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SYSTEMIC RISK, SYSTEMIC IMPORTANCE AND BANKING SECTOR RISK CONTAGION DEPENDENCIES

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ABSTRACT

The 2007-2009 financial crisis rigorously exposed the relevance of *systemic risk* and *systemically important financial institutions* (SIFIs) for financial market stability. While both notions are ubiquitous in the analysis of the financial crisis and in the discourse on banking sector regulation, there is still no consensus on adequate measurement approaches.

In this thesis we develop the 'expected systemic shortfall' (ESS) methodology which facilitates both the measurement of *aggregate* systemic risk *and* the assessment of a bank's *relative* systemic risk contribution. The ESS-indicator is derived transparently using standard measures from financial institutions risk management and represents the product of the probability of a systemic default event in the banking sector and the expected loss when this systemic event occurs. The measure is computed using a credit portfolio simulation model whose input parameters are estimated from market CDS spreads and equity return correlations. In addition to these methodological contributions we conduct the most comprehensive analysis of systemic risk and systemic importance in global and regional financial markets to date.

Our empirical results show that the ESS-indicator responds adequately to both the financial crisis events with global importance and to specific events in the regional sub-samples. The ESS-indicator reaches its peak in September 2008 and remains elevated at the end of the sample period in all samples and especially in the European sub-sample. The relative systemic risk contribution of individual banking groups is mainly driven by their size, corroborating the common 'too big to fail' statement. We contribute to the ongoing discourse concerning the regulation of systemically important financial institutions by suggesting the use of the relative contributions to the ESS-indicator as a measure for a bank's systemic importance. By applying a relative systemic risk contribution threshold of one percent, our empirical results show that there are 23 globally systemically important banks.

The recent financial crisis and the ensuing sovereign debt crisis also exposed the relevance of banking sector risk contagion dependencies. Specifically, inter-regional systemic risk contagion, bank vs. sovereign sector as well as bank vs. non-bank corporate sector risk contagion effects are mentioned frequently both in academia and among practitioners. However, there are only very few empirical investigations of these dependencies to date. In fact, to our best knowledge only the interdependencies between bank and sovereign credit spreads on the country level have been the focus of previous research. In the present thesis we add to this rather unexplored field of

financial research and conduct a comprehensive empirical analysis of banking sector risk contagion effects. In particular, we employ state-of-the-art time series methods in order to examine three types of banking sector risk contagion dependencies. Firstly, we analyze *inter-regional systemic risk contagion dependencies* using the regional ESS-indicator developed in this thesis (as measure of systemic risk) and alternatively regional bank credit spreads. Secondly, we examine *interdependencies between sovereign and bank credit spreads* for intra-/inter-regional and intra-country relations. Thirdly, we analyze the *interdependencies between bank and non-bank corporate sector credit spreads* and alternatively *equity returns* on the intra-regional level.

For the inter-regional systemic risk contagion effects we find that the systemic risk in the American financial system is contagious for the systemic risk in the other regions since the subprime crisis period. Moreover, the analysis shows new inter-regional systemic risk dependencies which have not been described previously. The analysis of sovereign vs. banking sector risk contagion exhibits a strong increase of the interdependencies between sovereign and banking sector credit spreads since the financial crisis. The impact of sovereign vs. bank default risk even increased during the sovereign debt crisis period. The analysis of bank vs. non-bank corporate risk contagion effects exposed that changes in the default risk of banks depend changes in the default risk of the corporate sector during the financial crisis period in all regions, corroborating the claim that banking sector risk impacts the real economy. The analysis of the bank vs. non-bank corporate equity returns shows interestingly that the bank equity returns *are led* by the corporate equity returns whereas the opposite dependency is only rarely observed.

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LIST OF ABBREVIATIONS

Abbreviation	*Definition*
ADF	Augmented Dickey/Fuller (1979) test
AIC	Akaike (1974) information criterion
AIG	American International Group
CDO	Collateralized debt obligation
CDS	Credit default swap
CoVaR	Conditional value at risk
DIP	Distress insurance premium
EC	Error correction
EFSM	European Financial Stabilization Mechanism
EL	Expected loss
ESM	European Stability Mechanism
ESS	Expected systemic shortfall
ETL	Expected tail loss
GIRF	Generalized impulse response function
IFRS	International financial reporting standards
KPSS	Kwiatkowski et al. (1992)
IMF	International Monetary Fund
IRF	Impulse response function
LGD	Loss given default
MER	Middle East& Russia
OLS	Ordinary least squares
PP	Phillips/Perron (1988)
PD	Probability of default

Abbreviation	*Definition*
PSD	Probability of systemic default
SBIC	Schwarz (1978) Bayesian information criterion
SES	Systemic expected shortfall of Acharya et al. (2010)
SIFI	Systemically important financial institution
SLT	Systemic loss threshold
TARP	Troubled Asset Relief Program
UAE	United Arab Emirates
VaR	Value at risk
VAR	Vector autoregressive
VEC	Vector error correction

LIST OF SYMBOLS

Symbol	*Definition*
$c_{i,t}$	Systemic loss contribution of bank i at time t
k	Simulation iteration in ESS analysis
K	Number of simulation iterations in ESS analysis
$l_{i,k,t}$	Loss in ESS simulation for bank i
$L_{k,t}$	Portfolio loss in ESS simulation
Λ_t	Portfolio loss distribution at time t
M	Common risk factor in Vasicek (1987) model
N	Number of sample banks in ESS analysis
P_t	Correlation matrix
$\Pr(\cdot)$	Probability of
$\Phi^{-1}(\cdot)$	Quantile of the standard normal distribution
q	Annualized default intensity
r	Risk-free rate of return
ρ	Correlation
s	CDS spread
τ, T	Maturity
V	Value of bank assets in Vasicek (1987) model
Y	Variable vector in the VAR model
$Y_{i,t}$	Sample value in ESS Monte Carlo simulation
Z	Idiosyncratic risk factor in Vasicek (1987) model

1 INTRODUCTION

1.1 MOTIVATION

The 2007-2009 financial crisis exposed the relevance of *systemic risk* in the financial sector which denotes the likelihood of the occurrence of a *systemic event* that would have serious detrimental effects not only on the stability of financial markets but also on the real economy. *Systemically important financial institutions (SIFIs)* are a related concept discussed extensively since the recent financial crisis. A financial institution is commonly regarded to be systemically important, if its failure would represent a systemic event. As a consequence of this, SIFIs are often considered to benefit from an implicit bailout guarantee since governments would never risk their failure. The notions 'too big to fail' and 'too interconnected to fail' are mentioned frequently in this respect and it is argued that the implicit guarantee may lead to inefficient incentives and negative externalities.

The existing banking sector regulatory architecture 'Basel II' has turned out to be insufficient to prevent the recent financial crisis and additionally several shortcomings of this regulatory framework were exposed during the crisis. These deficiencies were on the one hand *microprudential* in nature as the capital and funding liquidity standards for individual institutions did not prevent banks from failing or requiring government assistance. On the other hand, the financial crisis exposed a lack of *macroprudential* regulation which takes a system-wide perspective in order to ensure the stability of the financial system as a whole. Therefore, one guiding principle in the elaboration of the new banking sector regulatory regime 'Basel III' is the consideration of this macroprudential dimension aimed at mitigating systemic risk and ensuring efficient incentives as well as sufficient risk-bearing capacity of SIFIs amongst others.

Consequently, an adequate understanding of and measurement approaches for systemic risk and systemic importance are highly relevant for both the analysis of the recent financial crisis as well as the design and implementation of the future banking sector regulatory architecture. This relevance may also explain the recent growth of the literature on systemic risk and SIFIs and the advancement of this rather new finance research field. While the current literature provides several proposals for the measurement of either systemic risk *or* systemic importance, there are only very few approaches for the *consistent* measurement of both of these ubiquitous concepts. This may explain why there is still no consensus on the

methodologies for measuring systemic risk and assessing systemic importance. In this thesis we add to this literature and develop the 'expected systemic shortfall' (ESS) methodology which facilitates both the measurement of *aggregate* systemic risk *and* the assessment of a bank's *relative* systemic risk contribution as a measure of its systemic importance.

