our sample. But as Dresdner bank was delisted on 12 of July 2002, it is included in only a few events. Hence, to a large extent, only the effects on insurance companies within the group could be assessed.

The assessment of the Allianz group delivers the most disappointing results with respect to the intention of our study. On average, only 43 percent of the affiliates show the same reaction to the ad hoc announcements as the directly affected company. This is a fifteen percent lower average than the average over the total number of announcements. Moreover, in thirteen of 47 events, at least, one company has a significant CAR at the ten percent level or lower, moving in the opposite direction. This result implies that they are completely unaffected by those events. Unfortunately, it cannot be measured, whether this value would have been even higher in the absence of the event, that is, one cannot assess whether the event still had an impact on the affiliate's cumulative abnormal return development, only that other forces had simply been stronger.

Other groups: The results of the other groups remaining are in no way special and they support the arguments already brought in for the previous examples. Capitalia, San Paolo IMI and KBC have only one listed financial subsidiary. Results of these groups can, therefore, only be used as supportive arguments but cannot justify any conclusions on their own.

3.2.4.5. Weaknesses of the approach applied

In the following list some arguments will be highlighted that may considerably impact or even bias the results of the event study and which have to be kept in mind when an analysis is conducted.

- Only listed companies can be analysed, a fact that particularly impedes a complete analysis of many groups and their whole affiliation network.
- Small listed group affiliates often have quite illiquid securities and only a small percentage of free float on stock exchanges. The number of investors is restricted and the holding company is often holding more than fifty percent. As a consequence, the stock returns of these small affiliated institutions also move almost independently of stock indices (they do not form part of). As a result, the explanatory power of the market model for these companies is fairly weak, finally leading to rather arbitrary (cumulative) abnormal return calculations. The validity of the results in those cases is at least questionable.
- Event studies of this kind can demonstrate typical market reactions to company announcements, and, as such, reflect market perceptions. These reactions can be positive or negative. However, we do not obtain any information on material risk dissemination, for instance, due to strong linkages with the relevant company. The information, we get, is based on the assumptions of outsiders that do not necessarily have any insights on actual interdependences and developments. Balance sheet information is usually not sufficient to get an appropriate picture. Moreover, this information provides a snapshot only and may, in most cases, not reflect current circumstances.
- Non-linear dependences cannot be estimated due to the assumption of linearity in the estimations applied. Tail-events, which, per definitionem, should have an enormous impact, cannot be evaluated, or are not even recognised by this methodology.
- Gropp et al. (2006) argue that cumulative abnormal stock returns are not well suited to measure certain types of shocks, such as increases in earnings volatility or leverage.
- If the market is already aware of an institution's difficulties[111], the announcement may not contain much additional information and, therefore, does not produce considerable price movements.

3.2.4.6. Conclusions regarding the use of event studies

Finally, one can conclude that the results were disappointing, with regard to those expected. Eventually, the results could not support the assumption of a strong intra-group contagion risk, although they did not falsify these assumptions, either.

Clearly, ad hoc announcements were not selected with respect to their assumed contagion potential. For instance, profit warnings and capital increases may be such indicators. However, as explained it is not clear in advance whether bad news is really a negative event (or vice versa).

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[111] The argument is also valid for positive events, such as outstanding profit jumps.

As experience shows, investors are often able to price these events in advance. Therefore, share prices do not always show significant moves (jumps). Moreover, a negative event can even result in positive share price developments, or vice versa. This is the case, when the event is less severe than (or not as good as) a priori expected.

Obviously, events do not have a serious impact on group members, at least in terms of share price reactions. Despite this fact in the majority of cases group members' abnormal returns – albeit not significantly - move in the same direction as the abnormal returns of the directly affected company, i.e. CARs have the same sign. On average, more than fifty percent of all group members' share prices move in the same direction as the affected company's share price. This implies that the null hypothesis, which states that cumulative abnormal returns should be zero on average, can be rejected. A correct null hypothesis implies that when the CAR of the affected company is negative, the probability of an affiliate to have a negative CAR should not be higher than to have a positive CAR.

The assumption that insurance companies show even less dependence than groups consisting of credit institutions could not be supported. No considerable differences between banking groups and insurance groups were observable.

Finally, it has to be highlighted that this approach suffered from two main shortcomings: First, the number of financial groups and the number of ad-hoc announcements only allowed for case studies but prevented profound statistical analyses. Second, the weaknesses may have been too strong to derive clear and unique results.

3.2.5. Alternative methods to measure the intra-group spillovers of risks

3.2.5.1. Credit spreads

Credit spreads[112] are assumed to be rational market indicators or a convenient signal for the default risk of institutions, due to the downside risk of debtholders and their assumed risk sensitivity. Compared to traditional balance sheet analyses, these indicators benefit from being more forward looking and, if available, from being more frequent. Furthermore, they reflect public perception of the company's default risk and may, therefore, have a direct effect on the management's behaviour and, as a consequence, on the actual corporate condition.

Hence, several authors have proposed subordinated debt (e.g. uninsured certificates of deposit, debentures) as disciplining device that could complement other regulatory measures due to the risk instruments' sensitivity. This function can be traced back to the fact that subordinated debtholders are immediately exposed to

[112] Take, for instance, corporate bond spreads, credit default swap spreads (based on credit derivative pricing) or subordinated debt spreads.

loss but do not share any upside gains (cf. inter alia Calomiris, 1997 and 1999; Kane, 2000 or Evanoff and Wall, 2001 and 2002).

Comparing the developments of credit spreads within groups, especially, by assessing co-movements in the tails (for instance, five percent and 95 percent quantiles), is, therefore, assumed to provide information on intra-group dependences, albeit without providing information on the cause for the particular co-movement.

In this respect, one also has to mention the different informative quality of corporate bond spreads and CDS spreads as early warning indicators and, hence, as a means to estimate the impact of a certain corporate event on another group subsidiary. In theory, due to arbitrage processes, both prices can be assumed to be almost equal, i.e. the CDS spread is close to the excess of the yield of a bond (relative to the risk-free reference value), with the same maturity, and issued by the same reference entity. However, there are several factors that have an impact on this relationship and, thereby, cause the CDS price to be higher than the corporate debt spread.

The difference in both prices is based on the weak development or immaturity of the debt market. Some arguments for the inefficiency in the market are, for instance, provided by Blanco et al. (2005): First, physically settled CDS prices may contain cheapest to deliver (CTD) options. The risk shedder will hence deliver the bond with the lowest expected recovery in the case of default[113]. Second, short selling, necessary to keep up the arbitrage condition, is not costless and perhaps not even possible in illiquid bond markets. The third argument is liquidity premia as a particular transaction cost. Over all, corporate bond spreads exceed the CDS spread by a non-default component[114].

As a result, at least in the short run, we have two indicators that price credit risk differently. Blanco et al. (ibid.) find that CDS spreads mostly lead bond spreads, in the processing of new information and, hence, provide an interesting alternative for researchers.

Another argument in favour of CDS spreads comes from the way prices are found on the market. CDS spread data, provided by a broker, consist of firm bid and offer quotes from dealers, i.e. the dealer is committed to trading a minimum principal at the quoted price. By contrast, the bond yield data usually consist of indications without any commitment to trade from dealers. They may, therefore, be less accurate.

Additionally, while bond yields require an assumption on the appropriate benchmark risk-free rate to be converted into credit spreads (Hull et al. 2004), CDS spreads do not need any adjustment.

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113 If bond prices in default are equal, the delivery option has no value.

114 Nevertheless, an empirical study by Longstaff et al. (2005) indicates that default risk accounts for more than fifty percent of the total corporate spread.

3.2.5.1.1. Theoretical shortcomings and empirical evidence

To take advantage of CDS spreads as early warning indicators, one may be interested in the main drivers or determinants that can explain credit spread variation. Common factors that are tested are changes in the term structure of the yield curve, changes in the spot interest rate, changes in the equity prices, in implied volatility and in the bid-offer spread (cf. Blanco et al., 2005; Deutsche Bundesbank, 2004b).

All these factors have a significant impact on the CDS spreads. However, only a relatively small part of the spreads' variation can be explained by these drivers, that is, the explanatory power is rather weak and leaves a large share of the spread unexplained. Collin- Dufresne et al. (2001) come to similar results for bond spreads. They conclude that firm specific factors only have a minor explanatory power for credit spreads and, thus, account for a smaller fraction of the variability in changes. To a larger extent, credit spreads are influenced by aggregate factors. Put differently, the sensitivity of credit spreads to the S&P 500 index return is several times larger than the sensitivity to firm's own equity return.

Krishnan et al. (2005) come to similar results, by particularly observing banks' spread levels. As such, these measures produce fairly noisy signals of firm specific events. However, changes in systemic market factors may be reflected relatively well.

Credit spreads are also confronted by other weaknesses that are beyond aggregate factors. Hancock and Kwast (2001, p.147f.) provide several arguments for the dilution of debt as a risk measure: Yields are affected by rates of debt with similar maturities; yields generally increase with the underlying maturity of the instrument; they may be influenced by the characteristics that influence the timing of potential cash flows; they are a matter of the liquidity of the instrument and investors may require a risk premium that is beyond the expected loss from default, in order to compensate for systematic risk.

In the case of banks, the responsiveness of bond spreads may also be diluted by the expectation of external financial support[115] (cf. Mörttinen et al., 2005) due to the systemic importance of certain credit institutions and a generous safety net. In reality, the government cannot afford to abstain from acting as a "lender of last resort" if one of the country's core institutions is in a severe financial situation. However, a creditor that is ascertained, that the government will support the institution in a crisis situation, will incorporate this information in the risk premium. Thus, the risk premium is probably lower than it would otherwise be, without the assumption of governmental interference. Sironi's (2003) analyses of the European banking industry, for instance, provide evidence that subordinated debt investors are sensitive to bank risk, with the exception of subordinated debt, issued by public banks, i.e. government owned or guaranteed institutions.

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[115] This expectation is related to the assumption that certain institutions are "too big to fail".

Additionally, empirical observations show that the European credit market is still not entirely mature, i.e. it is quite thin and illiquid and, hence, does not allow for the construction of indicators for a large number of firms. Especially for our purpose, i.e. the measurement and assessment of contagious effects within groups, we lack the necessary data, as it is highly improbable for (small) subsidiaries to be engaged in the credit markets. Therefore, corporate bond spreads or CDS spreads are usually not available. But we have experienced a very strong and rapid expansion of the risk transfer market in the last years[116]. This fact results in liquidity, having considerably surged and bid-offer spreads, having continuously been narrowing (cf. Fitch Ratings, 2004). Nonetheless, the market's illiquidity is still excessively high, especially during times of low trading volume in the whole financial market, e.g. during the Christmas holidays. As an empirical example one may, for instance, observe CDS prices for European financials on 2 January 2006, taken from Thomson Datastream. In almost every case the prices almost exploded on this particular day, only to recover to normal levels, a few days after.

As a consequence, any analysis of credit spreads has to be taken with caution because these indicators, as explained above, suffer from certain shortcomings that adversely impact the quality of the underlying data and subsequently the analysis thereof.

Furthermore, several studies showed that CDS spreads lead a company's credit rating changes and may, therefore, serve as early warning indicators for changing credit quality. Credit ratings are usually stable and do not react to every single event, such that they do not permanently have to be corrected.

Moreover, companies may react to CDS spread changes in a way that makes rating corrections superfluous. Since rating agencies have access to more profound information than solely to public market data, this relationship may, under certain circumstances, also be reversed, i.e. rating changes then lead CDS spread changes. In this case, investors may use rating agencies as a kind of reference point for their own assessment or judgement and the corresponding price will crystallise on the market.

3.2.5.1.2. Proposal for the use of credit spreads for the analyses of corporate interdependences

Overall, due to their attractive properties, explained earlier, and shown in diverse assessments of subordinated debt as early warning indicator in the literature, credit spreads could be a very interesting indicator for contagious events within an industry or even within a (financial) group or conglomerate in the near future.

One advantage over share prices is that the company does not have to be listed on a stock exchange to engage in the credit risk transfer market. In the future even highly integrated groups may be assessed based on the information from their credit spreads because each business line can issue its own bonds or CDS. For instance,

[116] This development may, inter alia, be related to the search for yield in a low interest period.

we are confronted with two different credit spreads for the ING group, i.e. ING insurance and ING banking, while only the holding company is listed on stock exchanges[117].

Since only a few companies in Europe issue credit spreads, and as time series are very short - many credit spreads have been issued in 2005 for the first time, others are not older than three years - we can only conduct some exemplary calculations on their performance concerning the sensitivity to contagious effects after special company events. Moreover, frequently, only the holding company issues CDS, which prevents the assessment of intra-group spillovers. We are also well aware of the potential shortcomings, which can mostly be attributed to the weak liquidity of the respective market. We will, therefore, keep them in consideration in our derivations.

Data source:	Thomson Datastream
Data:	daily returns CDS mid course
Maturity:	5 years
Time period:	January, 1st 2003 (otherwise stated) – January, 19th 2006
Country	**Company**
Germany	• Allianz, • HVB, • Commerzbank, • Deutsche Bank (02/01/03), • Dresdner Bank, • HSH Nordbank, • Munich Re
France	• AXA (22/04/03), • BNP Paribas (02/01/03), • Crédit Agricole (04/07/03)
Spain	• Banco Espiritu Santo (24/03/03), • Banco Pastor, • Banco Popular Español (31/07/03), • Caixa General de Depositos (30/06/03)

117 Nevertheless, CDS spreads for ING Bank have only been available since October 19th 2005, while ING insurance has been issuing CDS spreads since beginning 2003.

Italy	• Generali, • Banca Monte Dei Paschi di Siena (06/05/03), • Banca Nazionale de Lavoro (02/07/03), • Banca Populare di Bergamo (14/07/03), • Banca Populare di Lodi (07/08/03), • Banca Populare di Milano (10/07/03), • Banca Populare di Verona, • Capitalia, • Banca Intesa (09/01/03), • Mediobanca, • Unicredito Italiano (02/01/03)
United Kingdom	• Abbey National (02/01/03), • Anglo Irish Banking Corporation (23/09/03), • Aviva (28/04/03), • Halifax Bank of Scotland (06/05/03), • Barclays (02/01/03), • Old Mutual, • Standard Chartered
Netherlands	• Aegon, • Fortis • ING insurance (10/01/03) • SNS Bank

Table 11: CDS data

To empirically measure potential contagion in financial institutions, co-exceedances of a sample of local CDS spreads were assessed. Since the market is still very young, a considerable number of companies, with a very short CDS spread history, had to be filtered out. These companies' data do not allow the application of the method chosen for the assessment. In a next step, the percentage change[118] of the daily mid spreads, i.e. the average between bid and offer, for CDS with a five year maturity was calculated. Due to the sometimes fairly large bid-offer spreads in an illiquid market, the mid spread – as provided by Datastream – was regarded as the appropriate figure.

Afterwards, the upper and lower five percent quantiles were estimated. A large positive change in the spread reflects a surge in risk premium. This means that investors require a higher compensation for the assumption of the risk, inherent in

[118] $Ln(spread_{t+1}) - Ln(spread_t)$

the CDS[119]. Thus, by analysing the upper tails, we expect to observe reactions to, or anticipation of, negative events, and vice versa.

Finally, these data are compared with the results of each company within a single country, in order to analyse whether certain events, characterised by a surge in return in the bottom and upper five percent tails, simultaneously had an impact on other companies. It does, however, not tell us anything about the source or the trigger of the event. The event may both be an internal and an external shock.

If only companies with strong linkages are affected, and ad hoc announcements of any of these institutions were released within a narrow time frame around the strong CDS spread jumps, this fact may indicate that the shock was internal. We cannot exactly verify this effect via this method but we get an indication of the propensity to the dissemination of risks across these institutions, if the credit spreads of linked institutions change almost simultaneously.

	No. of firms	observation period	number of co-exceedances in the bottom tails (5%)					
			>= 5	4	3	2	1	0
Germany	7	01.2003 - 12.2005	0	0	5	17	39	154
France	3	07.2003 - 12.2005	n.a.	n.a.	n.a.	0	6	88
Spain	4	07.2003 - 12.2005	n.a.	n.a.	0	1	16	97
Italy	11	07.2003 - 12.2005	1	3	5	11	55	176
United Kingdom	7	07.2003 - 12.2005	0	1	0	8	33	134
Netherlands	4	01.2003 - 12.2005	n.a.	n.a.	0	1	17	122

	No. of firms	observation period	number of co-exceedances in the upper tails (95%)					
			>= 5	4	3	2	1	0
Germany	7	01.2003 - 12.2005	0	3	4	12	39	117
France	3	07.2003 - 12.2005	n.a.	n.a.	n.a.	0	5	89
Spain	4	07.2003 - 12.2005	n.a.	n.a.	0	1	12	104
Italy	11	07.2003 - 12.2005	1	0	6	12	50	195
United Kingdom	7	07.2003 - 12.2005	0	0	1	6	31	145
Netherlands	4	01.2003 - 12.2005	n.a.	n.a.	0	1	19	118

For each country the relative changes of credit spreads were assessed and compared between the institutions analysed. The tables reflect the co-movements in the upper and lower five percent tails. For instance, the last column indicates the number of cases where no co-exceedances took place although at least one institution was in the lower (or upper) 5-percent tail. The results are based on daily spread data.

Table 12: Summary statistics of co-exceedances for daily ln (Δ spreads)

Table 12 shows the number of co-exceedances in the extreme tails of CDS price change distributions. The observation periods are either three or two and a half years, depending on the availability of data for the majority of firms[120]. A co-

[119] Naturally, this argument is based on the assumption of an efficient market. As explained earlier, in an illiquid market a price surge can also have other origins but the pure rise in risk.
[120] CDS that were issued in 2005 only, were not considered in the calculations.

exceedance of one means that, at least, two companies moved simultaneously in the same direction.

The CDS spreads of the following companies listed in the table were used for the analysis. Due to the immaturity of the market, this list considerably deviates from the companies observed in the event study. Those companies considered in both examinations are printed in bold.

Italy	Germany	United Kingdom	Netherlands	Spain	France
Generali	**Allianz**	Abbey National	Aegon	Banco Espirito Santo	**AXA**
Banca Monte Dei Paschi di Siena	**HVB**	Anglo Irish Banking Corporation	Fortis	Banco Pastor	BNP Paribas
Banca Nazionale di Lavoro	**Commerz-bank**	Aviva	ING insurance	Banco Popular	Crédit Agricole
Banca Populare di Bergamo	Deutsche Bank	Halifax Bank of Scotland	SNS Bank	Caixa General de Depositos	
Banca Populare di Lodi	**Dresdner Bank**	Barclays			
Banca Populare di Milano	HSH Nordbank	Old Mutual			
Banca Polare di Verona	**Munich Re**	Standard Chartered			
Capitalia					
Banca Intesa					
Mediobanca					
Unicredito					

Table 13: Analysed institutions

The more interesting statistics, of those provided, is the one that analyses the co-exceedances in the upper tail of the distribution, i.e. the 95% quantile. It includes the events where the spread increases the most. The higher this spread, the more investors demand as compensation for taking the risk of a potential credit event. Hence, an extraordinary expansion in the spread is a sign that risk takers change their opinion about the company in a negative way. This means that the investors' subjective probability of the company's default, reflected in the spread, must have increased.

For listed companies, one may also relate those CDS spread changes to ad hoc announcements to find out whether, at this point, in time there are any considerable price changes. In a perfect market both share prices and CDS prices should show considerable movements, albeit in opposite directions, that is, share prices should plummet, while CDS spreads rise.

In a next step, one may look at the CDS price reactions of affiliated companies and compare them, in order to observe potential co-movements, especially in the tails.

Assessing the CDS spread changes on the ad hoc announcements, taken from our event study analysis, brings about some contradictory results for the German financial market[121]. While for Munich Re almost every ad hoc announcement is reflected in a prominent CDS price change, this interrelation is not necessarily true for several other companies, such as Commerzbank, Allianz or HVB. Furthermore, significant changes of share prices do not necessarily coincide with large CDS price changes.

It is very interesting to observe that extreme CDS price changes of Allianz very often coincide with those of Munich Re, which might be an indicator that credit spreads may become a prominent measure to assess potential contagion across affiliated companies. CDS prices for Dresdner Bank, however, seem to be more highly related to changes in other German banking corporations and less to changes in the spreads of its parent company Allianz.

In the appendix, we provide an illustration of CDS extreme co-movements based on the German example. Table 41 shows the lower tail extreme co-movements and table 42 provides an illustration of the upper tail extreme co-movements. The data are based on a three year period (2002 – 2005), however for illustrative purposes only the data for the last year are presented.

Comparing the results for the bottom tail co-exceedances with those of the upper tail, we cannot identify considerable differences. This outcome is, to some extent, counter-intuitive as one might expect to see significantly more co-movements, when negative information is available. This negative information is assumed to be incorporated in a higher spread for the affected company.