The financial crisis and the ensuing sovereign debt crisis also exposed the relevance of banking sector risk contagion effects. Firstly, it is frequently mentioned that there are inter-regional systemic risk contagion effects, i.e., spillover of systemic risk in one region onto the systemic risk in other regions (particularly in times of crisis). Secondly, it stands to reason that interdependencies between sovereign and banking sector default risk have increased due to i) government interventions in the financial sector during the crisis and ii) the increase in sovereign credit spreads since the onset of the euro zone sovereign debt crisis. Thirdly, the financial crisis also highlighted the contagious effects of banking sector risk for the real economy which materialized in severe economic recessions in the aftermath of the crisis (amongst others). Although these banking sector risk contagion effects are mentioned frequently, there are only very few empirical investigations of these dependencies to date. The analysis of the banking sector risk dependencies in this thesis will not only facilitate an evaluation of their presumed existence but may also provide an analytical starting point for potential regulatory measures in order to mitigate certain detrimental effects.

1.2 RESEARCH QUESTIONS AND CONTRIBUTION

This thesis aims to derive an analytical framework for measuring systemic financial sector risk and consistently assessing systemic importance of financial institutions which we name the expected systemic shortfall (ESS) methodology. In addition, the ESS-methodology shall be applied in a comprehensive empirical analysis of systemic risk and systemic importance in global and regional financial markets. Moreover, this thesis seeks to conduct a comprehensive analysis of the relevant banking sector risk dependencies. Specifically, the following research questions are addressed in this thesis:

1. How can systemic risk in the financial sector be measured? What are the determinants of systemic risk and which differences exist between regions?
    a) Derivation of an analytical framework for measuring aggregate systemic risk using a credit portfolio simulation methodology whose input parameters are estimated from capital market data.

   b) Application of the systemic risk measurement framework to a global bank sample and regional sub-samples during the sample period between October 2005 and April 2011 and analysis of the resulting systemic risk indicators.
   c) Analysis of the input factor and risk premium determinants of the sample-specific systemic risk indicators.

2. How can the systemic importance of a financial institution be assessed consistently with its contribution to systemic risk?
   a) Derivation of the relative contribution of individual financial institutions to the aggregate systemic risk measure within the analytical systemic risk measurement framework.
   b) Analysis of the systemic risk contributions by individual banks and examination of the input factor determinants.
   c) Translation of a financial institution's systemic risk contribution into a measure of its systemic importance.

3. Is there empirical evidence for banking sector risk contagion effects? Are these effects also observed when general macroeconomic conditions are controlled for?
   a) Derivation of an econometric model for measuring risk contagion effects between financial variables and controlling for macroeconomic factors.
   b) Analysis of *inter-regional risk contagion effects* of i) the regional systemic risk measures and ii) regional banking sector credit spreads.
   c) Analysis of *contagion effects between banking sector and sovereign sector* default risk on the intra-/inter-regional level and intra-country level.
   d) Analysis of intra-regional *risk contagion effects between banking sector and non-bank corporate sector* credit spreads and equity returns.

As mentioned earlier, these topics are highly relevant for academia and practitioners alike.

The aggregate measure of systemic risk derived in this thesis can be employed in the continuous monitoring and steering of financial market stability by regulatory authorities. Similarly, an objective assessment of systemic importance is a necessary precondition for applying specific regulatory measures to systemically important financial institutions which is envisioned in the 'Basel III' banking sector regulatory framework. Hence, this thesis adds to the literature and regulatory discussion on measuring systemic risk and assessing systemic importance of financial institutions by suggesting the ESS-methodology as a consistent

analytical framework for these purposes. In addition to the methodological enhancements, this thesis provides the most comprehensive empirical analysis of systemic risk and systemic importance conducted to date.

The analysis of banking sector risk contagion dependencies is a research area which has so far received very little attention. In fact, to our best knowledge only the interdependencies between bank and sovereign credit spreads on the country level have been the focus of previous research. Therefore, we add to this rather unexplored field of financial research in the present thesis and conduct a comprehensive empirical analysis of banking sector risk contagion effects.

1.3 STRUCTURE OF ANALYSIS AND UNDERLYING WORKING PAPERS

In the remainder of this thesis we proceed as follows. Chapter 2 provides a definition of systemic risk and systemic importance and surveys the related literature on these concepts and on the banking sector risk contagion dependencies. The hypotheses which are examined in the banking sector risk contagion analysis are elaborated in chapter 3. In chapter 4 we derive our ESS-methodology for measuring systemic risk and assessing systemic importance. Also, the econometric model for analyzing financial market contagion effects is elaborated. In chapter 5 we describe the empirical data analyzed in this thesis. The results from applying the methodology to the empirical data are elaborated in chapter 6. Chapter 7 summarizes the previous chapters, concludes and outlines areas for future research.

This dissertation represents the consolidation of the following working papers by the author on the sub-topics of this thesis: Lahmann/Kaserer (2011a), Lahmann/Kaserer (2011b), Lahmann/Kaserer (2012), Lahmann (2012a) and Lahmann (2012b). The content from these working papers is used in this thesis also literally and corresponding references are made using footnotes at the beginning of the respective sections. Quotations from these working papers in the abstract, introduction and conclusion of this thesis are not stated expressly for expositional convenience.

2 RELATED LITERATURE

2.1 SYSTEMIC RISK AND SYSTEMIC IMPORTANCE[1]

2.1.1 Definition

Systemic risk in the financial sector is commonly described as the risk of correlated defaults of financial institutions which would not only affect the stability of the banking sector but also its ability to act as intermediary between depositors and borrowers with potentially serious consequences for the economy as a whole.[2] Systemically important financial institutions (SIFIs) are a related concept. A bank is generally considered to be systemically important if its bankruptcy would represent a trigger event for a series of correlated defaults in the sense of the above description of systemic risk.[3]

In the present dissertation we generalize the above descriptions of systemic financial sector risk and systemically important banks and employ the following definitions:

Definition D1 *'Systemic risk' in the financial sector denotes the likelihood of the occurrence of a 'systemic event' which would not only have severe implications for the stability of the financial system but also detrimentally affect the real economy.*

Definition D2 *A financial institution is considered as 'systemically important' if its failure represents a 'systemic event'.*

The main difference in our definition is that the trigger event of a systemic financial crisis is defined more broadly as 'systemic event' which comprises (but is not limited to) a correlated default event in the financial sector. This definition is consistent with the derivation of the expected systemic shortfall (ESS) indicator in this thesis which defines the systemic event as the loss of a certain percentage of the sample banks' total liabilities.

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[1] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2011a).

[2] Cf. Lehar (2005), p.2578 and Adrian/Brunnermeier (2011), p. 2 (amongst others).

[3] Cf. Huang/Zhou/Zhu (2010b), p. 3 and FSB (2009), pp. 5-6 (amongst others).

2.1.2 Measurement approaches

Approaches for the measurement of systemic risk and the assessment of systemic importance in the financial sector have been developed even before the financial crisis. The importance of this subject has grown significantly due to the recent financial crisis which is reflected in the sustained growth of literature on this topic. The approaches for the measurement of systemic risk and assessing systemic importance can be classified with respect to the underlying data used: financial statement-based measures, exposure-based network models and measures based on capital market data.

The first type of approaches uses financial statement data such as the share of non-performing loans, profitability, liquidity and capital adequacy measures. The disadvantage of this approach type is that financial statement data is available only with a relatively low frequency, is published only with a substantial delay and information in financial statements is backward-looking despite IFRS accounting.[4] Drehmann/Tarashev (2011) find that while market data and model based approaches are usually favorable, 'simple indicators' based on financial statement and regulatory data (such as bank size, interbank borrowing and lending) can offer a handy approximation in the assessment of bank's systemic importance whereas the *aggregate* systemic risk cannot be adequately determined by this approach.

Network models usually rely on mutual bank exposure data and model the direct connections among the banks to simulate the effects of a default event on the banks within the network. IMF (2009) and Espinosa-Vega/Sole (2010) apply a network model using the mutual bank exposures and the bank equity to model the effects of an initial default of one of the network banks on the other banks in the system. The systemic importance of a bank is derived based on the cumulated capital impairments which its initial default causes in the system.[5] *Aggregate* systemic risk can be measured using this approach by means of the cumulated exposure losses. Pokutta/Schmaltz/Stiller (2011) develop a similar network model that also facilitates the derivation of optimal bail-out strategies. As network models are usually based on confidential exposure data, their application is reserved for regulatory authorities and will – for the time being – be limited to the application within a country due to confidentiality restrictions. Besides, the required data are available only with a relatively low frequency.[6]

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[4] Cf. Huang/Zhou/Zhu (2009), p. 2036-2037.