Finally, credit spreads seem to be more convincing than share prices, although the market is still immature and data, thus, distorted. Moreover, the sample of companies that can be analysed is still quite small all over Europe, even though the number of institutions issuing and purchasing credit risk transfer products, is continuously growing. As the market becomes more liquid, and as the number of market participants is growing, one may expect to get a useful tool for future assessments.

[121] Compare ad hoc announcements with the illustration of extreme co-movements, provided in the appendix.

The potential attractiveness of credit spreads is also based on a theoretical foundation. If an investment or even a company fails, it is the debtholder that has to bear the consequences, while equityholders face limited liability but can participate in upside gains of the institution (cf. Jensen and Meckling, 1976 or Harris and Raviv, 1991). Therefore, the rational debtholder has to be compensated by a higher interest rate, if he anticipates the company's probability of default to have grown for a certain reason. As a consequence we recognise higher credit spreads for the particular institution. For that reason, share price reactions may be expected, to be far more lenient and credit market data, to be more promising in the assessment of negative events and their potential spillovers. Shareholder reactions may provide additional information because they do not only focus on the left tail of the distribution but take a more holistic view (cf. Gropp et al., 2006).

3.2.5.2. Distance to default

Besides the credit spreads, the distance to default is another convenient forward looking, market-based indicator for the assessment of financial stability, i.e. the default risk of the respective entity. This model is mainly inspired by Merton's structural default model (1974), which is based on option pricing and became well known as the basis of KMV's (1999) calculation of expected default frequencies.

The model underlies the following basic intuition and assumptions: The institution is expected to fully honour its debt obligations to bondholders when the debt matures. Otherwise, the bondholders take over the company, and the owners, i.e. the shareholders of the company, receive nothing. The rational shareholder, on the other hand, will refuse to pay the debt if the value of the institution's assets were to be valued less than its debt.

Using option pricing theory, this causal connection can be reproduced in a formal framework, where the equity of a company can be modelled as a call option on the assets of the company. With the help of the market value of equity, its volatility and debt - which is obtained from public accounts, both the unobservable level and volatility of the market value of assets can be derived.

The distance to default is then derived as the difference between the current market value of assets and the default point[122], scaled by the volatility of the asset value[123]. As such, the distance to default constitutes the number of standard deviations, the firm is from the default point. It is strongly related to the calculation of the probability of default as used for internal models in Basel II.

Gropp et al. (2006) emphasise the measure's advantage over cumulative abnormal stock returns – as used in our event study analysis in a preceding chapter – to measure shocks that are based on increases in earnings volatility or leverage. The superiority of the distance to default in this respect results from its derivation

[122] As argued above, the threshold level is the point the value of the assets equals the value of debt.

[123] The market value of assets can be interpreted as a measure of the expected future cash flow from the assets, while the volatility is a measure of its (un-)certainty.

because it combines information on leverage and asset volatility with information contained in stock returns.

The measure's advantage - in particular, with respect to the assessment of the risks of banks - vis-à-vis debt spreads is the fact that its explanatory power is not diluted by the presence of a safety net that may impact the investors' judgement. Under adverse circumstances the spread may, in contrast, not appropriately reflect the company's actual "distance to default".

Nevertheless, the necessity to incorporate balance sheet data in the distance to default formula also bears obvious disadvantages. In contrast to share or bond prices, these data are not available on a daily or weekly basis but rather at a semi-annual interval[124].

Moreover, these data are often not comparable among institutions. Corporate accounting philosophies i.e. essentially the level of prudence, may differ and the application of different accounting principles, such as IAS and US GAAP or any other national GAAP, may also result in different balance sheet characteristics. Accounting data are backward looking data, while share and bond prices have a prospective character. As such, the combination of these divergent factors naturally bears certain weaknesses.

In the derivation of the distance to default, we follow Gropp et al. (2004a or 2004b).

$$\ln V_A^T = \ln V_A + \left(r - \frac{\sigma_A^2}{2} \right) T + \sigma_A \sqrt{T} \varepsilon \tag{3.27}$$

This equation represents the asset value at time T, i.e. the maturity of debt, given its current (unobservable) value V_A. ε is the standard normally-distributed noise term of the firm's return on assets, with zero mean and unit variance. σ_A is the (unobservable) volatility of the asset value and r is the risk-free rate, which is usually approximated, by using government bond rates[125]. To measure contagion within European financial groups, we use the 12 month EURIBOR, the euro interbank offered rate, as approximation. The time to maturity T is generally set to one year.

The current distance d from the default point, where ln V_A^T equals ln D, i.e. where the market value of the firm's asset equals its total amount of debt, can be expressed as:

$$\begin{aligned} d &= \ln V_A^T - \ln D = \ln V_A + \left(r - \frac{\sigma_A^2}{2} \right) + \sigma_A \varepsilon - \ln D \\ \Leftrightarrow \quad \frac{d}{\sigma_A} &= \frac{\ln\left(\frac{V_A}{D}\right) + \left(r - \frac{\sigma_A^2}{2} \right)}{\sigma_A} + \varepsilon \end{aligned} \tag{3.28}$$

124 For larger institutions also quarterly reports may be recallable.

125 In emerging countries, however, government bond rates may not serve as good proxies for the risk free rate, r.

Hence the distance to default, DD, is defined as:

$$DD \equiv \frac{d}{\sigma_A} - \varepsilon = \frac{\ln\left(\frac{V_A}{D}\right) + \left(r + \frac{\sigma_A^2}{2}\right)}{\sigma_A} \tag{3.29}$$

As explained earlier, V_A and σ_A are not observable. However, they can be calculated (more precisely: approximated) from the observable market value of equity capital, V_E, its volatility, σ_E, and debt, D by using Black-Scholes formula:

$$V_E = V_A N(d_1) - De^{-rT} N(d_2)$$

$$\sigma_E = \left(\frac{V_A}{V_E}\right) N(d_1)\sigma_A$$

$$d_1 \equiv \frac{\ln\left(\frac{V_A}{D}\right) + \left(r + \frac{\sigma_A^2}{2}\right)T}{\sigma_A\sqrt{T}} \tag{3.30}$$

$$d_2 \equiv d_1 - \sigma_A\sqrt{T}$$

In order to solve this system of equations for the values of V_A and σ_A, the generalised reduced gradient method[126] is suggested to be used.

As underlying data for the market value of equity capital V_E, one may take monthly averages of equity market capitalisation. However, in order to avoid the problem of a surge in share capital, which may lead to sudden unexplainable jumps in the time series, we take the value of shares, as, for instance, provided by Datastream, instead.

The equity volatility may be calculated as an annualised three month rolling window standard deviation (i.e. $\sqrt{250}\sigma_E$) of the daily equity returns as, for instance, proposed by Campbell et al. (2005). The total debt is obtained from published accounts, which are issued at least annually, sometimes even quarterly. Since this value is also continually changing, and intra-annual (quarter) data are not available, it is indispensable to interpolate those values to get values for the periods between the respective announcements of reports.

For the sake of mathematical simplicity, we use linear interpolation to obtain the missing book values of debt although this procedure can lead to gradual overestimation of debt. However, from a conservative perspective, this slight imprecision is negligible, as the use of book value debt already constitutes a weakness of the concept applied.

Obviously, a polynomial, concave trend might better fit the existing data of debt than a linear trend. Therefore, a more correct measurement would imply the use of cubic spline interpolation, as proposed by Gropp et al. (2004a). But even this method cannot obscure the fact that the used book values contain hidden reserves

[126] This method can for instance be applied by using Excel's solver.

that distort the results. Hence, this approach assumes an accuracy, which is not supported by the data available.

The growing application of international accounting standards / international financial reporting standards (IAS/IFRS) and, thereby, the use of mark-to-market data reduces these shortcomings, even though the problem of data availability remains. Moreover, it has to be emphasised that accounting numbers are provided ex post and thus may contain events that individuals have not perceived, to their full extent, at the relevant point in time.

Supported by a paper by Byström (2003) and own observations, distance to default calculations can considerably be simplified without loss of validity and with rather small errors. The accuracy of the results achieved is not constrained.

Assuming that the drift term $\left(r+\frac{\sigma_A^2}{2}\right)T$ is small or even converging towards zero, the distance to default can be reduced to

$$DD=\frac{\ln\left(\frac{V_A}{D}\right)}{\sigma_A} \tag{3.31}$$

$N(d_1)$ can be assumed to be close to one. This is generally the case, unless the option is almost at the money (V_A is close to D) and asset volatility is very high. Hence, σ_A can be replaced by the term $\frac{\sigma_E V_E}{V_A}$ and DD can be simplified to

$$DD=\frac{\ln(V_A)/D}{\sigma_E V_E/V_A} \tag{3.32}$$

Finally, defining the leverage ratio as $L=\frac{D}{V_A}$ and as $\frac{D}{V_E+D}$ we derive the simplified expression for the distance to default:

$$DD_{\mathrm{mod}\,ified}=\frac{\ln(1/L)}{\sigma_E(1-L)}=\frac{\ln(L)}{(L-1)}\sigma_E=\frac{D/(V_E+D)}{\frac{D}{V_E+D}-1}\frac{1}{\sigma_E} \tag{3.33}$$

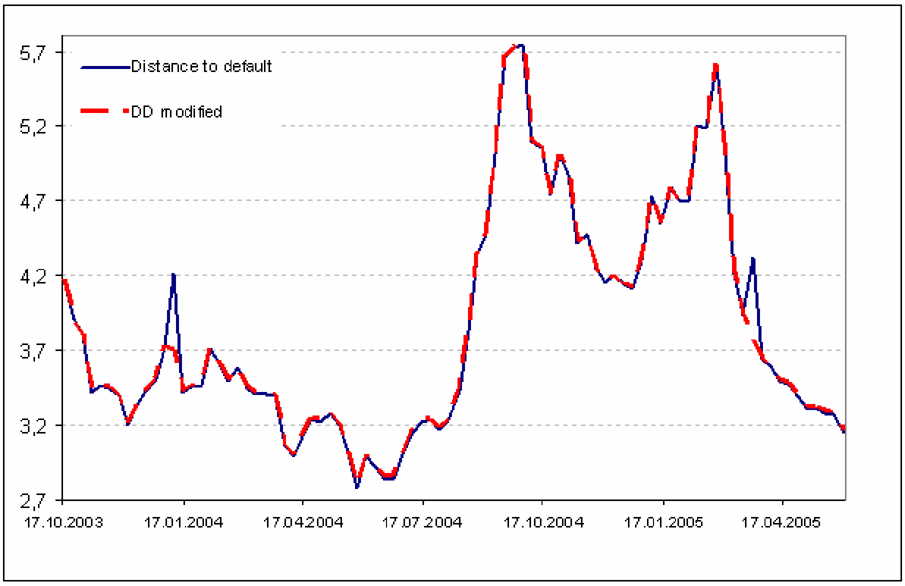

Figure 25: Comparison of distance to default calculations (illustration)

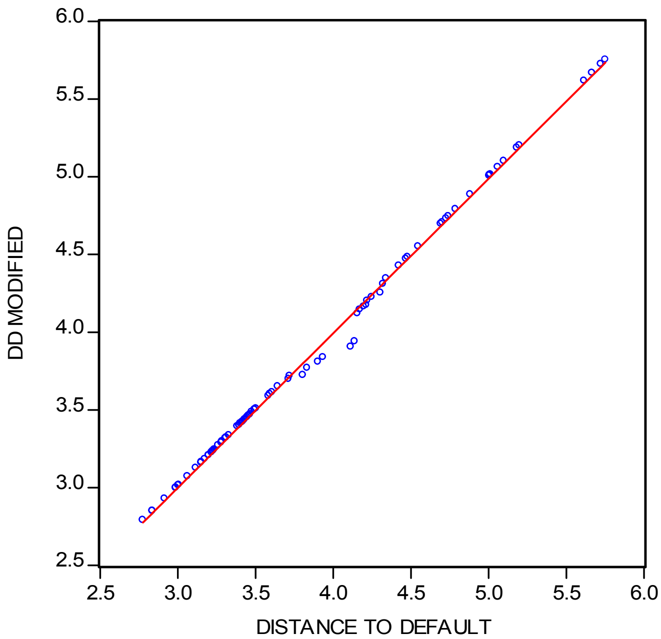

Figure 26: Quantile-quantile plot of exact and modified distance to default

For the illustration of the aforementioned results, the distance to default data for Bank Austria Creditanstalt are taken[127]. As can be seen from both figures above, the errors induced by the simplification are relatively small and the results of the exact and the modified estimations of corporate distance to default match each other quite well in our illustration.

127 The company choice was arbitrary.

For the sake of convenience, we, therefore, use the simplified approach for our further calculations. Byström (2003) emphasises the advantage of this method to highlight the drivers of default, i.e. equity volatility and the firm's leverage ratio.

3.2.5.2.1. How to use this measure for the assessment of contagion risk

To measure the change in the company's overall risk over a certain time, we apply a similar approach as for the assessment of the CDS spreads. We take the first difference between the distances to default in two subsequent periods, i.e. in our case two subsequent weeks. In mathematical terms that is $\ln(dd_t) - \ln(dd_{t-1})$ or $\ln(\Delta dd)$, which is the percentage change in the number of standard deviations beyond the default point.

In a next step, we note all periods, where the first difference in the distance to default is in the 5^{th} percentile positive or negative tail[128] of the overall distribution and compare those results with the other group constituents.

Co-exceedances – an event, where different companies' first difference to distance to default are extreme in the same direction and in the same period - are regarded as a sign for potential intra-group contagion effects because they imply that idiosyncratic shocks, affecting one affiliate, were transmitted to other group members. Hence, we count the number of these co-movements within financial groups. Then, we compare these results with arbitrarily chosen groups of non-affiliated companies to see whether extreme co-movements of affiliated companies are more frequent and, hence, of explanatory value.

The analysis of linear correlation of the $\ln(\Delta dd)$-time-series suffers from the same limitations as mentioned in a previous section on return correlations. Therefore, it is not driven further. A matrix of these correlations is provided in the appendix.

3.2.5.2.2. Empirical results of contagion measurement with distance to default

Calculation of (the first difference of) distance to default was conducted for the same groups as in the event studies. The observation period was 2000 to mid-2005. However, observations were finally restricted to end of 2004 because for several institutions balance sheet data are available at an annual basis, only. Otherwise, the number of affiliates in our observations would strongly vary.

[128] This choice of the 5^{th} and the 95^{th} percentile is arbitrary but rigid enough to contain the more significant shocks with an impact on other affiliates, only. For comparative reasons we also calculate the 10^{th} and the 90^{th} percentile. The results thereof can be found in the appendix, table 43.

Data source:	Thompson Datastream, interim and annual reports
Time period:	January, 1st 1999 – December, 31st 2004
Market value of shares (V_E)	Weekly data, Datastream
Equity returns (E):	Weekly data, Datastream
Risk free rate (r):	Weekly data, 12 month EURIBOR, Datastream
Total debt (D):	Bi-annually, interim and annual reports
Any other necessary ingredients are derivatives thereof	

Table 14: Data input for distance to default calculations

It has to be considered that for Dresdner Bank, Vereins- & Westbank, comdirect and Bank Austria Creditanstalt data were not available over the whole sample period. The former two were delisted; in July 2002 and end of October 2004, respectively, the latter two institutions were not listed before June 2000 and July 2003, respectively.

Furthermore, the examples, consisting of only two entities, i.e. KBC, Capitalia, San Paolo IMI, have to be taken with caution. Any derivations from these numbers are of limited value but may support the arguments, derived from the other examples.

As we can observe from table 15, which provides summary statistics of co-exceedances for the upper and lower five percent tails, in the majority of cases there are no co-exceedances in distance to default changes. The cases, where at least two affiliates move together is considerably lower. We do rarely observe co-movements in the affiliates' measures. Results are similar for the upper and the lower five percent of the distribution.

	number of institutions	number of co-exceedances in the bottom tails (5%)					
		5	4	3	2	1	0
Allianz	6	0	2	1	3	8	31
Generali	4	-	-	0	2	4	34
Munich Re	3	-	-	-	1	2	30
HVB	5	-	0	0	2	5	31
AXA	3	-	-	-	0	5	26
Commerzbank	3	-	-	-	0	4	28
Almanij	2	-	-	-	-	3	15
Capitalia	2	-	-	-	-	3	18
San Paolo IMI	2	-	-	-	-	4	19

	number of institutions	number of co-exceedances in the top tails (95%)					
		5	4	3	2	1	0
Allianz	6	0	1	1	3	7	41
Generali	4	-	-	0	1	5	35
Munich Re	3	-	-	-	0	5	30
HVB	5	-	0	0	1	3	31
AXA	3	-	-	-	0	2	29
Commerzbank	3	-	-	-	0	4	30
Almanij	2	-	-	-	-	10	5
Capitalia	2	-	-	-	-	1	24
San Paolo IMI	2	-	-	-	-	4	18

For each country the relative changes of distances to default were assessed and compared between the institutions analysed. The tables reflect the co-movements in the upper and lower five percent tails. For instance, the last column indicates the number of cases where no co-exceedances took place although at least one institution was in the lower (or upper) 5-percent tail. The results are based on weekly data from beginning 1999 to July 2005 .

Table 15: Summary statistics of co-exceedances for weekly ln (Δdd)

In table 44 in the appendix, we lower the restrictions of a tail event and provide the same table for the lower and upper ten percent tails. However, no remarkable differences are observable. Results are very similar.

Additionally, a correlation matrix of the weekly log-differenced distances to default was calculated, in order to support the results, while keeping in mind the deficiencies of linear correlation, as explained earlier. With the exemption of the KBC (0.71) and the San Paolo IMI (0.61) groups, correlation is rather low or even negative. Hence, these numbers provide no unambiguous indication of potential contagious forces.

In a next step, we define five arbitrarily chosen groups, consisting of five entities each and compare the results with those of the financial groups, analysed before. Assuming that dependences between affiliated companies are higher, and that, therefore, those companies are more prone to contagious effects, one may expect the number of co-exceedances to be significantly higher for financial groups compared to samples of independently and arbitrarily chosen companies. Otherwise, we cannot derive any significant conclusions from the results of our estimations.

Table 16 depicts how these artificial groups are composed. The composition was conducted with the aim to prevent close relations between the affiliates. Nonetheless, due to the strong inter-linkages between the markets, the composition of groups with unrelated affiliates is almost impossible.

Group A	Group B	Group C	Group D	Group E
Allianz Leben	Allianz	AGF	RAS	Euler Hermes
Generali	AMB	Munich Re	Ergo Versicherung	Ergo Previdenza
Bank BPH	DAB	HVB	AXA Versicherung	AXA
Finaxa	Commerzbank	Comdirect	BRE Bank	KBC
Capitalia	Fineco	San Paolo IMI	Banca Fideuram	Generali Vienna

Table 16: Arbitrarily composed groups

Comparing the results in table 15 with those in 17, we cannot discover any significant differences between the extreme co-movements of affiliated companies and the sample of independent (and arbitrarily chosen) companies. The asymmetry in bottom and top tail co-exceedances, however, is more pronounced for the sample of independent companies.

	number of co-exceedances in the bottom tails (5%)				
	4	3	2	1	0
Group A	0	2	2	10	27
Group B	0	1	5	7	25
Group C	0	3	5	5	25
Group D	0	0	3	8	42
Group E	0	1	2	6	40

	number of co-exceedances in the top tails (95%)				
	4	3	2	1	0
Group A	0	0	3	8	32
Group B	0	0	3	9	33
Group C	0	0	3	12	27
Group D	0	0	2	8	45
Group E	0	0	1	8	42

For each artificial group of institutions the relative changes of distances to default were assessed and compared between the institutions analysed. The tables reflect the co-movements in the upper and lower five percent tails. For instance, the last column indicates the number of cases where no co-exceedances took place although at least one institution was in the lower (or upper) 5-percent tail. The results are based on weekly data from beginning 1999 to July 2005 .

Table 17: Number of co-exceedances for a sample of independent companies

To conclude, the data did neither provide us with a clear indication of potential effects, nor could we derive that, in comparison to non-affiliated companies, affiliated companies are more prone to the dissemination of risks. The percentage of co-exceedances above one[129] is even lower for affiliated companies than for our sample groups, which is particularly disappointing as it implies that the explanatory power of the measure used is weak and the outcome is rather arbitrary. The correlation matrix of log-differenced distances to default, as provided in the appendix in table 45, does also not imply a strong dependence of group distances to default. In most cases the correlation factors are rather low.

Comparing bottom tail with top tail co-exceedances, the former seem to be more frequent. This result is also supported by our sample of independent companies and is consistent with the assumption that negative events have stronger spillover effects than positive events. However, this difference does not seem to be significant and would have to be tested on a larger sample.

Finally, also distances to default do not completely fulfil the objectives of their assessment. As a measure developed on the basis of several different data, the distance to default represents an interesting alternative to common indicators, such as credit spreads or share prices. Nevertheless, they similarly bear the inconvenience of high subjectivity.

A combined measure may even have a higher propensity to the dilution of its explanatory power as it aggregates several (minor) inaccuracies in its estimation. The distance default is dependent on the quality of both market and accounting data, both bearing considerable but different weaknesses.

In order to support possible conclusions, if available data allow it, one may combine the analyses of distances to default with those of credit spreads. The analyses may complement each other. While the distance to default constitutes an earlier indicator of weakening in an institution's condition, credit spreads react more significantly, relatively close to the default point (cf. Gropp et al., 2006). The reason lies in the fact that debtholders are only interested in the left tail of return distributions because they cannot participate in upside gains while equityholders care about the whole range of the distribution.

[129] That is, the $\ln(\Delta dd)$ of at least two companies is in the bottom or top tail of the (historic) distribution.

4. Implications and conclusions

Although our results from the empirical tests on contagious shocks within financial groups are not overwhelmingly satisfying, it is still an obvious fact that such effects exist and that they may have particularly adverse consequences on the group's constituents, and ultimately on the whole group. Cases, where these effects are most evident are extreme events, such as natural catastrophes or terrorist attacks. Albeit external effects, one may still imagine the impact of these effects, where a prominent group affiliate is severely hit. This situation may possibly cause a domino effect, for instance, due to strong capital relations or mutual guarantees between the affected company and other affiliates.

Certainly the most prominent (but not exclusive) limiting factors for the estimation of contagion and its potential impact on the safety of the respective entities and the group, as a whole, are the weak development or maturity of certain products and markets, restricted data availability and noise are. Nonetheless, it is still a challenge for corporate management and for financial supervisors to make these processes visible or calculable, which is more than just the assignment of an undefined haircut to any economic capital estimations provided by corporate or group risk management. It necessitates the attribution of exactly measured or estimated consequences, without the trust in the "rule of thumb" or expert opinion. Only if one has sufficient knowledge about risk dissemination across group entities, also positive group effects, such as diversification, can be acknowledged. Any acceptance of diversification in groups, without taking notice of possible adverse consequences of a strong linkage between different institutions, may contradict the "rule of prudence".

Admittedly, every endeavour on the part of regulators and supervisors is necessary to establish a framework that takes notice of such interdependences of firms, without excessively burdening the industry and without ignoring positive externalities within a group structure. The industry, on the other hand, has to accept that the supervisor will and has to take a broader perspective in its group assessment than the companies would take themselves.

In the following chapters we will therefore focus on diverse aspects that have to be taken into account and which are, to a certain extent, the result (of the consequences) of group interdependences. We try to assess the implications of these aspects both for supervisors and for the industry, in particular.

Probably the most decisive question is the determination of overall group risk because it has further implications for both supervisors and industry protagonists. It refers to the decision on adequate risk capital, to the judgement on potential intra-group diversification effects, and, with regard to capital requirements , their reallocation across subsidiaries. Eventually, one is interested in the overall safety of a group and the implications to be derived for the individual group entity. The solution of these questions is not at all a trivial task as will immediately become apparent.

In contrast to other current research projects on group diversification, on the one hand, and group spillover effects, on the other hand, this section for the first time, intends to integrate both major arguments in one single framework. Both effects in a group environment are evaluated simultaneously, in order to find out what that could mean to the determination of group risk capital. Eventually, in this approach positive group effects are confronted with their adverse counterparts.

We argue that portfolio effects are a relevant argument in groups although one has to keep in mind diverse countervailing effects that can inhibit their entire generation. Depending on the imminence of these forces, we will recognise a respective impact on actual diversification and, eventually, on the extent of a reasonable group risk capital level.

Furthermore, diverse obstacles to the incorporation of diversification in the solvency assessment are emphasised and contrasted with current industry arguments. Concretely, it is argued on the shortcomings of current approaches that postulate a noticeable reduction in capital adequacy requirements for groups and a corresponding reallocation to all their constituent institutions.

4.1. Determination of capital adequacy requirements and diversification effects[130]

In order to have sufficient liquidity available in times of distress, any regulated financial enterprise is required to hold sufficient capital. These requirements differ to a varying extent across the industries, although, overall, the main objectives are similar. Higher capital requirements for the banking industry are generally justified upon the specially pronounced argument on systemic stability, which is seen as a less imminent issue in other financial sectors.

The simple aggregation of the estimated values of each individual entity, to obtain the necessary group risk capital, may, however, ignore several fundamental aspects of group structure.

On the one hand, one may argue that a larger group portfolio allows for the generation of diversification effects because under simplified assumptions a financial group should follow the same rule as a vast portfolio, because often different products are offered, various markets are penetrated, a broader customer base is serviced, etc. Thus, idiosyncratic risk can be diversified away, depending on the extent of correlation between the different businesses. The benefit obtainable will vary with the scope of activity, i.e. the number of risk positions, the concentration of these positions and their correlation (cf. Kuritzkes et al., 2002).

On the other hand, one has to be aware that group constituents may be considerably exposed to the risks of other group members. Institutions may become indirectly affected by risks they are not directly exposed to. They may face contagion effects that a stand-alone institution does usually not encounter. Therefore, the actual diversification effects may be considerably lower because the calculation thereof does not take account of these countervailing forces. Moreover, it does not tell us anything about the actual risk profile of the respective entities. The combination of several ailing institutions, all active in different businesses, may allow for the generation of notable diversification effects but may worsen the condition of the group, as such. The problem is that diversification does not tell us anything about the financial condition of the individual entity. Under such circumstances, a highly diversified group may be in a worse condition than is possibly expected, regarding the diversification potential because it is constituted by a number of diverse ailing institutions.

The full acceptance of diversification across businesses may lead to less prudent capital endowments within groups. Moreover, one has to keep in mind other deficiencies that also cause the failure to hold the appropriate amount of risk capital in a group. Regulatory inconsistencies, both across countries and industry sectors, invite institutions to overstate their risk capital, by counting it twice or several

[130] This section is, essentially, based on Darlap and Mayr (2006a), which assesses the group aspects of regulatory reform in the insurance sector.

times. Through such multiple gearing practices, capital is used by several entities at the same time, and without raising additional capital, assets can be multiplied.

Regulatory arbitrage is strongly related to multiple gearing. A prominent example for regulatory arbitrage is credit risk transfer, where, for instance, insurers are actively selling credit protection to credit institutions. Thereby, capital requirements can be reduced because different rules apply to the banking and the insurance industry. In principle, this is an acceptable process. The insurer can diversify further its portfolio and the bank can simultaneously unload certain risk tranches and thereby increase the safety of its banking or trading book. If the insurer and the credit institution, however, belong to the same conglomerate, the full risk still remains within the borders of the group.

Another way of capitalising on regulatory inconsistencies is excessive leverage. In this case, the risk-bearing capacities of subsidiaries are financed via the issuance of debt instruments.

Hence, all these operations can be used to circumvent the aims of regulatory requirements, while still meeting them from a formal point of view. By taking advantage of these capital saving operations, consolidated group capital becomes less than the sum of the capital positions of the regulated subsidiaries. The acceptance of diversification even extends this gap.

Finally, these group deficiencies may consume a large part of the achieved group benefits, and regulators have to be cautious, when accepting a diversification discount on capital adequacy requirements for institutions belonging to financial groups.

In the subsequent section we will, therefore, evaluate the main challenges for group management and supervisors to allow the judgement on the risk of the group, taking account of the risks mentioned, in particular the risk of contagion.

4.1.1. Assessment of group risks

The assessment of group risks and subsequently the calculation of the relevant economic and regulatory capital[131] is not a trivial task as it necessitates the inclusion of diverse business models, different risks, varying accounting standards or different interpretation, thereof, etc. Therefore, it is indispensable to discuss some preliminary issues that can, ultimately, impact the results of group risk estimations.

[131] Economic capital is based on the calculations that are specific to the company's risks, while regulatory capital is based on industry averages and does not account for company specificities and relative risk attitudes. Its purpose is to balance the trade-off between the solvency and the profitability objectives. Economic capital is a measure of the amount of capital that a financial institution should have at the minimum, to be able to withstand both expected and unexpected future losses. As – from supervisory side – it is intended to promote the establishment of internal models both measures are expected to continuously assimilate.

4.1.1.1. Primary concerns

When assessing the risks of a group, one is faced with several conceptual challenges that complicate comparisons and the aggregation of data. Moreover, one has to be aware that also risk measures bear certain deficiencies that inhibit an exact judgement. The following concerns will be discussed in more detail:

- Time horizon of risk models
- Confidence levels applied
- Aggregation of risks
- Choice of risk measure

Time horizons for the different company risks may considerably vary. For instance, in order to measure potential credit losses, most credit risk measurement models focus on a 1-year time horizon. Market risk, on the other hand, is usually covered by VaR-models, focusing on a one- or ten-day horizon or even multi-year horizons for particular insurance activities, for instance, life insurance (cf. Joint Forum, 2001). In fact, the horizon, over which market risk is measured, reflects the underlying business activity and decision horizon. Operational risks cover such a broad field that one cannot generalise a commensurate time horizon, either. The same is true for other risks, not aforementioned.

Hence, it is doubtful whether those risks can be sensibly aggregated. The attempt to use a common time horizon for the various risks will result in an undue modification of the risk capital models and the assessment of the inherent risks. Scaling, using the (square) root-t rule, i.e. multiplying the (daily) standard deviation by the square root of the time horizon, which is a standard approach in practice, is inappropriate for non-iid data and may overestimate volatility at long horizons. The application of this rule will therefore lead to an inaccurate, albeit conservative, picture of the actual risk map of the company or group.

Since in most cases iid normal returns are implicitly assumed, the root-t rule can be applied to scale volatilities and risk. In most cases, this might be a rather innocuous assumption from a perspective of prudence (cf. Danielsson and Zigrand, 2003).

Harmonisation of the confidence level across risks can be obtained by rescaling the risk to the desired percentile using a fixed scaling factor as if the distribution were Gaussian, i.e. normal (cf. Saita, 2004). Naturally, the assumption of normality will not reflect the real situation in many cases or will simply be false in practice, but it, hopefully, enables a rough approximation. From a standpoint of prudence, one may, however, have to take account of varying underlying distributions. Insurance risks, in particular, are generally heavily skewed.

The question of how to aggregate risks across companies is probably most important in the context of our paper. It has certainly also been the most heavily discussed topic for financial groups and financial supervisors or regulators, respectively. Discussions are still going on but the outcome is still open as, for instance, the mutual replies of CEIOPS, the committee of European Insurance and

Occupational Pensions Supervisors, and the CRO-Forum[132] show. The discussions concentrate around the question of how to consider both possible group diversification effects and particular group risks, such as reputational risks or other forms of contagion.

Only under the premise that contagious risks and diversification effects level each other out, the current concept of simply summing the individual company risks reflects an accurate picture of the group's riskiness. Nevertheless, generally, this aggregation method does not recognise actual circumstances. Used as a supervisory tool to assess group risks and ultimately to define capital requirements, this method might punish companies with a large portfolio and a strong diversification potential that contributes to risk mitigation.

Another important concern is the choice of a risk measure that provides an accurate picture of a group's consolidated risks. This measure will allow an appropriate assessment and consolidation of such risks, without negligence of their potential mutual dependence. Furthermore, this risk measure ought to have the property to allow an accurate and consistent comparison of different risk portfolios. According to Artzner et al. (1999, p.5ff), such a coherent risk measure fulfils the following requirements:

a) Monotonicity: $X \leq Y \Rightarrow \rho(Y) \leq \rho(X)$

b) Subadditivity: $\rho(X+Y) \leq \rho(X) + \rho(Y)$

c) Positive homogeneity: $\rho(\lambda X) = \lambda \rho(X) \text{ for all } \lambda \geq 0$

d) Translation invariance: $\rho(X+c) = \rho(X) - c \text{ for all } c \in \Re$

The monotonicity argument states that if a portfolio Y is always worth more than X, then Y cannot be riskier than portfolio X. The subadditivity requirement says that the risk of the portfolio is never higher than the sum of its parts; which is the argument of diversification in portfolio theory. Homogeneity represents the limit case of subadditivity, when there is no diversification effect. It states that larger positions mean equal risk to many smaller positions. Finally, translation invariance requires that by adding a sure return c to a position X, the risk ρ(X) decreases by c.

The commonly used risk measure to assess the downside risk of an institution, i.e. the VaR[133], bears the shortcoming to both ignore diversification effects and the severity of events and, according to this definition, cannot be subsumed among the coherent risk measures. Expected shortfall (ES) – often also called tail-VaR, conditional tail expectation, average VaR[134], etc – does not bear these shortcomings and is, therefore, increasingly proposed by academics. It measures the expected loss

132 The Chief Risk Officer (CRO) Forum of the major European insurance groups is constituted as an expert group of the insurance sector for the establishment of the Solvency II regulation.

133 $P(Loss > VaR) \leq 1 - \alpha \quad \rightarrow \quad VaR_{\alpha}(X) = \inf\{x | F_X(x) \geq \alpha\}$

134 One may ignore minor deviations in the exact formulae, which only have academic relevance. Hence, usually these terms are used interchangeably. Refer to Acerbi and Tasche (2002), for a discussion of the differences.

conditional that this loss is larger than the corresponding VaR at the same confidence interval ($ES_\alpha = E[X|X > VaR_\alpha]$). Less technically: While the VaR measure is the minimum of the highest x percent of the confidence interval, the ES is the average of the highest x percent.

The expected shortfall is particularly useful for risk distributions that are highly skewed. Owing to certain infrequent but sizeable losses, many insurance distributions – essentially non-life insurance risk distributions - are skewed. The challenge, however, is that ES necessitates many data points at the extreme tail of the distribution, i.e. one requires sufficient data on (very) extreme events, which are usually not available, to a satisfying extent. Moreover, as historical data series are usually rather short distributions are imprecisely reproduced, especially the upper tail of the loss distribution.

From a supervisory perspective, the subadditivity argument poses some difficulties to the assessment of consolidated risks of a financial group. It reflects the standard argument of portfolio theory, which states, that whenever correlation is less than perfect, this circumstance should allow for diversification, that is, the idiosyncratic part of risk can be diversified away, such that the risk of the whole becomes lower than that of the sum of the individual entities.

Nevertheless, this coherence is not necessarily given when examining consolidated risks of a group because the group, as such bears certain risks not inherent in the stand-alone company. Hence, Cheng et al. (2004) extended the coherent risk measures to convex or weakly coherent risk measures by relaxing the constraints of subadditivity and positive homogeneity and, instead, requiring a weaker condition:

e) Convexity: $\rho(\lambda X + (1-\lambda)Y) \leq \lambda\rho(X) + (1-\lambda)\rho(Y)\ \textit{for all}\ \lambda \in [0,1]$

4.1.1.2. Causes for misestimating group risks

Indeed, there are several arguments that support the view that the inequality of the subadditivity requirement, the major pillar of portfolio theory, may not hold and that the relaxation of this requirement will be necessary. Taking into account reputational effects, that is, the idea that problems in one part or affiliate of a group may affect confidence in the other parts, the risk of the whole may be higher than that of the sum of its parts. This stands in strong contrast to the subadditivity argument. Following this line of argumentation, the Joint Forum (1999) comes to the conclusion that in the absence of consolidated risk management, significant risks could be overlooked or underestimated.

Another explanation, besides the argument of reputational risk, for this divergence from the conclusion in portfolio theory lies in the fact that risks are determined by many factors that can vary over time and are interdependent. Hence, any outcome also depends on decisions of other players, that is, the volatility of one unit's profitability may be affected by the actions of another unit within the financial group or conglomerate. Consequently, the aggregate position of the firm can be riskier than that of the sum of the assumed individual risks of the various business units (cf. Cumming and Hirtle, 2001).

The challenge is now to find an appropriate risk measure that reproduces. as appropriately as possible, the consolidated risk of a group by taking into account both potential diversification effects and the possibility of additional group risks, not considered at individual business units' level. Depending on which factor outweighs the other, the group risk may be lower or higher than the sum of the stand-alone entities' risks.

A further challenge results from both the properties of certain risks and the shortcomings of the statistical methodologies commonly applied. The use of linear correlation may be a convenient and "easy to implement" method and, therefore, enjoys great attractiveness among risk managers. Nonetheless, it may be an inappropriate measure to detect to detect interdependences between risks. First, the inclusion of non-linear derivative products invalidates many of the assumptions underlying the use of correlation. Furthermore, many risks, such as insurance claims data, are skewed and heavily tailed. Probably, only market risks can be assumed to be almost normal, to a certain extent, all other risks are biased under the assumption of normality and may, in certain cases, even lead to wrong conclusions. Correlation is a measure in the world of multivariate normal distributions. An identical correlation does not necessarily tell us anything about the dependence structures of different distributions. Linear correlation also fails to capture all the dependence structures that exist between losses of multiple business lines, which is particularly relevant in the assessment of group risk. It might miss the fact that certain areas of the loss distribution are highly correlated, while others are less correlated or independent. As seen from extreme events like 11 September 2001, dependence usually increases in the tails. Thus, while in "normal" circumstances, various lines of business may look almost independent, they become correlated in extreme events. Hence, dependence can be a valuable aspect for the management of the group or its supervisors. They are interested in whether extreme events have a tendency to occur together (cf. Embrechts et al, 2002), that is, whether the event has tail dependence, and certain loss distributions show dependence in the extreme tail, only. An often-cited example is the earthquake causing widespread damage to commercial property and triggering other catastrophes resulting in further losses.

Overall, as it now should have become apparent, the estimation of group risk underlies several pitfalls that are usually insufficiently taken account of. The challenge is that several impact factors, such as contagious forces, are not immediately visible and, therefore, not included in a company's or group's risk management. Most of these factors become observable in extreme situations only, where companies generally lack sufficient (historical) data. One may imagine the case of a 1/200-year event. The impact of such an event is, first, not easily foreseeable and, second, models may have underestimated such events due to misleading historic data. As a result, potential diversification effects would have been notably overestimated. In fact, most models have to be recalibrated after such catastrophic events.

4.1.1.3. Further obstacles to the generation of diversification effects

Beyond the arguments already presented, there are still further countervailing forces to the generation of diversification effects in financial groups, which stand in strong relation to the contagion argument and which therefore require a more profound analysis[135].

Achieving (high) diversification effects for the group, takes for granted a preferably high integration of the various business units and group entities. In principle, it requires the existence of a common portfolio at group level and a common governance of the business policy, in order to allow for a common aim for broad diversification. Nonetheless, this – from a diversification point of view - ideal strategy bears certain inconveniences, sometimes ignored: A uniform strategy, e.g. a common allocation policy, tends to result in a higher concentration of the group's portfolio, which leads to diversification-inverse effects. Given that these forces are particularly strong, the risk at group level may ultimately increase. The more intensive the integration of the group, the higher the potential risk of negative externalities to spread rather unimpeded and infect other group constituents, is. This effect may be due to actual interdependences between the business areas, but can also be triggered indirectly via reputation effects, that emerge, as a result of the perceptions of the group's environment, i.e. its stakeholders.

As a matter of fact, a highly decentralised group, representing a collection of disparate and autonomous businesses under common ownership is expected to bear lower risk of contagion, which is a perverse situation, given the objective of management to integrate companies, in order to make maximum use of economies of scale and scope. In contrast, highly centralised financial groups that try to exploit its business connection are expected to be more severely exposed to the risk of contagion[136]. Hence, the achievement of economies of scope is directly related to the level of risk.

A similar argument is valid for the internal transfer of risk to the holding company in order to justify the diversification effect, generated within a group. Only if all risks were – theoretically - pooled at one particular entity, the full diversification potential could be exploited because, otherwise, there are several countervailing forces that confine the exploitation of the maximum effects. For instance, company management may pursue different objectives; sub-portfolios are optimised at company level, which, however, does not necessarily lead to the optimisation of the group portfolio.

Given that such complete internal risk transfer were possible, the risk of contagion is raised again due to the strong interrelation of company portfolios. A failure of the

[135] Arguments are primarily based on the paper of Herzig and Mayr (2005) and Mayr (2006), respectively.

[136] On the other hand, the higher the centralisation of the group, the more fungible capital between the entities is. Thus, it enables a faster capital provision to ailing companies in times of distress.

holding company as reinsurer would, furthermore, result in higher than expected obligations for the primary entity, in the event of a claim. The credit risk is expected to be higher than that of a globally active reinsurer that can take full advantage of its vast international portfolio.

4.1.1.4. Risk assessment and aggregation

Economic capital models are current state of the art methods to assess minimum capital needed to guarantee smooth operations. Unfortunately, the concept of economic capital, which can be defined as sufficient surplus to cover potential losses at a given tolerance level over a specified time horizon, commonly assumes independence of claim costs from one business to the other within the group. Financial institutions do normally abstract from potential mutual impact between the various business areas and risks, although the dependence structure may have a substantial impact on the economic capital of that firm. Therefore, this aspect has to be included in the concept of economic capital if it is recognised as a cushion against all unexpected losses, resulting from operative losses or asset returns that fall below the levels expected, at the company's level of comfort. The concept, as such, if adapted, is convincing because it provides the company, and, to some extent, also the supervisor, with a single metric that reflects the aggregate risk of the company risk portfolio.