[5] An extension of the model considers the effects of lost funding sources and consequent fire sales.

[6] E.g., the large exposure reporting in the European Union is carried out on a quarterly basis.

Systemic risk measurement approaches based on capital market-data have three key advantages vis-à-vis measures based on balance sheet and exposure data: they can be updated more frequently (usually daily), are forward-looking by nature and can be implemented by all interested parties. These approaches are described in the following.

Lehar (2005) computes the probability of default of several financial institutions as a measure for aggregate systemic risk based on the asset return correlations which are estimated using the Merton (1974) contingent claims analysis. Gray/Merton/Bodie (2007a) also pursue a contingent claims approach and develop a systemic risk measure which accounts for sovereign risk. Gray/Merton/Bodie (2007b) follow the same analytical approach and derive a regulatory policy framework aimed at mitigating systemic macrofinancial risks.

Chan-Lau/Gravelle (2005) and Avesani/Pascual/Li (2006) consider the banks in the sphere of competence of a regulator as portfolio and compute the probability of default of *n* portfolio banks (*n*th-to-default probability) as measure of systemic risk in the portfolio. Billio et al. (2010) analyze the correlations and dependencies prevailing in equity returns of different types of financial institutions in order to obtain the aggregate systemic risk. Kim/Giesecke (2010) use Moody's US default data together with capital market parameters[7] to derive an aggregate systemic risk measure and its term structure.

While the above approaches based on market data can be used to measure *aggregate* financial sector risk, they are not appropriate to assess systemic importance. To this end, Acharya et al. (2010) measure systemic risk using the "systemic expected shortfall" (SES) measure which they define as the probability of an individual bank being undercapitalized when the whole system is undercapitalized. Adrian/Brunnermeier (2008) examine the systemic importance of banks based on equity data using the "Conditional Value at Risk" (CoVaR) metric which measures the value at risk of the whole financial system when one of the financial institutions experiences a distress situation. CoVaR can be used to assess the systemic importance of individual banks whereas it *cannot* be aggregated to measure aggregate systemic risk.

Huang/Zhou/Zhu (2009) employ a credit portfolio risk model using equity return correlations and CDS spreads to compute a risk-neutral measure of *aggregate* systemic risk, the distress insurance premium (DIP) for the US financial system. This measure represents the hypothetical insurance premium against the losses of a certain share of the total banking sector liabilities. Huang/Zhou/Zhu (2010a) extend the DIP approach by an importance

[7] Such as S&P 500, TED spread, the US yield curve.

sampling methodology to determine the marginal DIP contribution of individual institutions which facilitates the assessment of systemic importance and apply it to the Asian-Pacific banking system. Huang/Zhou/Zhu (2010b) employ the same approach in analyzing the US financial sector.

The use of a credit portfolio simulation approach based on capital market data to derive the aggregate expected systemic shortfall (ESS) indicator in this thesis is inspired by Huang/Zhou/Zhu (2009). There are, however, three important differences between the two approaches. Firstly, we define the systemic default event as a portfolio loss of the sample bank liabilities which exceeds a percentage of the total liabilities of the *sample banks* whereas Huang/Zhou/Zhu (2009) define the loss threshold relative to the *total banking sector* liabilities. This difference makes our approach also appropriate for banking systems in which a major portion of the banks is not exchange-listed. Secondly, we derive the ESS-indicator in a transparent manner using standard measures from financial institutions risk management, namely the probability of (systemic) default and the expected shortfall, which facilitates the application of our indicator by other parties. Thirdly, the relative systemic risk contributions in our ESS-methodology are computed in a transparent fashion as byproduct of the credit portfolio simulation as opposed to using an additional importance sampling procedure as in Huang/Zhou/Zhu (2010a) and Huang/Zhou/Zhu (2010b). This feature facilitates the use of our methodology as an intuitive measure of a bank's systemic importance.

Apart from the methodological enhancements in measuring systemic risk and assessing systemic importance, this thesis also contributes on the empirical side as it is the first truly global analysis of systemic financial sector risk which also accounts for regional differences by separately analyzing four regional sub-samples. By contrast, the above publications consider only individual regions or countries. Due to the global perspective in the present thesis we also to contribute to the ongoing discourse on the identification and regulation of systemically important financial institutions as our results can be used to identify those banks which are systemically important on a global scale.

2.2 BANKING SECTOR RISK CONTAGION DEPENDENCIES[8]

There is a vast literature concerning contagion in financial markets which is surveyed comprehensively by Dornbusch/Park/Claessens (2000) and Kaminsky/Reinhart/Vegh (2003). While most publications focus on cross-country market contagious effects it should be noted that contagion can take place between any sort of financial markets, e.g., between debt and equity capital markets.[9] We define contagion consistent with Dornbusch/Park/Claessens (2000) and Bae/Karolyi/Stulz (2003) as an elevation of market interconnection subsequent to a shock event in one market.[10] The literature distinguishes at least three channels by which contagion can be transmitted through financial markets.[11]

The *liquidity channel* describes a mechanism where a shock event in one financial market detrimentally impacts market liquidity of certain or even all financial markets with potential consequences for asset prices and investor conduct. Further consequences in case of a liquidity channel contagion may be elevated trading activity in other markets affected by the initial shock and diminished credit availability which may become fully effective first after an extended period. Allen/Gale (2000), Kodres/Pritsker (2002) and Brunnermeier/Pedersen (2009) describe relevant models for this contagion propagation channel.

In the *risk-premium channel* of financial market contagion an initial shock event in one market affects investors' risk-bearing willingness in other markets whereby changes in equilibrium risk premiums affect asset prices in *all* markets. Consequently, shock-induced return changes to the affected security may impact the returns on securities in other markets which also provides a rationale for the predictive power of distressed asset returns for other asset classes. Due to feedback effects, the implications of this propagation channel may first fully materialize after several periods. Consequently, the measurement of contagion via the risk-premium channel can be conducted in a vector autoregressive (VAR) framework provided that adequate data frequencies and lag lengths are chosen. Acharya/Pedersen (2005) and Vayanos (2004) present relevant models for this contagion transmission channel.

In the *correlated-information channel* a jolt to one financial market represents new economic information which is relevant also for asset prices in other markets, e.g., because the

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[8] The elaborations in this section are (also literally) based on Lahmann (2012b).

[9] Cf. Longstaff (2010), p. 438.

[10] Cf. Dornbusch/Park/Claessens (2000), p. 177 and Bae/Karolyi/Stulz (2003), p. 720.

[11] The subsequent elaboration of the three contagion propagation channels is based on Longstaff (2010), p. 438.

information pertains to economic factors which drive multiple markets. A common feature of the literature describing the correlated-information channel is the assumption that the contagion takes place via the price discovery mechanism. Therefore, one would expect to observe immediate price reactions in the *affected* financial markets especially when these are more liquid than the market where the initial shock occurred. Therefore, contagion propagated by means of the correlated-information channel can be tested using a VAR framework. Theoretical models for this contagion propagation channel are described by Dornbusch/Park/Claessens (2000), Kiyotaki/Moore (2002) and King/Wadhwani (1990).

Longstaff (2010) points out that while the three contagion channels affect security prices in specific ways, there are also similarities between the channels, an example of which is the relation between credit risk and liquidity during the recent financial crisis: while the subprime crisis of 2007 was characterized by 'credit-risk-induced illiquidity' (attributable to the risk-premium and/or correlated information channel), a critical determinant of the 2008 global financial crisis was 'illiquidity-induced credit risk' (attributable to the liquidity channel).[12]

The recent financial crisis exposed the relevance of *systemic risk* in the banking sector as defined in definition D1. It suggests itself that systemic risk in the banking sector can also be contagious for other parts of the financial market and it stands to reason that it could also be propagated by way of the above contagion transmission channels.[13] In the following we elaborate the systemic banking sector risk contagion effects which are the focus of this thesis along with the related literature.