A "cutting edge" concept that allows taking account of the aforementioned shortcomings of traditional methods is the copula function. As the name implies, the copula couples the marginal distributions together to form a joint distribution. This function embodies all the information about the dependence structure between the components of a random vector and, hence, allows the modelling of these dependence structures, considering different distributions. Copulae are a means to obtain a joint return or loss distribution of a portfolio when the percentiles of the portfolio differ from the percentiles of the marginals, whereas in usual portfolio VaR approximations, the equality is taken for granted. Additionally, those models, in contrast to copula models, face the deficiencies of certain restrictions, for instance, perfect correlation or restrictions of percentiles (e.g. to be derived from a normal density function). These assumptions limit the dependence on the data available (cf. Rosenberg and Schuermann, 2004). To this extent, the inclusion of copula theory into the economic capital approach makes sense as it allows an appropriate risk aggregation, considering potential diversification effects.

Although the extended concept of economic capital including the use of copulae is an appealing methodology, as it provides a single metric to measure a firm's risk, it still bears certain deficiencies. Certain risks, such as operational risk, business or reputational risk are not easily quantifiable and, consequently, require the use of proxies (e.g. equity prices), which, by definition, can only provide an approximation.

The Joint Forum's Working Group on Risk Assessment and Capital (Joint Forum, 2003) emphasises some additional aspects of why supervisors may be justified, in pursuing a rather cautious approach, by neglecting diversification across company risks. One argument is the lack of data available – which, however, also inhibits the use of copula models - to allow the justification of the calculations. Then, as explained - structural arguments may prevent the generation of group diversification effects. Moreover, correlation may fluctuate over time, and, according to several estimates, seems prone to revert to one during episodes of stress. As a consequence, the extent of diversification strongly diminishes. The events of September 11 provide an example of the potential for simultaneous effects that a priori would not have been expected to be correlated[137].

Assuming perfect dependence between the losses of the different business lines, the calculation of group risk, using economic capital as proxy, is straightforward. The aggregated economic capital required will simply be the sum of economic capital requirements for each business line. Consequently, no diversification effects are considered at group level.

However, risks are rarely perfectly dependent and there is substantial room for diversification, which requires a different approach to assess the overall risk of a financial group.

The following three issues have to be taken into account, when aggregating different risk measures (cf. Saita, 2004): (a) the identification of components that have to be aggregated; (b) the choice of the relevant aggregation technique or algorithm; and (c) the calibration of parameters.

Aggregation, in principle, has to occur at two levels. At the first level, given known marginal distributions, the respective risks in all business lines are aggregated within a single risk type. One may assume that risks differ across business lines, for example, market risk may underlie different distributions in life and non-life insurance due to different time horizons. In the end, this procedure should result in a joint distribution for each risk factor. The second level of aggregation contains the aggregation of risks across risk types, that is, the different risks are combined. Theoretically, the results should then provide us with the overall risk of the group.

The argument for this two-level approach lies in the fact that different sensitivities to the various risk types have to be assumed across the business lines of the respective groups. Hence, first, the particular risks have to be assessed from a group's viewpoint. Only, in a second step, the aggregation across all risk types can then be conducted, in order to evaluate the overall risk.

Nevertheless, certain inconveniences complicate an accurate assessment of the amount of risk of the group and necessitate certain simplifying assumptions to this, theoretically straightforward, approach. This fact leads to a trade-off between the accuracy of the results and the number of premises one is willing to accept to enable or ease the calculations and the comprehensibility, thereof. Different risks are assumed to underlie different distributions. However, also within a certain risk category, different business lines may require different distributions.

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[137] Refer to the respective sections in this paper.

The assumption of equal distributions across business lines in insurance, for instance, is particular problematic as business in the life and non-life sector (or even between different non-life sectors) is notably divergent. Especially in non-life insurance, one also has to keep reinsurance in consideration. Reinsurance particularly assumes risk in the tails, at the cost of potential additional credit risk. Additionally, across business lines, certain risk categories have to be borne to a different extent. For instance, life insurance has to bear relatively more market risk than non-life insurance, but considerably less operational risk.

The differences between credit institutions, on the other hand, seem to be of minor importance; especially in Europe, where most companies are universal banks, covering the whole range of banking operations. The difference to the insurance sector may (still) be considerable, though, which is important for conglomerates. The most important risk of credit institutions is definitely credit risk, followed by market risk and operational risk, to mention the three most important classes of risks according to the Basel II framework.

Thus, in order to obtain an all-embracing risk map or picture of the financial groups assessed, it is crucial to make the right decision concerning generalisation and assumptions in the aggregation of risks.

To our knowledge, one of the first papers to estimate group risks of (insurance) groups with real numbers by using copulae is that of Tang and Valdez (2004). The results suffer from several assumptions for the sake of tractability, but it still provides us with sufficient insight into the assessment of overall group risks.

To keep their analyses tractable, the authors introduced the following limitations: The modelled multi-line insurer restricts its business to non-life insurance. The authors, furthermore, focus purely on one risk, i.e. underwriting risk, while ignoring other sources of risks. This limitation saves the authors from conducting the aggregation of different risks, while reducing their focus to the aggregation of one risk in different business lines. Thus, one step of aggregation can be omitted. The effect of reinsurance is also excluded from the analysis. For the sake of simplicity and tractability, the analysis is further restricted to elliptical distributions as these distributions are amenable to standard risk management approaches. For instance, they support the use of VaR as a measure of risk.

The effect on economic capital requirements is analysed, by using copulae and then calculated using the VaR risk measure or - for the purpose of comparison – the tail-VaR. The diversification benefit is then calculated as the difference between the capital requirement on the aggregated loss and the weighted sum of each business line's capital requirements as if it were a stand-alone business.

4.1.1.5. Summarised findings of group assessments

Both industry and supervisory authorities agree that the current approach to estimate group risks is not the ultima ratio. Since it applies the unrealistic assumption of perfect dependence between risk factors, it does neither account for potential additional risks, resulting from the group, as such, nor does it account for the risk mitigation properties inherent in a larger group portfolio, i.e. essentially its diversification potential, and the argument of possible capital injections or other agreement of support by holding companies to their subsidiaries or even between subsidiaries.

To cover any group risks, certain supervisors simply propose to require a group or conglomerate surcharge on general capital adequacy requirements. However, albeit a sensible approach from a conservative supervisory perspective, it does not consider actual circumstances. Industry representatives, on the other side, predominantly emphasise diversification effects and neglect any countervailing forces that may prevent their full generation. A wealth of more sophisticated methods has been proposed, but they all more or less suffer from the same shortcomings.

- Lack of data or very short time series
- Empirical data do not necessarily reflect real data
- Dependences may change over time and in extreme circumstances
- Expensive and time-consuming approaches with only limited additional value
- Non-quantifiable risks, e.g. reputational risk can have a significant impact
- Choice of underlying methodology has paramount effect on
    - Economic capital requirements for the firm or the group
    - Diversification benefits

The best model is of no use when the relevant (amount of) data is not available. Thus, calculations may only provide a very crude approximation or may even provoke misleading conclusions.

As changing environments imply, empirical, i.e. historical, data do not necessarily adequately reflect current situation or developments. Ex post, we might observe a noticeable bias of these data and the conclusions that are drown based on the information used. In a dynamic environment it is indispensable for risk managers to scrutinise derivations or assumptions based on information from the past.

A very important aspect is the validity of the model. It is challenged in two respects: Dependences between risks may change over time. In extreme events, dependence will certainly be higher than in normal times. Accordingly, the model has to take these facts into account and must be adapted regularly or, at least, has to provide for a sufficient buffer.

Moreover, the model has to consider risks that are difficult to quantify but have an imminent impact on the financial safety of the group, such as most cases of negative externalities and reputational effects, in particular.

Furthermore, one has to keep in mind the value of such sophisticated models. They are usually cost-intensive or time-consuming and the additional benefits over traditional methodologies are often, at least, questionable. Therefore, if the benefits of a more sophisticated model cannot justify the inherent costs, the industry may prefer more conservative and crude models, using predefined parameters and haircuts, to take notice of possible adverse developments, instead.

In the following figure three popular methods of risk integration and aggregation are, therefore, compared based on the two determinants: complexity and explanatory power. This image will highlight the difficulty for risk management, concerning the right choice of the methodology applied under a cost-benefit perspective.

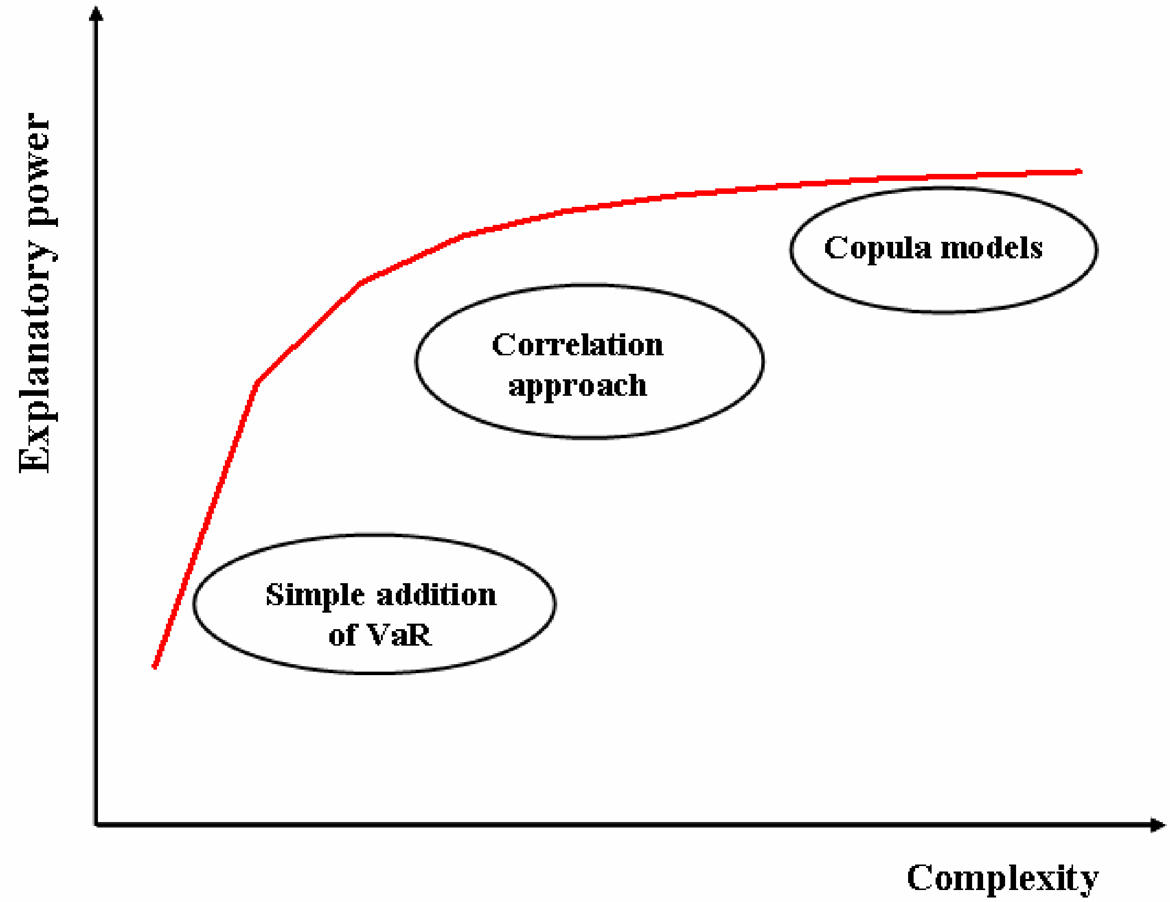

Figure 27: Trade off between ease of implementation and explanatory power

Overall, research still has to continue striving for improvements in the risk management of groups. Nevertheless, as long as all kinds of contagion risks cannot be estimated to a satisfying extent, one may suffer the constraint of crude assumptions, which might only insufficiently cover current or future circumstances. Portfolio theory may be easily applied but does possibly miss certain arguments that are relevant for the judgement on the financial condition and safety of a group or conglomerate.

4.1.2. Redistribution of potential diversification to respective entities

Given that both industry and supervisors agree that financial groups accrue sufficient diversification effects to outweigh any other negative externalities, resulting from group structure and the interdependences between the affiliates - i.e. overall group risk remains below the sum of the stand-alone companies' risks - one still faces the challenge of how to redistribute these effects across all affiliates. To what extent will each entity profit from the portfolio effect that is generated at the top level?

A seminal paper that makes the allocation of risk a subject of discussion and that treats the coherent allocation of risk capital as an axiomatic problem - similar to the coherent risk measure in Artzner, Delbaen, Eber and Heath (1999) - is Denault (2001). Similarly to the former, it does not take account of negative externalities that may impact the true extent of diversification within a group or between (sub-) portfolios[138]. The relation of these two concepts becomes obvious in table 18:

Coherent risk measure (Artzner et al., 1999)		**Coherent risk allocation (Delbaen, 2001)**	
Monotonicity	$X \leq Y \Rightarrow \rho(Y) \leq \rho(X)$	Full allocation	$\sum_{i \in N} K_i = \rho(X)$
Subadditivity	$\rho(X+Y) \leq \rho(X) + \rho(Y)$	No undercut	$\sum_{i \in M} K_i \leq \rho\left(\sum_{i \in M} X_i\right)$ *for all* $M \subseteq N$
Positive homogeneity	$\rho(\lambda X) = \lambda \rho(X)$ *for all* $\lambda \geq 0$	Symmetry	By joining any subset $M \subseteq N$; $\{i, j\} \notin N$, portfolio i and j make the same contribution to the risk capital
Translation invariance	$\rho(X+c) = \rho(X) - c$ *for all* $c \in \Re$	Riskless allocation	$K_n = \rho(\alpha r_f) = -\alpha$

Table 18: Properties of coherent risk measures and coherent risk allocation

The preliminary requirement is straightforward. It claims full allocation, which implies that the complete risk capital can be attributed to the respective entities of the portfolio, or the group in this context. No residual may remain unimputed. The remaining three properties represent the necessary requirements for a risk allocation to be coherent.

The no undercut property is similar to the subadditivity argument. It states that a portfolio's allocation will not be higher than the amount of risk capital it would face as a stand-alone entity. In game theory, it is known as the individual rationality condition, that is, the individual business line of the group may not cover more risk

[138] One, however, has to consider that these concepts were originally not developed to determine the overall risk (and its reallocation) of a group of independent entities.

capital than estimated on a stand-alone basis. Nevertheless, the no undercut axiom is criticised on the same basis as the subadditivity requirement.

The symmetry argument ensures that a portfolio's allocation depends only on its contribution to risk within the firm. The sequence of risk attribution to the respective entities does not impact the level of the (re-) allocated risk capital.

Finally, riskless allocation constitutes a similar axiom as translation invariance. A riskless portfolio should be allocated exactly its risk measure, which incidentally will be negative. Hence, a portfolio that increases its cash position should see its allocated capital decrease by the same amount (Denault, 2001).

The downstreaming of diversification effects is no trivial task because simple attribution of equal or proportional amounts to the group's subsidiaries may not suffice. In fact, one has to ensure that always sufficient risk capital is available at the entity's level in times of distress, which necessitates further measures that have to be accomplished. Reductions in capital adequacy requirements for financial groups have to be commensurate and must not jeopardise the group's safety.

In fact, the acceptance of risk capital discounts necessitates either full fungibility of capital across group companies or mutual guarantees that may assure the safety of the individual entity. As we have already learned, these arguments raise the risk of potential intra-group contagion because interdependences become stronger and firewalls, to prevent infection, are eliminated.

Furthermore, the implementation of guarantees or other collaterals also has an important legal dimension. For instance, banking law, company law and insolvency law may thwart the ideas of a sole focus on the overall group and thus may prevent the acceptance of alleviations in necessary group capital from a supervisory perspective, which has to aim at the domestic entity (cf. European Central Bank, 2005).

In the following section we, therefore, want to discuss these questions more intensively and highlight the greatest challenges supervisors and company risk management face, when trying to implement the new requirements[139].

4.1.2.1. Prerequisites for allocation discussion

There have been several proposals in the academic literature of how to reallocate capital in large portfolios although most of them neglect dynamic aspects of portfolio risk and times of distress, in particular. Most examples remain static models that take the diversification effect for granted and cannot deal with sudden adverse scenarios, where correlation has significantly increased and diversification consequently decreased.

Hence, it is questionable whether diversification, which under such conditions constitutes a "good weather effect", is sustainable over a longer period of time or, especially, during episodes of crises. On the other hand, a model that takes account

[139] The following expositions heavily borrow from a paper by Darlap and Mayr (2007).

of all these circumstances may result in highly volatile capital requirements for both the group as a whole and the respective institutions in particular.

If we assume that certain ominous events are hardly foreseeable, the risk manager faces a high challenge in adapting the available amount of current risk capital to the new conditions. The current, widely used approach to use correlation matrices[140] to combine individual sub-portfolios to a group-wide portfolio, such that portfolio effects can be estimated, suffers from the fact that it can actually not account for extreme events.

$$VaR_p = \sqrt{(VaR_1, VaR_2, ..., VaR_n) \cdot \begin{bmatrix} 1 & \rho_{1,2} & \cdots & \rho_{1,n} \\ \rho_{2,1} & 1 & & \vdots \\ \vdots & & \ddots & \rho_{n-1,n} \\ \rho_{n,1} & \cdots & \rho_{n,n-1} & 1 \end{bmatrix} \begin{pmatrix} VaR_1 \\ VaR_2 \\ \vdots \\ VaR_n \end{pmatrix}} \tag{4.34}$$

The methodology of linear correlation factors to aggregate risks or business lines causes the averaging out of any extreme scenarios and, thus, possibly underestimates actual dependences. Moreover, it is only applicable for elliptic distributions. Due to its particular convenience of application, it is an attractive methodology for risk aggregation among corporate risk managers. Regarding the level of diversification results, it is definitely not the most conservative technique but also not the one, which generates the largest effects. It lies somewhere in the middle and shows lower effects than the square root approach suggested by the American insurance supervisor, i.e. the National Association of Insurance Commissioners (NAIC).

The copula approach, which is a more precise methodology for the aggregation of risks, as outlined in earlier remarks, leads to lower diversification effects. Hence, the use of correlation matrices to combine the different risks and businesses, at least, slightly exaggerates actual portfolio benefits. Albeit more commensurate methods to couple individual company portfolios to calculate group diversification effects, these models are in practice often not feasible due to data and IT capacity limitations and the weak manageability by the corporate risk management.

[140] For a derivation of the correlation matrix as a means to aggregate economic capital or risks refer to Dhaene et al. (2005).

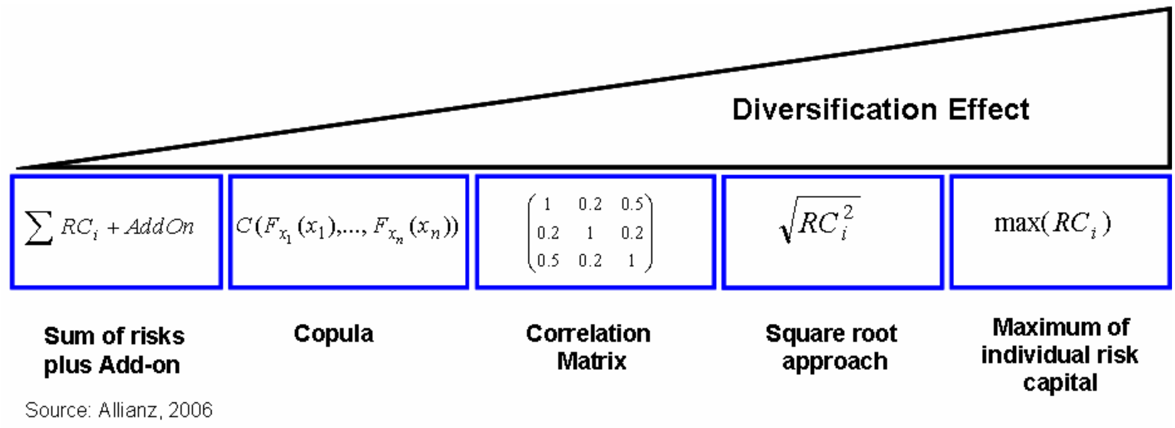

Figure 28: Diversification effect depending on risk aggregation approach

The use of tail correlation, instead, does not lead to more convincing results with respect to the quality of the models. Nevertheless, it produces more conservative, i.e. prudent, results with less extreme diversification effects.

Furthermore, the risk manager may have to deal with the difficulty of permanent availability of data that are used to determine the necessary risk capital level. Nonetheless, this is more of an issue for insurance risk managers than for their banking counterparts, who need this data for their trading book.