2.2.1 Inter-regional systemic risk contagion[14]

The 2007-2009 global financial crisis evolved from a subprime mortgage and CDO market crisis in the United States and the subsequent crisis events in the US – such as the Bear Stearns takeover and the Lehman Brothers default – were contagious for other regional financial markets and also led to increased systemic risk in these markets.[15] Additionally, one could observe inter-regional dependencies between regional crisis events and market reactions in other regions. Specifically, our results in section 6.1.1 show that since the onset of the euro

[12] Cf. Longstaff (2010), p. 438.

[13] To the best of our knowledge there are no publications concerning the contagion transmission channels of systemic risk, though. We outline the presumed contagion transmission channels for the analyzed dependencies in chapter 3.

[14] The elaborations in this section are (also literally) based on Lahmann (2012b).

[15] Cf. Acharya et al. (2009), p. 1.

zone sovereign debt crisis the systemic risk increases not only in Europe but also in other regions.

While the observation of *inter-regional systemic risk contagion* has been described frequently, there is – to the best of our knowledge – currently no published research analyzing the inter-regional contagion effects of systemic risk as measured by a systemic risk measure (or alternatively bank CDS[16]) available. This thesis fills this gap by analyzing the inter-regional systemic risk contagion effects between the relative ESS-indicator (and alternatively regional bank CDS) of the American, Asian-Pacific, European as well as the Middle Eastern and Russian sub-samples by means of Granger-causality tests and impulse response functions in VAR frameworks during four sub-periods between October 2005 and April 2011.

2.2.2 Sovereign risk vs. banking sector risk contagion[17]

In the course of the recent global financial crisis several financial institutions were supported by government interventions in order to avert their failure because a default event by a major financial institution was considered to represent a *systemic event* which could have further destabilized the financial system and the real economy.[18] While these financial stability measures substantially altered the size and structure of governments' balance sheets, Gray (2009) points out that the impact of this new interconnectedness between banking and sovereign sector and its effects for other economic sectors are largely unexplored.

One may wonder why systemic risk in the financial sector or – more generally – bank default risk is related with sovereign default risk. Gray/Merton/Bodie (2008) point out that there are several linkages between these two risk types which are influenced by the explicit and implicit guarantees of the sovereign to the banks. They also find that the presence of an elevated level of systemic risk in the financial sector entails recessionary tendencies in the real economy which strains public finances and shifts distress to the government which is even reinforced when there are state guarantees for the financial sector. Furthermore, banks and other owners of sovereign debt are affected by the decreased quality of the sovereign's credit risk and write-downs on their sovereign debt holdings.[19] Acharya/Drechsler/Schnabl

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[16] We find in section 6.1.1 that bank CDS spreads are a first-order approximation for the relative ESS-indicator.

[17] The elaborations in this section are (also literally) based on Lahmann (2012a).

[18] Additionally, governments introduced large-scale economic stimulus packages for the 'real economy' in order to alleviate the impact of the economic downturn.

[19] Cf. Alter/Schueler (2011), p. 2.

(2011) describe this interdependency as 'two-way feedback' and derive a theoretical model to capture the linkages between government bailouts of financial firms and the sovereign risk.

Recent research on the financial crisis effects also established *empirical* evidence for the linkage between financial and sovereign sector risk. Dieckmann/Plank (2010) find evidence for a risk transfer from the private to the public sector in Western Europe during the financial crisis and particularly for countries which introduced financial stability measures. Moreover, they find that the linkage of country-level bank and sovereign CDS spreads increased which they attribute to the fact that banks own significant amounts of sovereign debt and governments have large contingent liabilities for their banking systems.

Gerlach/Schulz/Wolff (2010) find that CDS spreads of Western European countries affected by sovereign debt issues are positively related with the countries' bank CDS spreads whereas no lead-lag relationships are analyzed. Moreover, they observe that sovereign and banking sector risk became more interlinked when governments started to guarantee some of the banks' liabilities. In addition to their above theoretical contributions Acharya/Drechsler/Schnabl (2011) find that government bailout programs to the financial sector increased the linkage between the credit risk of banks and sovereigns on the country-level. By analyzing the lead-lag dependencies between a country's sovereign CDS spread and the CDS spreads of two of the country's financial institutions Alter/Schueler (2011) show that in the period prior to the financial sector bailouts changes in bank credit risk mostly preceded changes in sovereign credit risk whereas in the post-bailout period the opposite effect occurred in the majority of the seven examined euro zone countries.[20]

In this thesis we contribute to the literature on the contagion effects between sovereign risk and banking sector risk by analyzing the interlinkages between sovereign and bank CDS spreads as proxy measure of systemic risk[16] on the regional *and* country level. On the regional level we analyze both *inter*- and *intra*-regional interlinkages between sovereign and bank CDS spreads of the sample regions America, Asia-Pacific, Europe as well as Middle East and Russia which has not been covered in previous research. On the country level we analyze the interlinkages between the country's sovereign CDS spread and the average CDS spread of the country's banking groups which has so far only been analyzed for certain euro zone countries by Alter/Schueler (2011). To the best of our knowledge, this is the most comprehensive analysis of sovereign and bank credit risk interlinkages conducted so far.

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[20] They consider the seven countries France, Germany, Ireland, Italy, Netherlands, Portugal and Spain.

2.2.3 Banking sector risk vs. corporate sector risk contagion[21]

The banking sector is interconnected with the non-bank corporate sector in several ways. Firstly, banks provide lending to firms and consequently a deterioration of the funding conditions in the financial sector should also spill over to the non-bank corporate sector. Secondly, a deterioration of the credit quality of corporate obligors in bank loan portfolios should also detrimentally affect the earnings of the lending financial institutions. Moreover, the 2007-2009 financial crisis exposed the relevance of systemic banking sector risk for the non-bank corporate sectors and it is argued frequently that systemic risk in the financial sector detrimentally impacts the real economy.[22]

Contagion effects between the credit spreads or equity returns of banking vs. non-bank corporate sector have to our best knowledge not yet been analyzed in the scientific literature. However, there are studies which cover somewhat related topics. Claessens/Tong/Wei (2011) analyze the importance of transmission channels on the performance of manufacturing firms and find that the financial linkages are relevant in explaining the decrease in profitability and equity performance during the global financial crisis. Raunig/Scheicher (2009) analyze the pricing of default risk of banks vs. non-bank firms using CDS data and find that the importance of common factors in explaining the CDS spreads has increased during the crisis.

In this thesis we analyze the interdependencies between bank and non-bank corporate[23] CDS spreads and equity returns. We account for regional differences by separately analyzing American, Asian-Pacific and European samples. Industry-specific peculiarities are accounted for by examining both the overall corporate sample as well as nine industry clusters for each region. To the best of our knowledge this is the first analysis of the interdependencies between bank and non-bank corporate CDS spreads and equity returns conducted so far.

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[21] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2012).

[22] This is consistent with our definition of systemic risk which we define as the likelihood of the occurrence of a systemic event which would not only have effects for the stability of financial markets but also the affect the real economy.

[23] In the following we also refer simply to ‘corporate’ firms when referring to non-bank corporate entities for expositional convenience.

3 HYPOTHESES FOR BANKING SECTOR RISK CONTAGION ANALYSIS

In this chapter we elaborate the hypotheses concerning the banking sector risk contagion dependencies which are analyzed empirically in this thesis.

3.1 INTER-REGIONAL SYSTEMIC RISK CONTAGION[24]

Before the 2007-2009 financial crisis the concept of systemic risk in the financial system was discussed primarily from an academic viewpoint whereas the crisis actually exposed the relevance of this topic for financial markets. Moreover, there is so far no evidence of inter-regional systemic risk contagion before the crisis. Therefore, we formulate:

Hypothesis A1 *Before the financial crisis there are no contagion effects between the systemic risk in the sample regions.*

As the financial crisis originated in the subprime mortgage market of the Unite States and the financial crisis events in the US affected financial markets around the globe, we test:

Hypothesis A2 *During the subprime and financial crisis periods the systemic risk in the United States was contagious for the systemic risk in other regions.*

In the course of the financial crisis the mutual sensitivity of bank CDS spreads[25] and equity prices to events affecting banks in other regions increased as markets increasingly perceived banks' asset- and liability-side risks to be highly correlated.[26] Consequently, we analyze

Hypothesis A3 *During the financial crisis period the feedback relations between the regional systemic risk increased.*

Due to the systemic component and particularly the high correlation of asset- and funding-side risks in the financial sector exposed during the crisis, we expect persistence of the observed inter-regional systemic risk contagion after the financial crisis and posit:

Hypothesis A4 *After the end of the financial crisis the systemic risk interdependencies observed during the financial crisis persist.*

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[24] The elaborations in this section are (also literally) based on Lahmann (2012b).

[25] For expositional convenience we refer synonymously to CDS (spreads), credit risk, credit spreads and default risk when denoting the market CDS spreads which we employ in the empirical analysis.

[26] Cf. Acharya et al. (2009), pp. 2-4.

We operationalize the analysis of these inter-temporal hypotheses by conducting the econometric analysis for four sub-periods which we specify in chapter 5. Regarding the contagion transmission channels involved, it stands to reason that during the financial crisis the inter-regional systemic risk transmission may have occurred via all three transmission channels of financial market contagion described in the preceding classification.

3.2 SOVEREIGN RISK VS. BANKING SECTOR RISK CONTAGION[27]

The sovereign and banking sector are interlinked in a multitude of ways. For example, financial institutions often hold sovereign debt as it is considered a 'low-risk' investment providing a stable source of income, it receives a favorable regulatory treatment and because sovereign debt represents a comparatively liquid asset also in times of strained markets.[28] Changes in the default risk of sovereigns should hence lead to changes in the default risk of banks in case the respective sovereign debt holding represents a significant share of the total assets. As the information regarding the composition of bank balance sheets is not publicly available, market participants need to conjecture the impact of changes in sovereign credit risk on a particular financial institution.[29]

Apart from the relative size of banks' sovereign asset holding, one would expect that the level and volatility of sovereign CDS spreads also influences the susceptibility of bank credit risk to changes in sovereign credit risk. Given the low level and volatility of sovereign CDS spreads in America and Europe before the 'core' financial crisis materialized as shown in Figure 8[30], it is likely that bank CDS spreads were not affected by the American and European sovereign CDS spreads before this period. Therefore, we analyze:

Hypothesis B1 *Before the financial crisis period the sovereign default risk of America and Europe does not impact bank default risk.*

By contrast, the CDS spreads of the Asia-Pacific and Middle East & Russian sovereigns are elevated and volatile even before the financial crisis. Therefore, we would expect that the sovereign risk in these regions impacts the bank default risk and examine

[27] The elaborations in this section are (also literally) based on Lahmann (2012a).

[28] Cf. Panizza/Sturzenegger/Zettelmeyer (2009), pp. 1-2 and Acharya/Drechsler/Schnabl (2011), pp. 2-4.

[29] Cf. Arteta/Hale (2008), pp. 54-55.

[30] The low level and volatility reflects the low default expectations associated with these countries.

Hypothesis B2 *Before the financial crisis period the sovereign default risk in the regions Asia-Pacific, Middle East and Russia impacts bank default risk.*

During the sovereign debt crisis period, the level and volatility of all sovereign spreads increased significantly. We suspect that this change in sovereign CDS spread characteristics also impacted on bank credit spreads and, therefore, analyze:

Hypothesis B3 *Since the sovereign debt crisis period changes in the sovereign default risk lead changes in bank default risk.*

In the analysis of intra-regional and intra-country sovereign vs. bank default risk dependencies, additional perspectives are to be taken into account. During the financial crisis several financial institutions were supported by their home countries' governments as their failure may have constituted a 'systemic event' with potentially disastrous consequences for financial markets and the real economy. The implicit guarantee by the state for 'systemically important financial institutions' is a frequently discussed notion in this regard. The support measures for banks altered the size and structure of governments' balance sheets and due to the implicit guarantee changes in the banking sector credit risk should also impact the sovereign debt in the same country.[31] Accordingly, the following hypothesis will be analyzed:

Hypothesis B4 *Since the financial crisis period, there is an intra-regional/-country lead-lag relation between changes in bank and sovereign default risk.*

In order to analyze these hypotheses we employ market CDS spreads as these are the most widely used market-based measure for credit risk. It should be noted that CDS spreads not only reflect the *actual* default risk, as measured by the *physical* default probability, but also risk-premium components.[32] The analysis of the inter-temporal hypotheses is operationalized by conducting the econometric analysis during four the sub-periods described in chapter 5.

With regard to the above financial market contagion channels we argue that the transmission of sovereign risk to the financial system occurs predominantly through the risk-premium channel and the correlated-information channel. In case of the risk-premium channel, increases in the risk-premiums of sovereign debt securities may also spill over to bank debt and thereby affect systemic risk (the reciprocal relation can be explained similarly). The correlated-information contagion channel applies when information pertaining to sovereign debt affect also the asset side of bank balance sheets or – equivalently – increases in banking

[31] Cf. Acharya/Drechsler/Schnabl (2011) and Alter/Schueler (2011).

[32] Cf. Longstaff/Mithal/Neis (2005) and Forte/Pena (2009).

sector risk elevate the contingent liability of countries to bail out their financial sectors which may in turn detrimentally impact sovereign credit risk.

3.3 BANKING SECTOR RISK VS. CORPORATE SECTOR RISK CONTAGION[33]

Banks provide lending to non-bank corporate firms and hence a deterioration in the refinancing conditions of banks should translate into increased funding costs of non-bank firms. The effective contagion transmission mechanism according to our classification can be due to the risk-premium channel, when the increase in bank credit spreads is due to an overall increase in risk premiums, or alternatively, due to the liquidity channel, when the deteriorated funding conditions can be attributed to an overall decrease in market liquidity for the respective funding instruments.[34] This dependence of non-bank corporate funding on bank funding conditions should also apply when firms can directly access debt capital markets (e.g., by issuing bonds) as these are also impacted by the conditions on bank funding markets.[35] Therefore, we examine:

Hypothesis C1 *Changes in the bank default risk affect changes in the default risk of non-bank corporates.*

Apart from the above funding relation between bank and corporate refinancing, the financial crisis has exposed the importance of bank (or systemic) risk for the real economy. With regard to the inter-temporal validity of hypothesis C1 we would hence assume that the dependency became more pronounced during the financial crisis. In order to analyze the hypothesis concerning the default risk we employ market CDS spreads as these are the most widely used market-based measure for credit risk. In this respect it should be noted that CDS spreads not only reflect the *actual* default risk, as measured by the *physical* default probability, but also risk-premium components.[32]

The quality of a bank's loan portfolio – and thereby its future earnings – is mainly determined by the credit quality of the firms to which the bank provides lending. Moreover, a company's ability to meet its payment obligations is also determined by its business prospects. A firm's business prospects should in turn be reflected in its equity prices since good business

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[33] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2012).

[34] For expositional convenience we refer synonymously to CDS (spreads), credit risk, credit spreads and default risk when denoting the market CDS spreads which we employ in the empirical analysis.

[35] This is due to the fact that bank funding markets are usually very liquid and dislocations in bank funding markets spread to non-bank funding markets (cf. Beck/Demirguc-Kunt/Maksimovic (2002)).

prospects usually translate into higher earnings and future dividends.[36] Moreover, the assets of banks also often comprise the shares of other non-bank corporate firms in the shape of long-term investments or as speculative instruments. Following this line of argument we hypothesize that the equity returns of non-bank firms should lead the equity returns of banks due to the correlated-information contagion transmission channel and analyze

Hypothesis C2 *Changes in the equity returns of non-bank corporates lead changes in the equity returns of banks.*

It should be noted that the argument of hypothesis C2 could be made equally well for a dependency in the other direction for similar reasons as described above for the dependency between bank and non-bank corporate default risk. Also, it could be argued that the opposite of the dependency described in C1 could be plausible, e.g., when an increase in the credit risk of corporate borrowers (as a whole or from certain industries) leads to increased default risk for the lending financial institution. In the empirical analysis we will test the stated hypotheses, though, as we consider them more plausible. Obviously, the formulation of the hypotheses does not impact the empirical results.

While there may exist industry-specific differences with respect to the existence or extent of the above hypothesized dependencies it is difficult to formulate industry-specific hypotheses ex ante and we will consider this aspect again in the analysis of the empirical results.

[36] In fact, several rating models, such as Moody's KMV, use public equity prices as one determinant in modeling a firm's credit risk (cf. Bharath/Shumway (2004)). In this respect, the equity price is relevant for its level (inverse relation between equity prices and default risk) and its volatility (for modeling the volatility of the firm's assets).