Additionally, we have to be aware that only parts of the overall diversification effects are generated at the level of the individual group entity's portfolio, and these effects are, to a certain extent, already implicitly recognised. A large part of the effects is the result of a large, group-wide portfolio, consisting of several, diverse companies or business lines with different businesses or a different geographical focus.

In fact, diversification effects are generated to a noticeable extent at group level, although numbers considerably vary in the different examples presented in the literature (cf. Kuritzkes et al., 2002 or Chief Risk Officer Forum, 2005). These facts make the commensurate reallocation of those effects to all affiliated entities extraordinarily challenging and, therefore, trigger intense discussions between supervisors and the industry.

These diversification effects are generated at the top level of the group. Despite this fact, keeping the potential discount at the holding company level, does not make all too much sense as the holding company does not have to hold risk capital. It would only be possible if risk were actually totally or partially transferred to the top level of the group although this procedure bears several difficulties, as outlined in Herzig and Mayr (2005).

The same argument is valid for any risk concentration or contagion "surcharge", which cannot easily be attributed to a certain entity. Most of the contagion arguments are a result of the strong interdependence of group affiliates, i.e. contagion is, to a certain extent, a negative by-product of conglomeration or group building and is, therefore, less pronounced for a stand-alone institution.

Since actual contagion effects can only be estimated ex post, and the risk per se is a quite nebulous concept, it is almost impossible to apportion the risks commensurately to the respective entities. Similar to the diversification effects, these externalities are “generated” at the top level, which makes imputation rather arbitrary.

The question of the acceptance of diversification effects and their redistribution to the respective group entities may also be of supranational relevance for supervisors if the group is truly multinational. In particular, the flows of capital in times of distress have to be defined, ex ante. Otherwise, public interventions that prevent the flow of capital from one entity to the other, to provide liquidity in adverse situations, cannot be precluded. Governments may try to intervene in order to safeguard national subsidiaries from other group affiliates’ negative externalities and, therefore, may stop any cash flows across borders.

Also, from a simple legal perspective, these cash flows may be prevented. The legal framework emphasises the stability of the legal entity but does hardly recognise the affiliation with a (financial) group, i.e. the overall interest of the group becomes secondary. Legal rules may, therefore, stand in strong contrast to group management policies.

If in a crisis situation intra-group transfers are considered as detrimental transactions[141] for the transferor or its creditors, these transfers may either be prohibited by law, leading to the transaction being null and void, or may trigger supervisory action and the setting of corrective measures if necessary (European Central Bank, 2005). In fact, in the worst case this may lead to a reverse transaction in order to restore the former condition.

Taking all these arguments together, one may assume two possible ways to enable the acceptance of diversification effects in financial groups:

- Risk is actually totally or partially transferred to the top level of the group (true transfer), such that the entity that can actually profit from diversification effects, i.e. the holding company, is simultaneously the ultimate risk bearer.
- Adequate provisions for payments in case of loss (e.g. guarantee or reinsurance contract), which would have to be treated as a surrogate for own funds, i.e. diversification effects are reallocated to the respective entities.

The first concept is an idealistic and hardly feasible model and will, therefore, not be treated in more detail. The latter approach, which is theoretically easy to implement, however, bears certain inconveniences that have to be emphasised. It requires full fungibility of capital, which is not necessarily given, provided that the

[141] There are several arguments that define such a transfer as detrimental. Here, we are essentially concerned about those transactions that endanger the safety and soundness of the transferor.

group has installed certain firewalls that are intended to mitigate intra-group contagion and given the legal framework, company law and insolvency law, in particular.

These firewalls counteract the free mobility of capital across group affiliates which leads to the perverse situation that a safety measure thwarts the support of an ailing institution.

In short, the subsequent list will provide the most urgent arguments that have to be recognised in debates on the consideration of diversification effects:

- Financial means may become insufficient to oppose unforeseeable (extreme) events.
    - These events are not commensurately reproduced in a correlation matrix that maps the overall group risks and that is commonly used to estimate portfolio effects.
- Dependences and, hence, diversification effects are not constant.
- Countervailing forces are usually not recognised.
- Firewalls between affiliates are broken down.
    - Stronger capital relations
    - Unimpeded contagious effects, i.e. even not directly affected institutions become concerned
- Business lines have to provide for risks, they are not directly exposed to.
- Clear supranational rules have to be established.

4.1.2.2. Downstreaming of diversification effects

Well aware of the principle shortcomings of a VaR-model, we will first take a look at a possible model that efficiently attributes the estimated diversification benefits to the corresponding entities in a group. Based on this example, one may, then, more easily discuss the challenges that are inherent in this downstreaming process.

In order to find an appropriate approach to redistribute risk capital, one may consider each institution's contribution to group risk capital. These incremental costs are determined by calculating the change of risk capital after the inclusion of this new position.

$$RC_{inc} = RC_{p+a} - RC_p \tag{4.35}$$

Thus, the incremental risk capital RC_{inc} is calculated, by subtracting the initial risk position RC_p from the total capital load after the inclusion of an additional risk element a. It has to be assured that the actual allocation of risk capital to the respective entity is symmetric, i.e. it does not depend on the sequence of imputation. Otherwise, equal risks were not treated equally.

As can be shown, the sum of these incremental risk capital positions is lower than the required group risk capital. The whole diversification benefit is always assigned to the new position although it has to be partitioned between the new position and the rest of the group[142].

$$\sum_{i=1}^{n} RC_{inc} < RC_p \tag{4.36}$$

Hence, the remaining costs, i.e. the capital gap, have then to be apportioned to all group constituents. This imputation may, for instance, be effected through equal or proportional parts, whereby the differences are only the risk weights. A prerequisite is, however, that the overall group risk capital that is to be distributed, is known. The advantage of this approach is that risk capital is completely allocated to the respective entities, i.e. the allocation of risk is efficient.

The use of a correlation matrix to estimate group portfolio risk, i.e. VaR_p, also guarantees that in most cases the final RC_i remains lower than the stand-alone value, which is due to the inherent diversification effects that are (implicitly) covered by the correlation matrix, that is, this risk allocation mechanism generally fulfils the individual rationality axiom[143]. Only in extreme cases, e.g. volatility is extremely diverse and correlation varies considerably, this requirement is not necessarily fulfilled. For certain entities the risk allocation may then be higher than the stand alone VaR. Thus, in most cases the individual rationality requirement is not breached, although the requirement $RC_i \leq VaR_i$ cannot be generalised.

$$VaR_i > \frac{\sum_{i=1}^{n} VaR_{inc}}{n} = \frac{VaR_p}{n},\ i = 1,...n \tag{4.37}$$

The imputation of this allocation gap may be effected through equal (first case) or proportional parts (second case). The advantage of both these approaches is their ease of implementation and their convenience. Nevertheless, a counter-argument to use these allocation methods may be the lack of economic foundation as the imputation is relatively arbitrary, in particular, in the case of an equal redistribution of the allocation gap. The proportional attribution, at least, takes account of the risk size of each affiliate, which is a reasonable factor with respect to the affiliates overall risk contribution to group risk.

The two cases can be formalised as follows:

$$RC_i = incremental\ RC_i + apportionment;\ i = 1,...n$$

$$\sum_{i=1}^{n} RC_i = RC \tag{4.38}$$

$$RC_i = VaR_{inc} + \frac{1}{n}\left(VaR_p - \sum_{i=1}^{n} VaR_{inc} \right),\ i = 1,...,n \quad or$$

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142 For a mathematical derivation refer to Albrecht and Koryciorz (2004):

143 According to Mandl (2004), efficiency, symmetry and individual rationality are essential and desirable properties of a capital allocation mechanism.

$$RC_i = incremental\ RC_i + apportionment; i = 1,...n$$

$$\sum_{i=1}^{n} RC_i = RC \tag{4.39}$$

$$RC_i = \frac{VaR_{inc}}{\sum_{i=1}^{n} VaR_{inc}} VaR_p, i = 1,...,n$$

Subscript i stands for the individual entity within the group and p for the total group portfolio. The first example of RC_i calculation is based on a uniform distribution of non-incremental costs, while the latter version attributes non-incremental costs proportionately.

In a next step in table 19 three admittedly simplified but illustrative examples are provided that are intended to show the approach described above. The three examples vary with respect to the underlying correlation factors and the confidence interval of the distributions. The first example is discussed in more detail in the subsequent chapter.

Summary

Group Confidence Level	99,5%
Correlation Coefficient	0,10

	Volatility	Stand-alone VaR	Diversified VaR	Incremental VaR	Adjusted Incremental VaR	Stand-alone Confidence Level
Portfolio 1	1000	2575,83		1066,72	1629,10	94,84%
Portfolio 2	1000	2575,83		1066,72	1629,10	94,84%
Portfolio 3	1000	2575,83		1066,72	1629,10	94,84%
		7727,49	4887,29	3200,16	4887,29	

The example assumes a financial group consisting of three lines of business, whose respective correlation is 10 percent each. Volatility is in all three cases 1000. Furthermore, a confidence level of 99.5% is set in order to estimate the group Value at Risk under the assumption of a normal distribution with mean zero. The stand-alone VaR is the simple of each portfolio VaR, without taking diversification into account. The incremental VaR shows each portfolio's contribution to the group VaR. The whole diversification benefit is always assigned to the new position although it has to be partitioned between the new position and the rest of the group. Therefore the incremental VaR has to be adjusted.

Group Confidence Level	99%
Correlation Coefficient	0,50

	Volatility	Stand-alone VaR	Diversified VaR	Incremental VaR	Adjusted Incremental VaR	Stand-alone Confidence Level
Portfolio 1	1000	2326,35		1669,01	1699,46	97,12%
Portfolio 2	1000	2326,35		1669,01	1699,46	97,12%
Portfolio 3	1000	2326,35		1669,01	1699,46	97,12%
		6979,05	5698,37	5007,03	5098,38	

The example assumes a financial group consisting of three lines of business, whose respective correlation is 50 percent each. Volatility is in all three cases 1000. Furthermore, a confidence level of 99% is set in order to estimate the group Value at Risk under the assumption of a normal distribution with mean zero. The stand-alone VaR is the simple of each portfolio VaR, without taking diversification into account. The incremental VaR shows each portfolio's contribution to the group VaR. The whole diversification benefit is always assigned to the new position although it has to be partitioned between the new position and the rest of the group. Therefore the incremental VaR has to be adjusted

Group Confidence Level	95%
Correlation Coefficient	0,00

	Volatility	Stand-alone VaR	Diversified VaR	Incremental VaR	Adjusted Incremental VaR	Stand-alone Confidence Level
Portfolio 1	1000	1644,85		522,80	949,66	82,89%
Portfolio 2	1000	1644,85		522,80	949,66	82,89%
Portfolio 3	1000	1644,85		522,80	949,66	82,89%
		4934,56	2848,97	1568,39	2848,97	

The example assumes a financial group consisting of three lines of business, whose respective correlation is 0 percent each. Volatility is in all three cases 1000. Furthermore, a confidence level of 95% is set in order to estimate the group Value at Risk under the assumption of a normal distribution with mean zero. The stand-alone VaR is the simple of each portfolio VaR, without taking diversification into account. The incremental VaR shows each portfolio's contribution to the group VaR. The whole diversification benefit is always assigned to the new position although it has to be partitioned between the new position and the rest of the group. Therefore the incremental VaR has to be adjusted

Table 19: Risk attribution (illustration)

4.1.2.3. *Discussion of example*

The first example provided purely serves explanatory purposes and does not necessarily reflect fully realistic assumptions. In the example above, we assume a common, arbitrarily chosen, but conservative, confidence level of 99.5 percent and a common correlation factor of 0.1 between each line of business (LoB). The volatility is also arbitrarily chosen.

Correlation between the entities may generally be too low in most cases, as is shown in the estimation for different lines of business in the non-life insurance industry in Tang and Valdez (2004). Without taking notice of any other effects, our underlying correlation matrix already has a tendency to overestimate potential diversification effects and, therefore, only serves an illustrative purpose.

Alternatively, one may apply the same technique by using ES instead of VaR. The principle criticism, concerning actual diversification effects, remains the same, however, one may obtain more conservative results in absolute terms because the ES is always higher than the VaR at the same confidence level.

The diversification benefit is then calculated as the difference between the simple sum of stand-alone VaRs and the estimated portfolio VaR. Then, the incremental VaR is estimated, which is defined as the change of risk capital after the inclusion of an additional LoB in the portfolio.

In the calculation of the incremental VaR, it is implicitly assumed that correlation factors do not change after stand alone institutions are integrated into a group portfolio, although it can be supposed that integrated companies show a higher interdependence and, hence, are more highly correlated than stand-alone companies. Thus, to be more concise, one would have to adapt the correlation matrix to the new circumstances, whenever a new entity is added to the group.

To find the incremental VaR of the third portfolio, one has to subtract the VaR of a portfolio, consisting of only the remaining two entities from the overall portfolio VaR, that is, the incremental VaR of a particular entity is calculated as the difference between portfolio VaR and the sub-portfolio VaR, exclusive of the respective entity.

The sum of these incremental risk capitals delivers the incremental VaR for the group. As is immediately evident, this value is lower than the portfolio VaR. Therefore, the difference between the two values still has to be attributed to the respective LoBs. In this case we, proportionately, imputed the remaining capital as in equation (6).

In the end, the whole value is partitioned, such that the sum of adjusted incremental VaRs is equal to the portfolio VaR, estimated before. However, the confidence level of each stand-alone entity is different to the initial confidence level applied for the group portfolio, which is obvious, due to the change of underlying risk capital for each entity. As explained earlier, those capital levels are generally lower than in the case of stand-alone calculations. Nonetheless, there may be rare cases where certain entities in the group would have to bear higher capital requirements than in the stand-alone case[144].

As can immediately be observed, the model applied does not take account of potential concentration or contagion effects. It assumes that diversification effects are fully realisable and that there are no barriers that prevent their realisation. By definition, however, the acceptance of diversification effects for the determination of group capital requirements entails a reduction in the confidence level of the individual entity because the attributed risk capital is in general – except for rather rare cases where the individual rationality requirement is not applicable - lower than the individual level. Put another way, to achieve a higher stand-alone confidence level, one has to raise the confidence level for group level calculations.

Another way out of this dilemma could be the attribution of an a priori defined group surcharge that should commensurately reflect any weaknesses of group structure, such as the ones aforementioned. This surcharge may, then, be attributed to the respective entities, by applying the same method as in the case of the reallocation of diversification effects.

Nevertheless, as explained in preceding chapters, it seems almost impossible to provide exact data on consequences of contagion or concentration and, thus, capital surcharges can hardly be more than a conservative (best) estimate.

Another problematic issue is the assumption of a normal distribution in the model. As we previously discussed, this is in some cases a very crude approximation, especially in the insurance industry but also in banking. With the potential exception of market risk, most risks in insurance lines of business, e.g. most non-life insurance contracts, are heavily tailed and skewed and result in a strong distortion of model implications if normality is assumed.

Overall, the supervisor is in a severe dilemma. All models, so far, bear certain inconveniences or weaknesses, as they can hardly reflect actual circumstances and only provide (more or less conservative) approximations. Simple summation of stand-alone risks, more exactly, stand-alone risk capital, does neither take account of potential diversification effects neither of any intra- or inter-group externalities. On the other hand, portfolio VaRs for groups assume a frictionless capital transfer between the respective institutions and probably overestimate potential diversification effects at holding company level.

[144] Refer to the example in table 46 in the appendix.

5. Final Conclusions

The objective of this paper was the assessment of (negative) group effects with particular emphasis on contagion. The risk of contagion was interpreted as a process by which liabilities, losses and events affecting a particular entity may affect another legal entity, resulting in loss or the risk of loss to that other legal entity (cf. Freshfields Bruckhaus Deringer, 2003).

In a first step the theoretical propensity of the financial industry and the differences between credit institutions and insurance companies regarding this phenomenon were assessed. Therefore, it was indispensable to take a look at the basic rationale of the existence of these financial intermediaries and hence their structure. Existing theoretical literature on contagion provided additional input on how to approach this project. A look at current sources of contagion, e.g. the interbank market, the convergence and consolidation of industries, risk transfer, etc., was intended to provide further insights regarding the exposure of the financial industry to the risk of contagion and the assumed differences in effect.

In a second step, an analytical derivation of contagion effects in financial groups or conglomerates was provided in order to introduce subsequent empirical estimates of this phenomenon. The main factors of contagion, i.e. physical interdependence and correlation of the portfolios, were evaluated at a very abstract level without making use of actual numbers or factors.

Based on the insights from the abstract treatment of contagion and its triggers, different empirical methodologies were applied to measure contagion in practice. Concretely, event studies of share prices, distance to default estimations and co-exceedance calculations of credit spreads were conducted to observe actual spillover behaviour or the propensity to risk dissemination with particular emphasis on financial groups.

Unfortunately, the results obtained were quite modest, which may be - to a large extent - due to the dilution of inherent information in the data available. For instance, share prices are strongly biased by investors' and analysts' perceptions, credit spreads suffer from the inefficiency or illiquidity of the market, and accounting data are influenced by the respective company's strategy, its retrospective information, etc.

As we have seen, ideas and concepts that are relatively easy to explain in theory are often difficult to verify in practice. Mostly, relevant data are not available and restrictive assumptions have to be taken that may considerably distort any estimation results. Furthermore, historical information may often not suffice to provide a good prediction for future events. Take, for instance, natural catastrophe events. Almost every major extreme event necessitates a readjustment of the models used for forecasts and premia and cost calculations in insurance. For example, a former 1/200-year event might then become a 1/100-year or even more frequent event, i.e. in the extreme, former tail events may then even become regular events.

This list of data weaknesses can easily be extended and force any examiner to follow a more qualitative approach. He has to push for the consideration of potential interdependences and make aware of certain intra-group effects which may not be measurable with customary methods and tools but which may still have an enormous impact. It is a convenient and commonly used procedure to integrate expert opinion into group estimations of certain group effects.

In our section on conclusions and implications, we therefore provide insights on the importance of the investigated effects on corporate or group risk management and eventually on group strategic decisions. It possibly even affects investment decisions and corporate control.

A prominent argument for group consolidation is the potential generation of extensive diversification effects of a broad portfolio consisting of several diverse businesses, different company focus and the penetration of different markets and geographies. The more diverse these businesses are, the higher the potential effect the group is assumed to generate is. However, frequently countervailing or limiting forces that reduce the potential effects are badly neglected.

Furthermore, current methodologies often bear certain weaknesses in the estimation of group risks. Thus, it is questionable whether a group can really take advantage of the maximum diversification effects. The effects achievable may differ considerably depending on the corporate group structure and the number of entities concerned.

Problems in one part of a group may affect confidence in other parts, i.e. reputational effects may play a considerable role as countervailing forces. Then, the volatility of one unit's profitability may be affected by the actions of another unit within the financial group. Moreover, one may assume that any risk spreads more easily across entities of a highly integrated group in comparison to risk dissemination between stand alone institutions.

Current risk aggregation methodologies usually assume linearity of factors and risks although this may not be a reasonable approach to detect interdependences. For instance, the inclusion of non-linear derivative products invalidates many of the assumptions underlying the use of correlation. Many risks and data are often skewed and heavily tailed. Linear correlation might miss the fact that certain areas of the distribution are highly correlated, while others are less correlated or even independent, which may be particularly true in extreme situations.

Alternative cutting-edge aggregation methodologies, e.g. copulae, can better map actual risks although they suffer from the necessity of extensive data availability. Institutions usually do not have a sufficiently large data pool or the means and capacity to establish more sophisticated risk management processes. Consequently, most institutions confine themselves to rough approximations and more convenient but imprecise approaches or even neglect any effects they cannot directly measure.

Contagion and other negative externalities even have direct implications on the generation and measurement of diversification effects within financial groups. It may be suspected that diversification is generally overestimated by group risk managers not taking account of any countervailing effects, which for them are often of academic interest only. It is argued that buffers in the correlation coefficients sufficiently cover negative effects that may be neglected otherwise. Nevertheless, also these numbers are usually the result of expert opinion and do not necessarily reflect actual circumstances. The argument again is the lack of sufficient data that allow appropriate measurement of interdependences of risks and lines of business.

Even if supervisors accept the estimated group effects in an internal model, it is still questionable how the group makes use of this result. Clearly, from a corporate, shareholder value perspective the ultimate goal must be the reduction of risk capital, which is costly as it cannot be efficiently used. Shareholders may exert pressure to limit the amount of uninvested capital. However, also the owners of the institutions, i.e. the shareholders, have or must have a natural interest in the safety of their "property".

Since diversification effects are eventually accrued at the top level of the group, it is possible that only the company at the top has its risk capital reduced while all the subsidiaries still have to bear their initial amount of risk capital. This procedure, as suggested by several companies in the insurance industry, takes for granted that the top level company is regulated and also has to bear regulatory capital. Otherwise, benefits cannot be assigned to the parent company.