4 METHODOLOGY

4.1 THE EXPECTED SYSTEMIC SHORTFALL (ESS) METHODOLOGY[37]

In this chapter we elaborate the ESS-methodology. In deriving our indicator we follow the approach by Huang/Zhou/Zhu (2009) and construct a hypothetical credit portfolio comprising the total liabilities of the banks in the sample and estimate the two key determinants for the credit portfolio risk, the asset return correlations and the default probabilities from capital market data. Based on these inputs we use an asset value model of portfolio credit risk in a Monte Carlo simulation to model the portfolio losses over time. The resulting loss distribution is used to derive the ESS-indicator as the product of the probability of a systemic default event and the expected loss in case this default event occurs. We also provide a methodology to determine the relative ESS-contributions of individual institutions.

4.1.1 Estimating asset return correlations from equity returns

In order to model the default correlations of assets in a credit portfolio there are two predominant procedures. The first uses historical default data and is described in Jarrow (2001), Das et al. (2007) and Duffie et al. (2009), amongst others. While being theoretically appropriate, this procedure may result in severe estimation errors in practice as defaults are rare events, especially for high-rated obligors, such as major banking groups.[38]

The second approach uses credit or equity market data to estimate the default correlations indirectly by following the contingent claims approach in Merton (1974) and interpreting equity as a call option and debt as a put option on the underlying firm's assets. The correlations of the market equity returns (or CDS spreads) of the firms under research are thus used as proxy for the asset return correlations. Tarashev/Zhu (2008b) obtain the asset return correlation by means of CDS spreads, Moody's Global Correlation model estimates the underlying asset value from equity market data and balance sheet parameters before calculating the asset return correlations, Hull/White (2004) suggest to use equity return correlations as proxy for asset return correlations for practical implementations.

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[37] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2011a).

[38] Cf. Huang/Zhou/Zhu (2009), p. 2038.

In this thesis we use the second approach and follow the suggestion by Hull/White (2004) to estimate the asset return correlations from the equity return correlations. Correlations derived from equity returns benefit from the high liquidity of exchange-traded equity shares which – under ideal market conditions – ensures that changes in the firm's default risk or overall market conditions are incorporated instantaneously in the firm's equity market price. The rationale for employing equity return correlations as proxy for the asset return correlations results from the fact that under constant firm leverage it can be shown the asset and equity return correlations are equal.[39]

As the assumption of constant leverage is more likely to hold in the short-run, we estimate the correlations based on the equity returns from the past 50 trading days whereby we construct the symmetrical matrix of the pairwise equity return correlations of the banks under research for each day during the observation period. This correlation estimation methodology ensures that only the equity returns from a defined period of time are included in the correlation estimation so that the constant-leverage assumption at least approximately tends to hold.[40]

4.1.2 Calculating risk-neutral probabilities from CDS spreads

We estimate the other relevant determinant of portfolio credit risk, the probability of default (PD), from single-name credit default swap (CDS) spreads. A CDS is a contract which provides insurance against the default of a reference entity in exchange for a continuous payment of the CDS spread on the underlying notional value. The CDS market has grown substantially since the turn of the millennium[41] and CDS spreads are considered to be better measures of credit risk than bond spreads or loan spreads.[42]

Under the standard assumption that the present value of the indemnification payments in case of default (numerator of the subsequent equation) equals the present value of the CDS insurance payments (the denominator), the market CDS spread $s_{i,t}$ of bank i can be written as

[39] The derivation for this rationale is provided in Appendix A.

[40] By conducting robustness checks we find that the empirical results are also robust when equity returns from other time lags or alternative correlation estimation methods are employed.

[41] Cf. Jakola (2006) for a discussion of the growth and importance of the CDS market.

[42] Cf. Longstaff/Mithal/Neis (2005) and Forte/Pena (2009) for a discussion of the advantages of CDS vs. bond spreads and Norden/Wagner (2008) for a discussion of the advantages of CDS vs. loan spreads.

$$s_{i,t} = \frac{LGD_{i,t} \cdot \int_t^{t+T} e^{-r_\tau \tau} q_{i,\tau} d\tau}{\int_t^{t+T} e^{-r_\tau \tau} \left(1 - \int_0^\tau q_{i,u} du\right) d\tau} \quad (1)$$

where $LGD_{i,t}$ is the expected loss given default used in the pricing of the CDS, r is the risk-free rate of return, $q_{i,\tau}$ denotes the annualized risk-neutral default intensity and $1 - \int_0^\tau q_{i,u} du$ denotes the risk-neutral probability of survival of bank i over the following τ years. By assuming that the recovery rates are uncorrelated with the default rates and that both the risk-free and the default intensity term structures are flat, Duffie (1999) and Tarashev/Zhu (2008b) obtain the risk-neutral default probabilities $PD_{i,t}$ as

$$PD_{i,t} = \frac{a_t \cdot s_{i,t}}{a_t \cdot LGD_{i,t} + b_t \cdot s_{i,t}} \quad (2)$$

where $a_t \equiv \int_t^{t+T} e^{-r\tau} d\tau$ and $b_t \equiv \int_t^{t+T} \tau e^{-r\tau} d\tau$.[43] A flat default intensity term structure is also assumed in the subsequent analysis which is not necessarily given at any time in reality but has become standard practice among practitioners and researchers.[44]

It is important to take account of the fact that the resulting default probability is a *risk-neutral* measure. This means that it contains not only the *physical* default probability but also risk premium components such as the credit default risk premium and the liquidity risk premium. As the ESS-indicator is computed using these risk-neutral PDs, it is also a a risk-neutral measure.[45] As there is no persuasive quantitative approach to decompose the individual components embodied in the risk-neutral PDs, one needs to rely on the commonly accepted observation that the increases in CDS spreads during the financial crisis can be attributed mainly to increases in the default and liquidity risk premium components. This observation is supported by the only slight increase of actual default rates during the financial crisis which suggests that the increase of CDS spreads in this time period resulted mainly from increased risk aversion and uncertainty with respect to the adequate level of default and liquidity risk

[43] Cf. Tarashev/Zhu (2008b), pp. 6-7 and Huang/Zhou/Zhu (2010b), pp. 5-6.

[44] By comparing one and five year CDS spreads Huang/Zhou/Zhu (2009) come to the conclusion that there is no empirical evidence against this assumption.

[45] It should be noted that one could also use *actual* default probabilities to compute the ESS-indicator. These are, however, less readily available than risk-neutral PDs obtained from market CDS spreads.

premiums.[46] We further analyze the risk premium determinants of the ESS-indicator in section 6.1.2.

Another feature of the resulting default probability is that it is – similarly as the above equity return correlations – a market-based *forward-looking* measure in the sense that it contains an average of the expected default probability during the life of the CDS. In that respect it stands in clear contrast to backward-looking measures (e.g., based on financial statement data), which only state what *has* occurred in the past as opposed to what *will* occur in the future.

4.1.3 Constructing the systemic risk indicator

The estimated equity return correlations and risk-neutral default probabilities are used as inputs for the Monte Carlo simulation using the single-risk-factor portfolio credit risk methodology of Gibson (2004) and Tarashev/Zhu (2008a), which we apply to the hypothetical credit portfolio comprising the total liabilities of the sample banks to obtain our expected systemic shortfall indicator. The methodology is elaborated in the following.

We assume that the asset values of the sample banks in the hypothetical debt portfolio are characterized by the Vasicek (1987) single-risk-factor model, which postulates that a firm defaults when its assets fall below a certain threshold and that the asset values are determined by a single common risk factor:

$$V_{i,T} = \rho_i M_T + \sqrt{1-\rho_i^2} \cdot Z_{i,T} \tag{3}$$

where $V_{i,T}$ denotes the asset value of bank i at time T, M_T is the common risk factor and ρ_i represents bank i's exposure to the common factor. $Z_{i,T}$ denotes the idiosyncratic factor of bank i. The correlation between banks i and j is consequently given by $\rho_i \rho_j$.[47] In order to facilitate the model's implementation, we follow standard practice and assume that the common risk factor follows a standard normal distribution so that the default threshold of bank i contingent on the realization of the common factor M_T can be shown to equal $\Phi^{-1}\left(PD_{i,T}\right)$ where Φ^{-1} denotes the quantile of the standard normal distribution.[48]

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[46] Cf. Huang/Zhou/Zhu (2009), p. 2038.