A more logic approach would try to reallocate the assumed reductions in risk capital, which bears several difficulties. On the on hand, it has to be argued how to redistribute the effects. On the other hand, it has to be ascertained that the subsidiary can always easily be recapitalised in terms of distress. Capital has to be fungible between group constituents and there must be certain guarantees that enable the access to the necessary financial means. These facts, however, contradict the existence of firewalls between subsidiaries that are designed to allow protection from contagious effects and which eventually are a necessary requirement for regulatory capital reductions to be accepted.

Since both regulators and financial groups cannot satisfactorily substantiate their arguments with empirical and convincing proofs concerning diversification on the one hand and any countervailing forces on the other hand, it can be expected that the process will end up with a political decision with insecure outcome. In a European framework several aspects and considerably different industries have to be taken into account. Thus, one may expect a kind of compromise that allows the consideration of diversification effects in the calculation of economic and hence regulatory group capital but which forces groups to apply higher confidence levels for VaR or ES calculations. According to discussions with group representatives, this may be a viable approach.

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7. Appendix: Tables and Figures

linear correlation

United Kingdom

partial correlation full correlation	ALLIANCE & LEICESTER	BARCLAYS	CLOSE BROTHERS GROUP	HBOS	HSBC HDG.	LLOYDS TSB GROUP	NORTHERN ROCK	RBOS	STANDARD CHARTERED	INVESTEC
ALLIANCE & LEICESTER	1	0,24	-0,07	0,37	-0,03	0,25	0,33	0,10	-0,04	-0,01
BARCLAYS	0,60	1	-0,07	0,29	0,03	0,41	0,18	0,34	0,06	-0,17
CLOSE BROTHERS GROUP	0,23	0,30	1	-0,02	0,15	-0,12	-0,01	0,04	0,15	0,10
HBOS	0,63	0,65	0,29	1	-0,04	0,23	0,30	0,18	0,01	0,11
HSBC HDG.	0,44	0,58	0,42	0,47	1	-0,03	0,09	-0,04	0,46	0,04
LLOYDS TSB GROUP	0,60	0,75	0,27	0,62	0,54	1	0,20	0,24	0,01	0,13
NORTHERN ROCK	0,59	0,56	0,27	0,59	0,50	0,57	1	0,28	-0,02	0,10
RBOS	0,50	0,70	0,35	0,57	0,51	0,65	0,59	1	0,06	0,07
STANDARD CHARTERED	0,40	0,55	0,41	0,47	0,74	0,52	0,41	0,52	1	0,07
INVESTEC	0,25	0,19	0,22	0,33	0,29	0,35	0,31	0,33	0,30	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

rank correlation

United Kingdom

partial correlation full correlation	ALLIANCE & LEICESTER	BARCLAYS	CLOSE BROTHERS GROUP	HBOS	HSBC HDG.	LLOYDS TSB GROUP	NORTHERN ROCK	RBOS	STANDARD CHARTERED	INVESTEC
ALLIANCE & LEICESTER	1	0,22	-0,03	0,40	-0,01	0,21	0,31	0,18	-0,03	0,03
BARCLAYS	0,58	1	-0,02	0,36	0,05	0,40	0,20	0,36	0,07	-0,21
CLOSE BROTHERS GROUP	0,24	0,29	1	0,01	0,15	0,00	0,03	0,09	0,15	0,16
HBOS	0,66	0,68	0,29	1	-0,05	0,31	0,34	0,29	-0,04	0,09
HSBC HDG.	0,47	0,57	0,40	0,49	1	-0,02	0,10	-0,02	0,44	0,00
LLOYDS TSB GROUP	0,56	0,70	0,29	0,65	0,52	1	0,18	0,28	0,11	0,11
NORTHERN ROCK	0,58	0,55	0,27	0,62	0,51	0,53	1	0,27	0,02	0,01
RBOS	0,55	0,69	0,35	0,64	0,52	0,64	0,59	1	0,05	0,09
STANDARD CHARTERED	0,44	0,55	0,38	0,47	0,74	0,55	0,45	0,53	1	0,10
INVESTEC	0,21	0,07	0,26	0,27	0,22	0,28	0,19	0,27	0,27	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 20: Correlations of weekly British banking stock returns

linear correlation

Italy

partial correlation / full correlation	BANCO BPI	BANCA LOMBARDA	BANCA INTESA	BANCA POPOLARE MILANO	BANCO ESPIRITC SANTO	VERONA NOVARA BCA.PPO.DI	BANCA NAZ.LAVOR	CAPITALIA	MEDIOBANCA	SAN PAOLO IMI	UNICREDITC ITALIANC	BANCA MONTE DEI PASCHI	CASSA RISP.DI FIRENZE	ANTONVENETA BANCA	BANCHE POPOLARI UNITE
BANCO BPI	1	0,00	-0,01	0,03	0,29	0,01	0,12	0,07	0,07	0,00	0,04	0,11	0,17	-0,05	0,00
BANCA LOMBARDA	0,07	1	0,14	0,18	-0,03	0,21	0,16	0,19	0,19	-0,01	0,14	0,24	0,19	0,04	0,02
BANCA INTESA	0,16	0,26	1	0,28	0,12	0,24	0,42	0,58	0,38	0,28	0,37	0,45	0,23	0,20	0,17
BANCA POPOLARE MILANO	0,16	0,27	0,47	1	0,06	0,37	0,30	0,29	0,28	0,15	0,14	0,26	0,12	0,31	0,37
BANCO ESPIRITO SANTO	0,32	0,02	0,19	0,14	1	0,11	0,12	0,04	0,09	0,01	-0,05	0,07	-0,01	-0,11	0,00
BCA.PPO.DI VERONA NOVARA	0,15	0,30	0,46	0,50	0,19	1	0,15	0,15	0,22	0,10	0,11	0,33	0,23	0,37	0,44
BANCA NAZ.LAVORO	0,24	0,27	0,57	0,47	0,20	0,39	1	0,59	0,22	0,27	0,12	0,41	0,18	0,46	0,25
CAPITALIA	0,22	0,29	0,66	0,48	0,14	0,41	0,67	1	0,38	0,23	0,31	0,40	0,22	0,44	0,22
MEDIOBANCA	0,22	0,29	0,58	0,48	0,19	0,46	0,47	0,57	1	0,05	0,26	0,33	0,15	0,37	0,20
SAN PAOLO IMI	0,21	0,19	0,60	0,47	0,15	0,46	0,55	0,57	0,52	1	0,31	0,33	0,00	0,56	0,36
UNICREDITO ITALIANO	0,21	0,27	0,61	0,43	0,10	0,43	0,45	0,57	0,56	0,64	1	0,46	0,24	0,29	0,38
BANCA MONTE DEI PASCHI	0,28	0,33	0,64	0,49	0,23	0,54	0,60	0,61	0,58	0,63	0,65	1	0,24	0,52	0,11
CASSA RISP.DI FIRENZE	0,26	0,25	0,34	0,27	0,11	0,34	0,31	0,34	0,31	0,28	0,35	0,35	1	-0,11	0,25
BANCA ANTONVENETA	0,10	0,12	0,44	0,47	0,10	0,50	0,54	0,53	0,50	0,54	0,47	0,56	0,10	1	0,12
BANCHE POPOLARI UNITE	0,14	0,13	0,36	0,46	0,07	0,51	0,36	0,37	0,37	0,47	0,47	0,34	0,31	0,10	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

rank correlation

Italy

partial correlation / full correlation	BANCO BPI	BANCA LOMBARDA	BANCA INTESA	BANCA POPOLARE MILANO	BANCO ESPIRITC SANTO	BCA.PPO.DI VERONA NOVARA	BANCA NAZ.LAVORO	CAPITALIA	MEDIOBANCA	SAN PAOLO IMI	UNICREDITC ITALIANC	BANCA MONTE DEI PASCHI	CASSA RISP.DI FIRENZE	ANTONVENETA BANCA	BANCHE POPOLARI UNITE
BANCO BPI	1	0,00	0,02	0,03	0,23	0,04	0,09	0,07	0,10	-0,03	0,00	0,12	0,18	-0,08	-0,10
BANCA LOMBARDA	0,08	1	0,25	0,15	-0,15	0,14	0,10	0,17	0,12	0,01	0,20	0,18	0,15	0,21	0,19
BANCA INTESA	0,16	0,29	1	0,30	0,20	0,26	0,26	0,25	0,24	0,20	0,16	0,32	0,19	0,25	0,18
BANCA POPOLARE MILANO	0,15	0,26	0,51	1	0,41	0,33	0,31	0,29	0,26	0,08	0,29	0,09	0,27	0,18	0,25
BANCO ESPiRITO SANTO	0,26	0,03	0,25	0,43	1	0,09	0,13	0,08	0,09	0,00	-0,03	0,14	0,00	0,04	0,08
BCA.PPO.DI VERONA NOVARA	0,14	0,29	0,45	0,48	0,15	1	0,25	0,21	0,21	0,16	0,12	0,31	0,20	0,33	0,47
BANCA NAZ.LAVORO	0,20	0,26	0,48	0,49	0,19	0,42	1	0,37	0,17	0,21	0,06	0,38	0,11	0,39	0,20
CAPITALIA	0,20	0,34	0,51	0,51	0,16	0,41	0,55	1	0,26	0,18	0,13	0,25	0,16	0,27	0,12
MEDIOBANCA	0,22	0,29	0,51	0,49	0,16	0,42	0,42	0,52	1	0,17	0,21	0,27	0,16	0,30	0,15
SAN PAOLO IMI	0,16	0,21	0,54	0,42	0,11	0,42	0,49	0,53	0,52	1	0,25	0,27	0,05	0,31	0,33
UNICREDITO ITALIANO	0,17	0,27	0,49	0,53	0,09	0,37	0,38	0,48	0,53	0,61	1	0,17	0,10	0,13	0,28
BANCA MONTE DEI PASCHI	0,25	0,30	0,58	0,40	0,21	0,50	0,58	0,55	0,56	0,62	0,54	1	0,20	0,31	0,13
CASSA RISP.DI FIRENZE	0,24	0,26	0,32	0,37	0,05	0,29	0,23	0,29	0,29	0,24	0,26	0,33	1	-0,09	0,20
BANCA ANTONVENETA	0,12	0,20	0,45	0,37	0,11	0,47	0,53	0,47	0,49	0,52	0,40	0,52	0,06	1	0,174
BANCHE POPOLARI UNITE	0,08	0,18	0,37	0,40	0,14	0,57	0,36	0,33	0,36	0,50	0,46	0,36	0,29	0,33	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 21: Correlations of weekly Italian banking stock returns

linear correlation
Germany

partial correlation / full correlation	HYPO & VEREINSBANK	COMMERZBANK	DEUTSCHE BANK	DEPFA BANK	DEUTSCHE POSTBANK
HYPO & VEREINSBANK	1	0,53	0,25	0,01	0,20
COMMERZBANK	0,74	1	0,22	-0,05	0,45
DEUTSCHE BANK	0,61	0,63	1	0,07	0,29
DEPFA BANK	0,23	0,22	0,30	1	0,40
DEUTSCHE POSTBANK	0,79	0,85	0,82	0,40	1

rank correlation
Germany

partial correlation / full correlation	HYPO & VEREINSBANK	COMMERZBANK	DEUTSCHE BANK	DEPFA BANK	DEUTSCHE POSTBANK
HYPO & VEREINSBANK	1	0,69	0,63	0,31	0,44
COMMERZBANK	0,69	1	0,64	0,32	0,65
DEUTSCHE BANK	0,59	0,61	1	0,19	0,53
DEPFA BANK	0,26	0,29	0,25	1	0,47
DEUTSCHE POSTBANK	0,37	0,58	0,56	0,55	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 22: Correlations of weekly German banking stock returns

linear correlation
Spain

partial correlation / full correlation	BANKINTER	BBV ARGENTARIA	BANCO DE VALENCIA	BANCO POPULAR ESP.	BSCH	BANCO DE SABADELL
BANKINTER	1	0,05	-0,03	0,06	0,09	0,30
BBV ARGENTARIA	0,44	1	0,00	0,02	0,51	0,00
BANCO DE VALENCIA	0,04	0,11	1	0,07	0,06	0,10
BANCO POPULAR ESP.	0,29	0,41	0,12	1	0,03	0,15
BSCH	0,46	0,83	0,14	0,41	1	0,01
BANCO DE SABADELL	0,47	0,35	0,17	0,34	0,34	1

rank correlation
Spain

partial correlation / full correlation	BANKINTER	BBV ARGENTARIA	BANCO DE VALENCIA	BANCO POPULAR ESP.	BSCH	BANCO DE SABADELL
BANKINTER	1	0,16	-0,03	0,21	0,23	0,25
BBV ARGENTARIA	0,50	1	0,04	0,11	0,58	0,11
BANCO DE VALENCIA	0,05	0,12	1	0,05	0,07	0,09
BANCO POPULAR ESP.	0,41	0,42	0,11	1	0,08	0,13
BSCH	0,52	0,81	0,14	0,38	1	0,14
BANCO DE SABADELL	0,39	0,34	0,13	0,27	0,35	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 23: Correlations of weekly Spanish banking stock returns

linear correlation
France

partial correlation / full correlation	BNP PARIBAS	SOCIETE GENERALE	NATEXIS	CREDIT AGRICOLE
BNP PARIBAS	1	0,48	-0,08	0,35
SOCIETE GENERALE	0,80	1	0,08	0,25
NATEXIS	0,31	0,39	1	0,07
CREDIT AGRICOLE	0,67	0,63	0,39	1

rank correlation
France

partial correlation / full correlation	BNP PARIBAS	SOCIETE GENERALE	NATEXIS	CREDIT AGRICOLE
BNP PARIBAS	1	0,52	-0,05	0,38
SOCIETE GENERALE	0,77	1	0,07	0,27
NATEXIS	0,28	0,36	1	0,07
CREDIT AGRICOLE	0,65	0,60	0,33	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 24: Correlations of weekly French banking stock returns

linear correlation

United Kingdom

partial correlation / full correlation	AMLIN	AVIVA	BRIT INSURANCE HLDG.	BRITANNIC GROUP	HISCOX	JARDINE LLOYD THOMPSON	LEGAL & GENERAL	PRUDENTIAL	ROYAL & SUN ALL.IN.	ST.JAMES'S PLACE CAP.	WELLINGTON UNDERWRITING	OLD MUTUAL
AMLIN	1	0,06	0,59	0,16	0,53	0,11	0,01	0,07	0,19	0,12	0,56	0,14
AVIVA	0,21	1	0,09	0,08	0,04	0,01	0,33	0,38	0,23	0,22	-0,04	0,07
BRIT INSURANCE HOLDINGS	0,62	0,27	1	0,15	0,5	0,1	0,1	0,1	0,1	0,1	0,5	0,1
BRITANNIC GROUP	0,22	0,27	0,22	1	0,2	0,1	0,1	0,1	0,0	0,1	0,2	0,0
HISCOX	0,56	0,22	0,57	0,22	1	0,03	0,04	0,05	0,08	0,15	0,45	0,07
JARDINE LLOYD THOMPSON	0,17	0,19	0,15	0,16	0,09	1	0,06	-0,01	0,08	0,04	0,11	0,08
LEGAL & GENERAL	0,18	0,70	0,25	0,28	0,21	0,22	1	0,35	0,18	0,03	-0,02	0,05
PRUDENTIAL	0,22	0,74	0,27	0,31	0,23	0,19	0,71	1	0,21	0,07	0,02	0,11
ROYAL & SUN ALL.IN.	0,28	0,59	0,26	0,22	0,22	0,22	0,55	0,58	1	0,24	0,11	0,11
ST.JAMES'S PLACE CAP.	0,18	0,38	0,22	0,17	0,22	0,11	0,25	0,29	0,37	1	0,21	0,09
WELLINGTON UNDERWRITING	0,58	0,12	0,56	0,22	0,47	0,15	0,13	0,16	0,21	0,26	1	0,06
OLD MUTUAL	0,25	0,51	0,27	0,21	0,21	0,22	0,49	0,54	0,46	0,26	0,17	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

rank correlation

United Kingdom

partial correlation / full correlation	AMLIN	AVIVA	BRIT INSURANCE HLDG.	BRITANNIC GROUP	HISCOX	JARDINE LLOYD THOMPSON	LEGAL & GENERAL	PRUDENTIAL	ROYAL & SUN ALL.IN.	ST.JAMES'S PLACE CAP.	WELLINGTON UNDERWRITING	OLD MUTUAL
AMLIN	1	0,15	0,42	0,16	0,41	0,12	0,05	0,12	0,17	0,15	0,41	-0,03
AVIVA	0,25	1	0,13	0,12	0,05	0,04	0,27	0,34	0,27	0,20	0,04	0,10
BRIT INSURANCE HOLDINGS	0,44	0,25	1	0,16	0,41	0,19	0,15	0,05	0,11	0,19	0,41	0,09
BRITANNIC GROUP	0,23	0,36	0,24	1	0,23	0,14	0,16	0,18	0,13	0,18	0,22	0,03
HISCOX	0,43	0,15	0,44	0,27	1	0,05	0,07	0,12	0,11	0,17	0,33	0,02
JARDINE LLOYD THOMPSON	0,16	0,20	0,23	0,22	0,09	1	0,10	0,02	0,08	0,08	0,16	0,06
LEGAL & GENERAL	0,18	0,64	0,26	0,39	0,17	0,24	1	0,31	0,18	0,05	0,08	0,11
PRUDENTIAL	0,23	0,69	0,21	0,41	0,20	0,20	0,68	1	0,21	0,06	0,08	0,14
ROYAL & SUN ALL.IN.	0,26	0,55	0,22	0,32	0,19	0,20	0,50	0,53	1	0,27	0,11	0,09
ST.JAMES'S PLACE CAP.	0,20	0,34	0,24	0,28	0,21	0,15	0,24	0,26	0,38	1	0,24	0,06
WELLINGTON UNDERWRITING	0,43	0,13	0,43	0,26	0,34	0,19	0,17	0,17	0,17	0,27	1	0,00
OLD MUTUAL	0,09	0,45	0,20	0,24	0,11	0,19	0,46	0,49	0,37	0,21	0,08	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 25: Correlations of weekly British insurance stock returns

linear correlation

Italy

partial correlation / full correlation	ALLEANZA	GENERALI	FONDIARIA-SAI	MEDIOLANUM	MILANO ASSIC.	RAS	UNIPOL	CATTOLICA ASS.
ALLEANZA	1	0,49	0,23	0,07	0,31	0,48	0,30	0,10
GENERALI	0,76	1	0,17	-0,01	0,21	0,35	0,26	0,08
FONDIARIA-SAI	0,41	0,39	1	0,08	0,35	0,16	0,28	0,10
MEDIOLANUM	0,49	0,48	0,30	1	0,14	0,13	0,05	0,18
MILANO ASSIC.	0,49	0,44	0,45	0,36	1	0,24	0,32	0,23
RAS	0,68	0,62	0,34	0,45	0,41	1	0,27	0,03
UNIPOL	0,35	0,32	0,33	0,17	0,37	0,33	1	0,10
CATTOLICA ASS.	0,31	0,31	0,22	0,36	0,34	0,23	0,17	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

rank correlation

Italy

partial correlation / full correlation	ALLEANZA	GENERALI	FONDIARIA-SAI	MEDIOLANUM	MILANO ASSIC.	RAS	UNIPOL	CATTOLICA ASS.
ALLEANZA	1	0,47	0,24	0,08	0,26	0,48	0,23	0,05
GENERALI	0,72	1	0,15	0,04	0,18	0,32	0,20	0,10
FONDIARIA-SAI	0,40	0,34	1	0,05	0,30	0,15	0,17	0,12
MEDIOLANUM	0,48	0,48	0,26	1	0,10	0,12	0,06	0,12
MILANO ASSIC.	0,51	0,47	0,42	0,39	1	0,23	0,27	0,23
RAS	0,66	0,56	0,30	0,41	0,43	1	0,25	-0,02
UNIPOL	0,36	0,34	0,25	0,23	0,36	0,35	1	0,05
CATTOLICA ASS.	0,28	0,32	0,23	0,33	0,37	0,18	0,15	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 26: Correlations of weekly Italian insurance stock returns

linear correlation

France

partial correlation / full correlation	AGF	AXA	CNP ASSURANCES	FINAXA	SCOR	EULER HERMES
AGF	1	0,07	0,09	0,07	0,13	0,13
AXA	0,71	1	0,01	0,32	-0,03	0,02
CNP ASSURANCES	0,30	0,30	1	0,09	0,07	0,15
FINAXA	0,44	0,59	0,24	1	0,16	0,24
SCOR	0,39	0,36	0,20	0,34	1	0,18
EULER HERMES	0,26	0,22	0,22	0,32	0,26	1

rank correlation

France

partial correlation / full correlation	AGF	AXA	CNP ASSURANCES	FINAXA	SCOR	EULER HERMES
AGF	1	0,12	0,13	0,09	0,15	0,15
AXA	0,60	1	0,01	0,36	0,03	0,03
CNP ASSURANCES	0,28	0,25	1	0,07	0,11	0,12
FINAXA	0,41	0,63	0,21	1	0,11	0,09
SCOR	0,37	0,37	0,21	0,31	1	0,15
EULER HERMES	0,27	0,22	0,18	0,21	0,15	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 27: Correlations of weekly French insurance stock returns

linear correlation

Germany

partial correlation / full correlation	ALLIANZ	AMB GENERALI HDG.	HANNOVER RE	MUNICH RE
ALLIANZ	1	0,01	-0,02	0,54
AMB GENERALI HDG.	0,37	1	0,07	0,03
HANNOVER RE	0,52	0,35	1	-0,04
MUNICH RE	0,83	0,37	0,50	1

rank correlation

Germany

partial correlation / full correlation	ALLIANZ	AMB GENERALI HDG.	HANNOVER RE	MUNICH RE
ALLIANZ	1	0,05	0,00	0,51
AMB GENERALI HDG.	0,30	1	0,09	0,08
HANNOVER RE	0,44	0,26	1	-0,09
MUNICH RE	0,81	0,31	0,38	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 28: Correlation of weekly German insurance stock returns

linear correlation

Switzerland

partial correlation / full correlation	BALOISE	HELVETIA PATRIA	NATIONAL-IN.	SWISS LIFE HOLDING	SWISS RE	ZURICH FINANCIAL SVS.	CONVERIUM HOLDING
BALOISE	1	0,15	0,15	0,35	0,33	0,16	0,03
HELVETIA PATRIA	0,40	1	0,09	0,18	0,01	0,16	0,15
NATIONAL-IN.	0,35	0,21	1	0,11	0,19	0,08	0,04
SWISS LIFE HOLDING	0,71	0,39	0,30	1	0,19	0,07	0,00
SWISS RE	0,79	0,34	0,37	0,67	1	0,08	0,07
ZURICH FINANCIAL SVS.	0,68	0,40	0,30	0,58	0,69	1	0,03
CONVERIUM HOLDING	0,23	0,24	0,13	0,19	0,25	0,20	1

rank correlation

Switzerland

partial correlation / full correlation	BALOISE	HELVETIA PATRIA	NATIONAL-IN.	SWISS LIFE HOLDING	SWISS RE	ZURICH FINANCIAL SVS.	CONVERIUM HOLDING
BALOISE	1	0,21	0,12	0,27	0,29	0,13	0,20
HELVETIA PATRIA	0,38	1	0,11	0,14	0,07	0,14	0,18
NATIONAL-IN.	0,26	0,19	1	0,16	0,14	0,10	0,09
SWISS LIFE HOLDING	0,55	0,30	0,27	1	0,14	0,10	0,05
SWISS RE	0,67	0,31	0,29	0,50	1	0,23	0,18
ZURICH FINANCIAL SVS	0,59	0,34	0,25	0,47	0,67	1	0,06
CONVERIUM HOLDING	0,37	0,28	0,17	0,22	0,37	0,29	1

Time period of assessment: Beginning 1999 to end of June 2005
Share prices taken from Thomson Datastream

Table 29: Correlations of weekly Swiss insurance stock returns

Hypo & Vereinsbank	Munich Re	Allianz	Generali	AXA	Commerzbank
HVB	Munich Re	Allianz AG	Generali	AXA	Commerzbank
DAB	Ergo Previdenza	Allianz Leben	AMB Generali Holding	AXA Konzern AG	BRE Bank SA
BPH	Ergo Versicherung	RAS	Generali Holding Vienna	Finaxa	Comdirect
BA-CA		AGF	Generali Schweiz Holding	AXA Versicherung	
		Euler Hermes			
		Dresdner			
Fondiaria	**BSCH**	**Almanij**	**Capitalia**	**Aviva**	**San Paolo IMI**
Fondiaria SAI	BSCH	KBC	Capitalia	Aviva	San Paolo IMI
Milano Assicurazioni	Banesto	Almanij	Fineco	Norwich Union	Banca Fideuram
	Abbey National				

Table 30: group subsidiaries

Sample: 1 181

Included observations: 181

Method	df	Value	Probability (p-value)	critical F-Value
t-test	315	2,6773	0,0078	
Anova F-statistic	(1315)	7,1679	0,0078	3,8712

Analysis of Variance

Source of Variation	df	Sum of Sq.	Mean Sq.
Between subgroups	1	0,2273	0,2273
Within subgroups	315	9,9882	0,0317
Total	316	10,2155	0,0323

Category Statistics

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
BANKS	181	0,4040	0,1836	0,0136
INSURERS	136	0,3499	0,1704	0,0146
All	317	0,3808	0,1798	0,0101

Table 31: Test for equality of means between series

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	banks thereof	sig. 5%	sig. 10%	+	banks thereof	sig. 5%	sig. 10%	other group members move in same direction
Dresdner	14.08.2001	-0,052	0,256	5	4		0	0	1		0	0	0,80
Dresdner	05.11.2001	-0,079	0,150	5	3		0	0	1		0	1	0,60
Allianz Leben	27.11.2002	0,136	0,046**	4	0		0	0	4		0	1	1,00
Allianz Leben	12.03.2004	0,067	0,231	4	3		0	0	1		0	0	0,25
Allianz Leben	25.05.2004	-0,007	0,468	4	4		0	0	0		0	0	1,00
Allianz Leben	11.03.2005	0,015	0,407	4	0		0	0	4		0	2	1,00
Allianz	17.05.2005	-0,012	0,374	4	1		1	1	3		0	0	0,25
Allianz	04.04.2005	-0,008	0,413	4	2		0	2	2		0	1	0,50
Allianz	17.03.2005	0,042	0,133	4	1		0	0	3		0	1	0,75
Allianz	26.01.2005	-0,026	0,256	4	0		0	0	4		0	0	0,00
Allianz	12.01.2005	-0,073	0,032**	4	2		0	0	2		0	2	0,50
Allianz	15.12.2004	-0,029	0,231	4	2		0	0	2		0	0	0,50
Allianz	12.11.2004	0,078	0,025**	4	2		1	1	2		0	0	0,50
Allianz	08.10.2004	-0,102	0,404	4	2		0	0	2		0	1	0,50
Allianz	16.08.2004	0,036	0,224	4	4		0	0	0		0	0	0,00
Allianz	05.05.2004	-0,020	0,366	4	3		1	1	1		0	0	0,75
Allianz	23.10.2003	0,112	0,114	4	4		0	0	0		0	0	0,00
Allianz	16.05.2003	0,075	0,258	4	1		0	0	3		0	0	0,75
Allianz	09.04.2003	0,058	0,291	4	0		0	0	4		1	1	1,00
Allianz	01.04.2003	-0,003	0,488	4	1		0	0	3		1	1	0,25
Allianz	20.03.2003	-0,274	0,004***	4	1		0	0	3		0	1	0,25
Allianz	18.12.2002	-0,049	0,304	4	1		0	0	3		0	0	0,25
Allianz	13.09.2002	-0,092	0,112	4	3		2	2	1		1	1	0,75
Allianz	14.08.2002	-0,203	0,001***	4	1		0	1	3		0	0	0,25
Allianz	31.07.2002	-0,261	0,000***	4	2		1	2	2		0	0	0,50
Allianz	16.05.2002	-0,070	0,250	5	2	1	0	0	3		0	0	0,40
Allianz	04.04.2002	-0,039	0,282	5	3		0	0	2	1	0	0	0,60
Allianz	07.02.2002	-0,018	0,397	5	3	1	0	1	2		0	0	0,60
Allianz	21.09.2002	-0,012	0,425	5	3		1	2	2	1	0	0	0,60
Allianz	12.09.2001	-0,131	0,021**	5	3		2	3	2	1	0	0	0,60
Allianz	16.07.2001	-0,028	0,336	5	5	1	0	1	0		0	0	1,00
AGF	24.09.2003	0,043	0,322	4	2		0	0	2		0	0	0,50
AGF	05.09.2003	-0,044	0,322	4	4		0	0	0		0	0	1,00
AGF	30.07.2003	-0,012	0,450	4	2		0	0	2		0	1	0,50
AGF	18.07.2003	0,017	0,429	4	0		0	0	4		1	2	1,00
RAS	10.03.2005	0,007	0,422	4	0		0	0	4		0	1	1,00
RAS	28.04.2004	0,062	0,092*	4	4		1	1	0		0	0	0,00
RAS	11.03.2004	0,027	0,317	4	3		0	0	1		0	0	0,25
RAS	30.01.2004	-0,015	0,402	4	1		0	0	3		0	1	0,25
RAS	06.10.2003	0,005	0,477	4	1		0	0	3		0	0	0,75
RAS	16.01.2003	-0,057	0,266	4	3		0	0	1		0	1	0,75
RAS	05.12.2002	0,008	0,464	4	1		0	0	3		0	0	0,75
RAS	10.09.2002	0,187	0,013**	4	3		2	3	1		0	0	0,25
RAS	24.07.2002	-0,014	0,432	4	4		0	0	0		0	0	1,00
RAS	29.04.2002	-0,047	0,278	4	4	1	0	0	1		0	0	1,00
RAS	30.01.2002	0,046	0,291	5	0		0	0	5	1	0	1	1,00
RAS	07.11.2001	-0,065	0,256	4	3	1	0	0	2		0	0	0,75
											mean total		0,58

* p-value < 10 percent

** p-value < 5 percent

*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 32: Descriptive statistics on events of Allianz group constituents

	event date	Affected company CAR	p-value	Affiliated Companies: number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
HVB	23.02.2005	0,087	0,139	3	0	0	0	3		1	1,00
HVB	21.01.2005	0,041	0,285	3	1	0	0	2	0	0	0,67
HVB	24.08.2004	-0,014	0,438	4	3	0	0	1	0	0	0,75
HVB	11.05.2004	-0,072	0,249	3	2	1	1	1	0	0	0,67
HVB	19.04.2004	-0,146	0,087*	3	3	1	1	0	0	0	1,00
HVB	26.02.2004	-0,122	0,166	3	0	0	0	6	0	0	0,00
HVB	29.10.2003	0,174	0,111	3	1	0	0	2	0	0	0,67
HVB	16.07.2003	0,050	0,373	3	0	0	0	3	0	0	1,00
HVB	29.01.2003	-0,181	0,067*	3	3	0	1	0	0	0	1,00
HVB	07.08.2002	-0,067	0,233	3	2	0	2	1	0	0	0,67
HVB	22.05.2002	0,019	0,414	3	0	0	0	3	0	0	1,00
HVB	20.02.2002	0,090	0,152	3	2	0	0	1	0	0	0,33
HVB	25.10.2001	0,125	0,067*	3	1	0	0	2	1	1	0,67
HVB	30.07.2001	-0,048	0,248	3	2	1	1	1	0	0	0,67
HVB	12.06.2001	0,042	0,285	3	3	0	0	0	0	0	0,00
										mean	0,67
DAB	09.03.2005	0,058	0,303	3	1	1	1	2	1	1	0,67
DAB	26.10.2004	-0,005	0,346	3	2	0	0	1	0	0	0,67
DAB	27.07.2004	-0,059	0,309	4	2	0	0	2	0	0	0,50
DAB	27.04.2004	-0,324	0,017**	3	2	0	0	1	0	2	0,67
DAB	16.03.2004	-0,084	0,302	3	2	0	0	1	0	0	0,67
DAB	13.11.2003	-0,166	0,168	3	3	0	0	0	0	0	1,00
DAB	03.07.2003	0,395	0,025**	3	0	0	0	3	0	0	1,00
DAB	04.11.2002	-0,135	0,249	3	1	0	1	2	0	0	0,33
DAB	14.08.2002	-0,234	0,143	3	1	0	0	2	0	0	0,33
DAB	17.04.2002	-0,271	0,104	3	1	0	0	2	0	0	0,33
DAB	09.04.2002	-0,260	0,124	3	2	0	0	1	0	0	0,67
DAB	26.03.2002	-0,238	0,152	3	1	0	0	2	0	0	0,33
DAB	11.03.2002	0,063	0,400	3	1	0	0	2	0	0	0,67
DAB	15.01.2002	0,137	0,298	3	0	0	0	3	0	0	1,00
DAB	16.10.2001	0,394	0,057*	3	1	0	0	2	0	1	0,67
										mean	0,63
BA-CA	04.05.2005	-0,042	0,279	3	2	0	0	1	0	0	0,67
BA-CA	24.02.2005	0,101	0,071	3	0	0	0	3	1	2	1,00
BA-CA	22.11.2004	-0,021	0,385	3	0	0	0	3	0	0	0,00
BA-CA	04.11.2004	0,001	0,497	3	2	0	0	1	0	0	0,33
BA-CA	12.10.2004	0,000	0,498	4	3	0	0	1	0	0	0,75
BA-CA	05.08.2004	-0,021	0,393	4	3	0	0	1	0	0	0,75
* p-value < 10 percent										mean	0,58
** p-value < 5 percent											
*** p-value < 1 percent									**mean total**		**0,63**

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 33: Descriptive statistics on events of HVB group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
Munich Re	15.02.2005	0,077	0,110	2	0	0	0	2	0	0	1,00
Munich Re	21.01.2005	-0,061	0,093*	2	0	0	0	2	0	0	0,00
Munich Re	17.03.2004	0,074	0,214	2	0	0	0	2	0	0	1,00
Munich Re	19.02.2004	-0,014	0,442	2	1	0	0	1	0	0	0,50
Munich Re	25.11.2003	-0,011	0,460	2	0	0	0	2	0	0	0,00
Munich Re	23.10.2003	0,155	0,081*	2	0	0	0	2	0	1	1,00
Munich Re	17.10.2003	0,164	0,070*	2	0	0	0	2	0	0	1,00
Munich Re	20.03.2003	-0,353	0,000***	2	0	0	0	2	0	0	0,00
Munich Re	10.07.2002	0,098	0,085*	2	2	0	0	0	0	0	0,00
Munich Re	22.03.2002	-0,028	0,343	2	1	0	0	1	0	0	0,50
Munich Re	17.01.2002	-0,097	0,088*	2	1	0	0	1	1	1	0,50
Munich Re	20.09.2001	0,084	0,116	2	1	0	0	1	0	0	0,50
Munich Re	12.09.2001	-0,016	0,409	2	2	0	1	0	0	0	1,00
Munich Re	30.03.2001	0,005	0,478	2	1	0	0	1	0	0	0,50
										mean	0,54
ErgoVersicherug	02.04.2004	-0,008	0,471	2	2	0	0	0	0	0	1,00
ErgoVersicherug	13.03.2002	-0,022	0,447	2	0	0	0	2	0	0	0,00
ErgoVersicherug	07.11.2001	-0,073	0,221	2	2	0	0	0	0	0	1,00
										mean	0,67
										mean total	**0,60**

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 34: Descriptive statistics on events of Munich Re group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
San Paolo IMI	19.11.2004	-0,007	0,443	1	0	0	0	1	1	1	0,00
San Paolo IMI	14.10.2004	0,070	0,096*	1	0	0	0	1	0	1	1,00
San Paolo IMI	01.09.2004	-0,006	0,452	1	1	0	0	0	0	0	1,00
San Paolo IMI	18.05.2004	-0,037	0,263	1	0	0	0	1	0	0	0,00
San Paolo IMI	29.07.2003	-0,028	0,362	1	1	0	0	0	0	0	1,00
San Paolo IMI	29.04.2003	0,041	0,306	1	0	0	0	1	0	0	1,00
San Paolo IMI	30.07.2002	-0,127	0,045**	1	1	1	1	0	0	0	1,00
San Paolo IMI	14.05.2002	-0,173	0,001***	1	1	0	0	0	0	0	1,00
										mean	0,75

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 35: Descriptive statistics on events of San Paolo IMI group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
AXA	06.08.2004	-0,003	0,467	2	1	0	0	1	0	0	
AXA Konzern	28.03.2003	0,781	0,000***	2	2	0	0	0	0	0	0,00
AXA Konzern	18.12.2002	-0,076	0,289	2	2	0	0	0	0	0	1,00
AXA Konzern	31.10.2002	-0,126	0,172	2	1	0	0	1	0	0	0,50
AXA Konzern	26.03.2002	0,028	0,421	2	1	0	0	1	0	0	0,50
AXA Konzern	18.12.2001	-0,133	0,176	2	2	0	0	0	0	0	1,00
AXA	10.11.2004	0,008	0,404	2	0	0	0	2	0	0	1,00
AXA	18.10.2004	0,013	0,034	2	0	0	0	2	0	0	1,00
AXA	08.07.2004	0,011	0,386	2	1	0	1	1	0	0	0,50
AXA	18.05.2004	-0,014	0,357	2	2	0	0	0	0	0	1,00
AXA	26.02.2004	-0,008	0,442	2	1	0	0	1	0	0	0,50
AXA	02.02.2004	-0,037	0,244	2	0	0	0	2	0	0	0,00
AXA	07.11.2003	-0,006	0,458	2	2	0	0	0	0	0	1,00
AXA	29.07.2003	-0,044	0,305	2	1	0	0	1	0	0	0,50
AXA	09.08.2001	0,048	0,243	2	0	0	0	2	0	0	1,00
									mean total		0,68

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent
In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 36: Descriptive statistics on events of AXA group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
KBC	25.11.2004	-0,059	0,116	1	0	0	0	1	1	1	0,00
KBC	02.09.2004	0,025	0,307	1	0	0	0	0	0	0	0,00
KBC	03.06.2004	-0,009	0,437	1	1	0	0	0	0	0	1,00
KBC	04.03.2004	-0,041	0,249	1	1	0	0	0	0	0	1,00
KBC	20.11.2003	-0,025	0,338	1	1	0	0	0	0	0	1,00
KBC	03.09.2003	-0,035	0,325	1	1	0	0	0	0	0	1,00
KBC	22.05.2003	0,059	0,243	1	0	0	0	1	0	0	1,00
KBC	05.03.2003	0,018	0,418	1	1	0	0	0	0	0	0,00
KBC	20.01.2003	0,008	0,462	1	0	0	0	1	0	0	1,00
KBC	12.12.2002	-0,030	0,366	1	1	0	0	0	0	0	1,00
KBC	26.11.2002	-0,039	0,335	1	1	0	0	0	0	0	1,00
KBC	02.09.2002	0,047	0,301	1	1	0	0	0	0	0	0,00
KBC	23.05.2002	0,050	0,282	1	0	0	0	1	0	0	1,00
KBC	04.03.2002	-0,013	0,439	1	1	0	0	0	0	0	1,00
KBC	22.11.2001	0,162	0,013**	1	0	0	0	1	0	0	1,00
KBC	26.10.2001	-0,079	0,126	1	1	0	0	0	0	0	1,00
									mean		0,75

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent
In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 37: Descriptive statistics on events of KBC group constituents

		Affected company		Affiliated Companies							other group members move in same direction
	event date	CAR	p-value	number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	
Commerzbank	03.05.2005	-0,06	0,12	2	1	0	0	1	0	0	0,50
Commerzbank	16.02.2005	0,03	0,30	2	1	0	0	1	0	0	0,50
Commerzbank	09.11.2004	-0,03	0,33	2	0	0	0	2	0	0	0,00
Commerzbank	04.08.2004	-0,01	0,43	2	2	0	0	0	0	0	1,00
Commerzbank	10.05.2004	-0,04	0,31	2	2	0	0	0	0	0	1,00
Commerzbank	26.04.2004	-0,05	0,30	2	1	0	0	1	0	0	0,50
Commerzbank	07.04.2004	-0,02	0,43	2	0	0	0	2	0	0	0,00
Commerzbank	18.02.2004	-0,07	0,24	2	1	0	0	1	0	0	0,50
Commerzbank	12.11.2003	-0,12	0,16	2	2	0	0	0	0	0	1,00
Commerzbank	06.08.2003	-0,01	0,48	2	1	0	0	1	1	1	0,50
Commerzbank	07.05.2003	0,00	0,49	2	0	0	0	2	1	1	1,00
Commerzbank	05.02.2003	-0,09	0,23	2	2	0	0	0	0	0	1,00
Commerzbank	12.11.2002	0,10	0,18	2	1	0	0	1	0	0	0,50
Commerzbank	08.08.2002	-0,10	0,12	2	1	0	0	1	0	1	0,50
Commerzbank	08.05.2002	0,03	0,37	2	2	0	0	0	0	0	0,00
Commerzbank	04.02.2002	0,02	0,43	2	2	0	0	0	0	0	0,00
Commerzbank	09.11.2001	0,13	0,0479**	2	0	0	0	2	0	0	1,00
Commerzbank	05.11.2001	0,18	0,0073***	2	0	0	0	2	1	1	1,00
Commerzbank	01.11.2001	0,15	0,0187**	2	0	0	0	2	0	0	1,00
Commerzbank	15.10.2001	-0,01	0,44	2	0	0	0	2	1	1	0,00
Commerzbank	09.08.2001	0,05	0,21	2	1	0	0	1	0	0	0,50
comdirect Bank	22.04.2005	-0,10	0,14	2	2	0	0	0	0	0	1,00
comdirect Bank	15.03.2005	0,01	0,47	2	1	0	0	1	0	0	0,50
comdirect Bank	21.10.2004	-0,10	0,13	2	1	0	0	1	0	0	0,50
comdirect Bank	27.07.2004	-0,17	0,0356**	2	1	0	0	1	0	0	0,50
comdirect Bank	30.01.2003	0,04	0,42	2	2	0	0	0	0	0	0,00
comdirect Bank	02.09.2002	0,12	0,27	2	0	0	0	2	0	0	1,00
comdirect Bank	26.04.2002	-0,20	0,17	2	2	0	0	0	0	0	1,00
comdirect Bank	22.03.2002	-0,07	0,37	2	1	0	0	1	0	0	0,50
comdirect Bank	13.03.2002	0,12	0,29	2	1	0	0	1	0	0	0,50
comdirect Bank	25.02.2002	0,18	0,21	2	0	0	0	2	0	1	1,00
BRE Bank	29.04.2005	-0,04	0,31	2	2	0	1	0	0	0	1,00
BRE Bank	02.11.2004	0,07	0,20	2	1	1	1	1	0	0	0,50
BRE Bank	12.12.2003	0,05	0,33	2	2	0	0	0	0	0	0,00
BRE Bank	29.10.2003	-0,21	0,0177**	2	2	0	0	0	0	0	1,00
BRE Bank	11.09.2003	-0,04	0,32	2	1	0	0	1	0	0	0,50
BRE Bank	18.08.2003	0,43	0***	2	2	0	0	0	0	0	0,00
									mean total		0,58