[47] Cf. Vasicek (1987), pp. 1-2.

[48] Cf. Tarashev/Zhu (2008a), pp. 135-137.

In order to implement the Monte Carlo simulation for the N banks in the sample we first estimate the symmetrical $N \times N$ correlation matrix P_t and compute the $1 \times N$ vector of the 1-year risk-neutral default probabilities PD_t for every day t in the sample period. We then draw a $1 \times N$ vector Y_t of standard-normally distributed variables whose correlation matrix is P_t. This procedure is repeated for K simulation iterations, resulting in a $K \times N$ matrix of correlated normally distributed sample values for each day in the sample period.

A default for bank i at the end of the one-year period under consideration occurs when the sampled value is below the default threshold, i.e., $Y_{i,t} < \Phi^{-1}\left(PD_{i,t}\right)$. When default occurs for bank i, we sample an LGD from a symmetrical triangular distribution with a mean of 0.55 in the range [0.1, 1] which is a widely-used distribution assumption for LGDs.[49] Multiplying this sample LGD with the total liabilities of bank i outstanding on day t results in the corresponding loss $l_{i,k,t}$ of bank i. Summing over the losses of all N banks in a particular simulation iteration k, we obtain the total portfolio loss $L_{k,t}$ which we use to construct the portfolio loss distribution Λ_t for each observation day t.

We define the 'systemic loss threshold' (SLT) as a share of the total liabilities of the sample banks. When the total portfolio loss $L_{k,t}$ exceeds the SLT_t we assume the occurrence of the systemic default event. Within the meaning of 'systemic event' in definition D1, we interpret this default event as a situation in which the stability of the financial system is severely endangered due to the default of a substantial share of the banking sector liabilities. In our analysis we use a value of 10 percent for the relative systemic loss threshold, i.e., $SLT^{rel} = 10\%$.[50] We define the 'probability of systemic default' (PSD) as the probability of the occurrence of the systemic default event, i.e., $\Pr\left(L_t > SLT_t\right)$, which we obtain from the portfolio loss distribution Λ_t for each day t in the sample period.

From the portfolio loss distribution Λ_t we further derive the expected tail loss (ETL), which we define as the expected value of the total portfolio loss given that the portfolio loss exceeds

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[49] Cf. Tarashev/Zhu (2008a), pp. 145-146. In a robustness check exercise we use a Beta distribution for the LGD as suggested by Loeffler/Posch (2010).

[50] We also used 5% and 15% as relative systemic loss thresholds and find that the ESS over time shows the same trajectory as for 10% albeit – of course – on a different level. The definition of the relative SLT depends on the specific application.

the systemic loss threshold, i.e., $ETL_t = E\left(L_t | L_t > SLT_t\right)$. This definition is consistent with the common definition of expected shortfall in the financial risk management literature.

We obtain the *absolute* expected systemic shortfall indicator by multiplying the probability of systemic default by the expected tail loss:

$$ESS_t = \Pr(L_t > SLT_t) \cdot E\left(L_t | L_t > SLT_t\right) = PSD_t \cdot ETL_t \tag{4}$$

The interpretation of the ESS-indicator is straightforward: it represents the product of the probability of a severe default event in the financial system multiplied by the expected value of the losses in case this default event materializes. It is also possible to evaluate the PSD and ETL individually in order to understand the drivers of the aggregate ESS-indicator. Furthermore we also compute the *relative* ESS-indicator by dividing ESS_t by the total liabilities of the sample banks outstanding at time t in order to facilitate inter-sample comparability of the empirical results.

The ESS-indicator is an *aggregate* measure of systemic risk in the financial system accounting for *all* sample banks. However, it is also important to understand the relative contribution of *individual* banks to the aggregate systemic risk as macroprudential measures need to be introduced at the level of the individual institution. To this end we compute the relative systemic loss contribution[51] $c_{i,t}$ of bank i when the total portfolio loss $L_{t,k}$ exceeds the systemic loss threshold in a simulation iteration. Summing over all K iterations yields the contribution of each bank to the systemic risk indicator on sample day t

$$c_{i,t} = \sum_{k=1}^{K} \frac{l_{i,t,k}}{L_{t,k}} \ \ when \ L_{t,k} > SLT_t \tag{5}$$

Calculating this measure over the whole or parts of the sample period results in the systemic risk contribution c_i of bank i which can be evaluated either by considering individual banks or groups of banks (e.g., all banks from a specific country).

4.1.4 Technical comparison with other systemic risk measures

While the usage of a credit portfolio approach and the estimation of its input parameters from capital market data to measure systemic risk was inspired by Huang/Zhou/Zhu (2009), there

[51] In the subsequent elaboration we will refer to the (relative) systemic loss contribution synonymously as (relative) systemic risk contribution and (relative) ESS contribution.

are a few, but important differences to their distress insurance premium (DIP). Huang/Zhou/Zhu (2009) assume the systemic loss threshold (SLT) as a percentage of the total liabilities of the *banking system*. While this may be adequate for the US banking system, where most relevant banks are exchange-listed (and consequently the sample banks' liability portfolio covers a larger share of the total banking system liabilities), it would be inappropriate for countries where a significant number of banks are not listed as is in many European countries.[52] Therefore, we define the SLT as a share of total liabilities of the *sample banks* in our analysis.

The DIP-indicator measures the cost of insurance against distress losses in excess of the SLT. While the computation methodology is not stated expressly by the authors, we conjecture that the DIP-indicator is computed by discounting the expected portfolio loss in excess of the SLT. As we derive our ESS-indicator using standard measures from financial institution risk management, it may have certain advantages in terms of transparency and usability vis-à-vis the DIP-indicator. Besides, Huang/Zhou/Zhu (2009) consider a three-month time horizon while we compute the portfolio loss at the end of a one-year time period. The relative risk contributions to the ESS-measure are computed in a transparent fashion as byproduct of our credit portfolio simulation as opposed to an auxiliary importance sampling procedure in Huang/Zhou/Zhu (2010a) which facilitates the application of our methodology to measure the systemic importance of individual institutions.

Moreover, we compute the ESS-measure for *each day* during the observation period which ensures that the indicator can respond immediately to financial market events. By contrast, Huang/Zhou/Zhu (2009), Huang/Zhou/Zhu (2010a), Huang/Zhou/Zhu (2010b) compute the DIP measure only on a *weekly* basis which leads to some delay in the indicator's response to financial market events. However, this is no drawback of the DIP per se but rather a disadvantage of the chosen implementation.

An important similarity is that both the DIP and the ESS-indicator are *risk-neutral* measures as they are derived from risk-neutral default probabilities obtained from market CDS spreads. This is also a distinguishing feature with respect to other measures of systemic risk described in the following. Besides, both the DIP and the ESS-indicator are coherent risk measures according to the definition by Artzner et al. (1999).

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[52] The importance of state banks ("Landesbanken") in Germany but also the savings banks in several European countries supports this statement.

The systemic expected shortfall (SES) of Acharya et al. (2010) considers the probability of an individual bank to be undercapitalized when the system as a whole is undercapitalized. The marginal expected shortfall of individual banks is obtained by computing the expected loss of individual banks when the whole system is in distress. The SES-indicator is derived using equity market data, whereas the most important input for the ESS-indicator are CDS spreads which by construction are better predictors of credit risk.[53] The SES measure is also a coherent risk measure but differs from the ESS-indicator in that it defines the occurrence of a systemic event as percentile of the portfolio loss distribution, whereas we define it as percentage of the sample banks' total liabilities.

The Adrian/Brunnermeier (2008) Conditional Value at Risk (CoVaR) measure computes the value at risk of the financial system conditional on one bank being in distress. Our ESS-measure takes the opposite approach by considering the contribution of an individual bank when the system as a whole is in distress. CoVaR can be used to determine the systemic importance of individual institutions, whereas it *cannot* be aggregated to measure the level of aggregate systemic financial sector risk. The CoVaR measure suffers from the general shortcomings of VaR-based measures as it is not a coherent measure of risk according to the Artzner et al. (1999) definition.

[53] Cf. Longstaff/Mithal/Neis (2005), pp. 2216-2217.