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 38: Descriptive statistics on events of Commerzbank group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
Generali Ass.	09.09.2004	0,024	0,202	3	1	0	0	2	0	0	0,67
AMB Generali	03.03.2005	-0,003	0,481	3	2	1	1	0	0	0	0,67
AMB Generali	11.11.2004	0,006	0,461	3	1	0	1	1	0	1	0,33
AMB Generali	12.08.2004	-0,072	0,151	3	1	0	1	1	0	0	0,33
AMB Generali	13.05.2004	-0,024	0,389	3	3	1	1	0	0	0	1,00
AMB Generali	10.03.2004	-0,023	0,410	3	2	0	1	1	0	0	0,67
AMB Generali	13.11.2003	0,107	0,185	3	0	0	0	3	0	0	1,00
AMB Generali	13.08.2003	-0,020	0,445	3	2	0	0	1	0	0	0,67
AMB Generali	13.05.2003	0,028	0,424	3	1	0	0	2	1	1	0,67
AMB Generali	19.02.2003	-0,169	0,101	3	0	0	0	3	1	1	0,00
AMB Generali	17.01.2003	0,051	0,345	3	1	0	0	2	0	2	0,67
AMB Generali	13.11.2002	-0,092	0,237	3	0	0	0	3	0	0	0,00
AMB Generali	13.08.2002	0,050	0,319	3	2	0	0	1	0	1	0,33
AMB Generali	08.04.2002	-0,038	0,351	3	2	0	0	1	0	0	0,67
AMB Generali	22.01.2002	0,051	0,310	3	1	0	0	2	0	0	0,67
AMB Generali	16.10.2001	0,121	0,107	3	2	0	0	1	0	0	0,33
AMB Generali	19.09.2001	-0,002	0,493	3	3	0	0	0	0	0	1,00
Generali Holding Vienna	23.01.2003	0,062	0,113	3	0	0	0	3	0	1	1,00
Generali Holding Vienna	06.12.2002	-0,016	0,389	3	1	0	0	2	1	1	0,33
Generali Holding Vienna	28.11.2002	0,024	0,334	3	1	0	0	2	1	2	0,67
Generali Holding Vienna	29.08.2002	-0,024	0,331	3	2	0	1	0	0	0	0,67
Generali Holding Vienna	29.05.2002	0,006	0,470	3	1	0	0	2	0	0	0,67
Generali Holding Vienna	09.04.2002	-0,071	0,199	3	1	0	0	2	0	0	0,33
Generali Holding Vienna	26.03.2002	-0,028	0,374	3	2	0	0	1	0	0	0,67
Generali Holding Vienna	22.02.2002	0,147	0,0709*	3	3	0	0	0	0	0	0,00
Generali Holding Vienna	30.11.2001	0,041	0,354	3	2	1	1	1	0	0	0,33
Generali Holding Vienna	17.09.2001	0,003	0,491	3	3	1	1	0	0	0	0,00
Generali Holding Vienna	31.08.2001	0,002	0,494	3	3	1	1	0	0	0	0,00
Generali Holding Vienna	20.07.2001	0,037	0,373	3	2	0	0	1	0	0	0,33
									mean total		0,51

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 39: Descriptive statistics on events of Generali group constituents

	event date	Affected company CAR	p-value	Affiliated Companies number of other group members	-	sig. 5%	sig. 10%	+	sig. 5%	sig. 10%	other group members move in same direction
Capitalia	25.05.2005	-0,046	0,204	1	0	0	0	1	0	0	0,00
Capitalia	04.10.2004	-0,001	0,494	1	0	0	0	1	1	1	0,00
Capitalia	26.05.2004	0,054	0,306	1	0	0	0	1	0	0	1,00
Capitalia	07.04.2004	0,057	0,309	1	1	0	0	0	0	0	0,00
Capitalia	07.01.2004	0,058	0,280	1	0	0	0	1	0	0	1,00
Capitalia	23.09.2003	0,107	0,205	1	0	0	0	1	0	0	1,00
Capitalia	25.07.2002	-0,201	0,030**	1	1	1	1	0	0	0	1,00
										mean	0,57

* p-value < 10 percent
** p-value < 5 percent
*** p-value < 1 percent

In each row a particular event to one group constituent is presented, highlighting CAR and p-value of this event for the affected company. Other affiliates are then assessed on the question whether their CARs have a negative or positive sign and whether these are significant. The last column summarises the effect on other group affiliates.

Table 40: Descriptive statistics on Capitalia group constituents

Company:	ALLIANZ	HVB	COMMERZ BANK	DEUTSCHE BANK	DRESDNER BANK	HSH NORDBANK	MUNICH RE	co-exceedance
Quantile:	5%	5%	5%	5%	5%	5%	5%	5%
04.01.05					1	1		2
06.01.05							1	1
07.01.05	1	1						2
20.01.05								
21.01.05				1			1	2
26.01.05		1			1			2
04.02.05		1			1			2
09.02.05	1		1					2
10.02.05				1				1
11.02.05	1				1		1	3
21.02.05	1						1	2
24.02.05					1			
25.02.05		1		1				2
01.03.05								
02.03.05		1	1	1	1			4
04.03.05	1						1	2
07.03.05								
16.03.05								
21.03.05								
06.04.05			1		1			2
15.04.05								
18.04.05								
19.04.05				1		1	1	3
20.04.05	1						1	2
21.04.05		1		1				2
29.04.05							1	1
02.05.05								
03.05.05							1	1
10.05.05								
13.05.05								
17.05.05								
19.05.05	1	1			1		1	4
26.05.05		1					1	2
05.07.05	1		1				1	3
11.07.05					1	1		2
26.07.05				1	1			2
27.07.05								
26.08.05								
27.10.05		1					1	2
15.11.05	1					1		2
06.12.05	1					1		2

The table above provides a short illustration of extreme co-movements (lower 5 % of the distribution) in relative changes of German CDS quotes of financial institutions in 2005. The data are based on a three-year time series (2003 - 2005).

Table 41: CDS extreme co-movements (lower tail) of at least two companies (German example)

Company:	ALLIANZ	HVB	COMMERZ BANK	DEUTSCHE BANK	DRESDNER BANK	HSH NORDBANK	MUNICH RE	co-exceedance
Quantile:	95%	95%	95%	95%	95%	95%	95%	95%
04.01.05	1	1						2
06.01.05	1	1						2
07.01.05						1	1	2
20.01.05				1			1	2
21.01.05	1	1						2
26.01.05								
04.02.05				1				1
09.02.05				1				1
10.02.05	1		1		1			3
11.02.05								
21.02.05								
24.02.05		1		1				2
25.02.05								
01.03.05		1	1	1	1			4
02.03.05								
04.03.05								
07.03.05	1						1	2
16.03.05			1				1	2
21.03.05	1		1	1	1		1	5
06.04.05								
15.04.05	1					1	1	3
18.04.05		1	1	1	1	1		5
19.04.05								
20.04.05								
21.04.05								
29.04.05		1			1			2
02.05.05	1						1	2
03.05.05				1		1		2
10.05.05			1	1	1			3
13.05.05	1	1	1		1		1	5
17.05.05	1	1						2
19.05.05								
26.05.05								
05.07.05								
11.07.05								
26.07.05								
27.07.05	1				1			2
26.08.05	1						1	2
27.10.05								
15.11.05			1					1
06.12.05								

The table above provides a short illustration of extreme co-movements (upper 5 % of the distribution) in relative changes of German CDS quotes of financial institutions in 2005. The data are based on a three-year time series (2003 - 2005).

Table 42: CDS extreme co-movements (upper tail) of at least two companies (German example)

	number of institutions	number of co-exceedances in the bottom tails (10%)					
		5	4	3	2	1	0
Allianz	6	1	4	0	6	15	61
Generali	4	-	-	0	5	11	59
Munich Re	3	-	-	-	3	12	41
HVB	5	-	0	1	4	14	52
AXA	3	-	-	-	2	10	46
Commerzbank	3	-	-	-	0	7	56
Almanij	2	-	-	-	-	11	16
Capitalia	2	-	-	-	-	7	32
San Paolo IMI	2	-	-	-	-	11	27

	number of institutions	number of co-exceedances in the top tails (90%)					
		5	4	3	2	1	0
Allianz	6	0	2	2	10	13	60
Generali	4	-	-	0	3	13	62
Munich Re	3	-	-	-	4	7	51
HVB	5	-	0	0	4	11	54
AXA	3	-	-	-	1	5	59
Commerzbank	3	-	-	-	1	9	57
Almanij	2	-	-	-	-	13	19
Capitalia	2	-	-	-	-	6	38
San Paolo IMI	2	-	-	-	-	9	30

For each country the relative changes of distances to default were assessed and compared between the institutions analysed. The tables reflect the co-movements in the upper and lower ten percent tails. For instance, the last column indicates the number of cases where no co-exceedances took place although at least one institution was in the lower (or upper) 10-percent tail. The results are based on weekly data from beginning 1999 to July 2005 .

Table 43: Summary statistics of co-exceedances for weekly ln(Δdd)

	Allianz Leben	Dresdner Bank	Allianz	AGF	RAS	Euler Hermes	Generali Vienna	Generali	AMB	Generali S	Munich Re	Ergo Vers.	Ergo Prev.	Bank Austria	Bank BPH	DAB	HVB	VuW-Bank	AXA Vers.	AXA	Finaxa	Commerzbank	comdirect	BRE Bank	KBC	Almanij	Capitalia	Fineco	San Paolo IMI	Banca Fideuram
Allianz Leben	1	0,25	0,4	0,21	0,35	0,06	0,03	0,37	0,35	0,31	0,41	0	0,19	0,2	0,09	0,25	0,5	0,32	0	0,5	0,26	0,45	0,21	0,09	0,36	0,25	0,31	0,3	0,43	0,36
Dresdner Bank	0,3	1	0,4	0,07	0,23	-0,1	-0,1	0,29	0,14	0,11	0,29	0,29	0,27	NA	0,09	0,24	0,63	0,14	0,07	0,4	0,29	0,4	0,11	-0	0,29	0,12	0,45	0,22	0,38	0,22
Allianz	0,4	0,41	1	0,28	0,48	0,19	0	0,59	0,4	0,33	0,76	0,25	0,36	0,33	0,21	0,35	0,58	0,33	0	0,7	0,32	0,49	0,3	0,08	0,33	0,46	0,35	0,42	0,47	0,41
AGF	0,2	0,07	0,3	1	0,36	0,17	-0	0,5	0,29	0,12	0,44	0,15	0,2	0,25	0,2	0,25	0,32	0,22	-0,1	0,6	0,18	0,39	0,19	0,15	0,27	0,28	0,19	0,21	0,35	0,32
RAS	0,4	0,23	0,5	0,36	1	0,12	-0,1	0,53	0,33	0,17	0,53	0,18	0,25	0,14	0,09	0,34	0,39	0,11	0,01	0,5	0,2	0,31	0,21	0,13	0,32	0,36	0,15	0,29	0,46	0,43
Euler Hermes	0,1	-0,1	0,2	0,17	0,12	1	-0	0,09	0,08	0	0,19	-0	0,09	0,07	-0	0,15	0,16	0,05	-0	0,2	0,04	0,09	0,1	0,01	0,15	0,22	0	0	0,06	0,08
Generali Vienna	0	-0,1	0	-0	-0,1	-0	1	0,06	-0	-0,1	-0,1	0,01	-0	0,11	0,06	0	-0,1	-0	-0,1	0	-0	0,03	-0	-0,1	-0	-0,1	-0	0,03	0,02	0,01
Generali	0,4	0,29	0,6	0,5	0,53	0,09	0,06	1	0,34	0,25	0,54	0,2	0,36	0,12	0,19	0,23	0,4	0,23	-0,1	0,6	0,33	0,46	0,23	0,13	0,35	0,32	0,35	0,38	0,52	0,49
AMB	0,4	0,14	0,4	0,29	0,33	0,08	-0	0,34	1	0,28	0,32	0,15	0,18	-0,1	0,05	0,12	0,42	0,27	-0	0,4	0,27	0,31	0,17	0,06	0,28	0,37	0,26	0,14	0,32	0,17
Generali S	0,3	0,11	0,3	0,12	0,17	0	-0,1	0,25	0,28	1	0,24	0,11	0,15	-0,2	0,04	0,18	0,24	0,29	0,05	0,2	0,19	0,32	0,21	-0,1	0,22	0,19	0,3	0,21	0,25	0,28
Munich Re	0,4	0,29	0,8	0,44	0,53	0,19	-0,1	0,54	0,32	0,24	1	0,36	0,35	0,14	0,11	0,28	0,57	0,27	-0	0,6	0,28	0,57	0,25	0,08	0,28	0,37	0,3	0,31	0,4	0,47
Ergo Vers.	0	0,29	0,3	0,15	0,18	-0	0,01	0,2	0,15	0,11	0,36	1	0,15	-0	0,04	0,09	0,25	0,19	0,04	0,2	0,11	0,29	0,11	0,01	0,11	0,06	0,13	0	0,15	0,19
Ergo Prev.	0,2	0,27	0,4	0,2	0,25	0,09	-0	0,36	0,18	0,15	0,35	0,15	1	0,14	0,34	0,2	0,33	0,21	-0	0,3	0,33	0,32	0,14	0,18	0,13	0,2	0,18	0,16	0,27	0,27
Bank Austria	0,2	NA	0,3	0,25	0,14	0,07	0,11	0,12	-0,1	-0,2	0,14	-0	0,14	1	0,1	0,3	0,19	0,61	-0,1	0,3	0,06	0,29	-0,1	0,37	0,3	-0,1	0,16	-0,1	0,34	0,32
Bank BPH	0,1	0,09	0,2	0,2	0,09	-0	0,06	0,19	0,05	0,04	0,11	0,04	0,34	0,1	1	0,15	0,09	0,1	-0,1	0,2	0,2	0,14	0,17	0,42	0,14	0,18	0,09	0,07	0,06	0,19
DAB	0,3	0,24	0,4	0,25	0,34	0,15	0	0,23	0,12	0,18	0,28	0,09	0,2	0,3	0,15	1	0,24	0,07	-0,1	0,3	0,17	0,37	0,48	0,06	0,4	0,32	0,19	0,32	0,39	0,36
HVB	0,5	0,63	0,6	0,32	0,39	0,16	-0,1	0,4	0,42	0,24	0,57	0,25	0,33	0,19	0,09	0,24	1	0,4	-0	0,5	0,33	0,64	0,23	0,03	0,28	0,37	0,36	0,31	0,41	0,37
VuW-Bank	0,3	0,14	0,3	0,22	0,11	0,05	-0	0,23	0,27	0,29	0,27	0,19	0,21	0,61	0,1	0,07	0,4	1	-0	0,3	0,24	0,4	0,15	0,01	0,2	0,11	0,48	0,13	0,24	0,23
AXA Vers.	0	0,07	0	-0,1	0,01	-0	-0,1	-0,1	-0	0,05	-0	0,04	-0	-0,1	-0,1	-0,1	-0	-0	1	0	-0	-0	0	0	-0,2	0,01	-0,1	-0,1	-0	-0,1
AXA	0,5	0,35	0,7	0,55	0,53	0,22	0,03	0,63	0,43	0,19	0,56	0,23	0,32	0,33	0,18	0,28	0,53	0,26	0,01	1	0,34	0,5	0,33	0,18	0,49	0,51	0,26	0,3	0,5	0,49
Finaxa	0,3	0,29	0,3	0,18	0,2	0,04	-0	0,33	0,27	0,19	0,28	0,11	0,33	0,06	0,2	0,17	0,33	0,24	-0	0,3	1	0,32	0,24	0,11	0,26	0,14	0,31	0,26	0,28	0,38
Commerzbank	0,5	0,4	0,5	0,39	0,31	0,09	0,03	0,46	0,31	0,32	0,57	0,29	0,32	0,29	0,14	0,37	0,64	0,4	-0	0,5	0,32	1	0,26	0,04	0,26	0,16	0,4	0,3	0,5	0,46
comdirect	0,2	0,11	0,3	0,19	0,21	0,1	-0	0,23	0,17	0,21	0,25	0,11	0,14	-0,1	0,17	0,48	0,23	0,15	0	0,3	0,24	0,26	1	0,02	0,36	0,33	0,1	0,22	0,22	0,28
BRE Bank	0,1	-0	0,1	0,15	0,13	0,01	-0,1	0,13	0,06	-0,1	0,08	0,01	0,18	0,37	0,42	0,06	0,03	0,01	0	0,2	0,11	0,04	0,02	1	0,15	0,14	0,12	-0	0,12	0,12
KBC	0,4	0,29	0,3	0,27	0,32	0,15	-0	0,35	0,28	0,22	0,28	0,11	0,13	0,3	0,14	0,4	0,28	0,2	-0,2	0,5	0,26	0,26	0,36	0,15	1	0,71	0,29	0,23	0,4	0,42
Almanij	0,3	0,12	0,5	0,28	0,36	0,22	-0,1	0,32	0,37	0,19	0,37	0,06	0,2	-0,1	0,18	0,32	0,37	0,11	0,01	0,5	0,14	0,16	0,33	0,14	0,71	1	0,23	0,22	0,32	0,31
Capitalia	0,3	0,45	0,4	0,19	0,15	0	-0	0,35	0,26	0,3	0,3	0,13	0,18	0,16	0,09	0,19	0,36	0,48	-0,1	0,3	0,31	0,4	0,1	0,12	0,29	0,23	1	0,37	0,39	0,38
Fineco	0,3	0,22	0,4	0,21	0,29	0	0,03	0,38	0,14	0,21	0,31	0	0,16	-0,1	0,07	0,32	0,31	0,13	-0,1	0,3	0,26	0,3	0,22	-0	0,23	0,22	0,37	1	0,41	0,52
San Paolo IMI	0,4	0,38	0,5	0,35	0,46	0,06	0,02	0,52	0,32	0,25	0,4	0,15	0,27	0,34	0,06	0,39	0,41	0,24	-0	0,5	0,28	0,5	0,22	0,12	0,4	0,32	0,39	0,41	1	0,61
Banca Fideuram	0,4	0,22	0,4	0,32	0,43	0,08	0,01	0,49	0,17	0,28	0,47	0,19	0,27	0,32	0,19	0,36	0,37	0,23	-0,1	0,5	0,38	0,46	0,28	0,12	0,42	0,31	0,38	0,52	0,61	1

Table 44: Correlation matrix of log-differenced distances to default

Curriculum Vitae

Bernhard Mayr

born in Wels / Austria on the 22^{nd} of July 1978

1989 – 1997	Gymnasium Ramsauerstraße, Linz
1997 – 1998	Military Service
1998 – 2002	Economics and Commerce at the Vienna University of Economics and Business Administration Exchange terms at Norges Handelshøyskole (NHH) Bergen / Norway and Ecole de Management (EM) Lyon / France Diverse internships in Austria and Germany
2000 – 2002	CEMS-Master program
2003 – 2004	Doctoral program at University of St. Gallen
2004 – 2006	Writing of doctoral thesis
2004 – date	Economist at the Austrian Financial Market Authority, Vienna