4.2 MEASURING CONTAGION EFFECTS IN FINANCIAL MARKETS[54]

The analysis of contagion and interdependencies in financial markets is most frequently conducted by analyzing the mutual predictive power of the relevant market variables by means of Granger-causality tests in vector autoregressive (VAR) or vector error correction (VEC) models and by interpreting the respective impulse response functions.[55] In this thesis we pursue the same methodological pathway and employ VAR and VEC frameworks in order to test the described hypotheses. We derive the methodology in the following.

Macroeconomic and financial variables often exhibit the unit root property which according to Nelson/Plosser (1982) can lead to incorrect conclusions in time series econometrics hypothesis testing when it is left unaccounted for. In this thesis we employ the three most common unit root (stationarity) tests in order to examine the relevant variables:

1. Augmented Dickey and Fuller (ADF) test as suggested by Dickey/Fuller (1979),
2. Philips and Perron (PP) test proposed in Phillips/Perron (1988),
3. Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test elaborated in Kwiatkowski et al. (1992).

We conclude that the time series under research has a unit root, i.e., is integrated of order one (formalized as $I(1)$), when at least two of these tests suggest the presence of a unit root at the five percent significance level. If we find a variable to be non-stationary we employ the first differences of the respective variable in the analysis. When analyzing $I(1)$ variables one needs to test the variables for cointegration, i.e., a common stochastic trend, as described by Engle/Granger (1987) in order to avoid false inferences. This study employs the Engle/Granger (1987) ADF test as well as the Johansen (1995) trace *and* maximum eigenvalue tests in order to analyze the bivariate time series for common stochastic trends. We conclude that two series are cointegrated if at least two of these tests suggest the presence of cointegration at the five percent significance level.

When the variables are $I(1)$ but *no cointegration* is found between the variables we use the following VAR model for the analysis

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[54] The elaborations in this section are (also literally) based on Lahmann (2012b).

[55] The theoretical background for this methodological proceeding is described in section 2.2. Examples for corresponding empirical implementations are Alter/Schueler (2011), Huang/Yang/Hu (2000), Longstaff (2010) and Roll/Schwarz/Suess (2007).

$$\begin{pmatrix} \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} = \nu + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{1,1,i} & \alpha_{1,2,i} \\ \alpha_{2,1,i} & \alpha_{2,2,i} \end{bmatrix} \begin{pmatrix} \Delta y_{1,t-i} \\ \Delta y_{2,t-i} \end{pmatrix} + u_t \tag{6}$$

where $y_{1,t}$ and $y_{2,t}$ are the variables under research, Δ denotes the first difference, ν is a vector of intercepts, p denotes the lag order of the VAR system and u_t denotes a white noise error term. [56] We follow standard practice and estimate the VAR model using ordinary least squares (OLS). Accepting the first null hypothesis $H_{0,1}: \alpha_{1,2,1} = \alpha_{1,2,2} = ... = \alpha_{1,2,p} = 0$ implies that $y_{2,t}$ does not Granger-cause $y_{1,t}$ and equivalently $y_{1,t}$ Granger-causes $y_{2,t}$ when one fails to reject $H_{0,2}: \alpha_{2,1,1} = \alpha_{2,1,2} = ... = \alpha_{2,1,p} = 0$. When both null hypotheses are rejected, there exists a feedback relation between $y_{1,t}$ and $y_{2,t}$. Hypothesis tests are conducted using a Wald test based on the F-statistic against the one, five and ten percent critical values.

In case *cointegration is found* between $y_{1,t}$ and $y_{2,t}$ an error correction (EC) term needs to be included in the Granger causality regression equation as follows:

$$\begin{pmatrix} \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} = \begin{pmatrix} \delta_{1,t} \\ \delta_{1,t} \end{pmatrix} \left(\beta_1 y_{1,t-1} - \beta_2 \gamma y_{2,t-1} + \beta_0 \right) + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{1,1,i} & \alpha_{1,2,i} \\ \alpha_{2,1,i} & \alpha_{2,2,i} \end{bmatrix} \begin{pmatrix} \Delta y_{1,t-i} \\ \Delta y_{2,t-i} \end{pmatrix} + u_t \tag{7}$$

where δ_1 and δ_2 represent the speed of adjustment to the long-run equilibrium. The EC part of the model is estimated using the Johansen (1995) maximum likelihood procedure whereas the VAR part is estimated using OLS. Rejecting the first null hypothesis $H_{0,1}: \alpha_{1,2,1} = \alpha_{1,2,2} = ... = \alpha_{1,2,p} = 0$ *and* $\delta_1 = 0$ implies that $y_{2,t}$ Granger-causes $y_{1,t}$ whereas a rejection of the second null hypothesis $H_{0,2}: \alpha_{2,1,1} = \alpha_{2,1,2} = ... = \alpha_{2,1,p} = 0$ *and* $\delta_2 = 0$ denotes that $y_{1,t}$ Granger-causes $y_{2,t}$. When both null hypotheses are rejected, there exists a feedback relation between $y_{1,t}$ and $y_{2,t}$. Hypothesis tests are conducted using a Wald test based on the F-statistic against the one, five and ten percent critical values. The regression residuals are examined for auto-correlation by means of the Ljung/Box (1978) Q-test.[57]

The data variables actually used for $y_{1,t}$ and $y_{2,t}$ in the above VAR models for the contagion analysis in this thesis are described in the next chapter on the employed empirical data. All variables are transformed to natural logarithms as suggested by Forte/Pena (2009) and

[56] We do not provide separate equations for stationary variables as we do not observe stationary variable pairs in our sample.

[57] Cf. Lütkepohl (2007), pp. 316-318.

Granger/Huangb/Yang (2000).[58] In order to determine the lag length p we follow common practice and employ the Akaike (1974) information criterion (AIC) and the Schwarz (1978) Bayesian information criterion (SBIC).[59] In case the AIC and the SBIC suggest different lag lengths we use the smaller lag length for the sake of parsimony.[60]

Including control variables to ensure result robustness

Macroeconomic and financial variables are often affected by common economic factors and shocks. This commonality may lead to erroneous conclusions in causality analysis when the actual causality relationship does not exist directly between the variables under research but rather 'via' the common factor.[61] In order to control for this commonality and to ensure robustness of the findings we conduct the analyses in the VAR and VEC frameworks both without and with control variables as exogenous variables. To this end, we include a relevant *stock market index* as proxy for market expectations of overall economic conditions. Specifically we use the MSCI World in the inter-regional analysis, the S&P 500 index for the analysis of the American sample, the MSCI Asia-Pacific for Asia-Pacific and the MSCI Europe for the European sample. Besides, as daily economic variables are only scarcely available, we additionally employ the federal funds rate as a measure of macroeconomic shocks. We include the control variables both separately and together as exogenous variables in the regression equations.[62]

Trading time adjustments in the lag structure

In the inter-regional analyses we account for differences in trading times between the regions where necessary and perform the necessary trading time adjustments in the lag structure of the variables used in the VAR framework as proposed by Huang/Yang/Hu (2000) in order to ensure that the analyzed variables reflect the same level of information.[63]

Capturing the model dynamics by means of impulse response analysis

In addition to the above Granger causality tests of the lead-lag relationships in the bivariate setting we employ impulse response analysis in order to analyze the full dynamics of the

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[58] This step is further motivated by comparatively low values of the research variables at the beginning of the observation period compared to rather high values at the end of the period.

[59] Cf. Huang/Yang/Hu (2000), Granger/Huangb/Yang (2000) and Hiemstra/Jones (1994) (amongst others).

[60] This proceeding is consistent with the proposal of Roll/Schwarz/Suess (2007), p. 2216.

[61] Cf. Granger (2003), pp. 69-70.

[62] This proceeding is motivated by Granger/Huangb/Yang (2000), pp. 349-350.

[63] Cf. Huang/Yang/Hu (2000), p.292.

VAR model in case a Granger causality relationship has been identified. Specifically we analyze the effect of a one standard deviation 'shock'[64] in one variable on the other variable over time. Following the seminal thesis of Sims (1980), the dynamics analysis of VAR models is conducted frequently by computing the orthogonalized impulse responses using the Cholesky decomposition.[65] Koop/Pesaran/Potter (1996) and Pesaran/Shin (1998) find two shortcomings of this approach, though. Firstly, the impulse response functions are not unique as they depend on the ordering of the variables in the VAR model. Secondly, the restriction of uncorrelated contemporaneous shocks is imposed.[66] However, in the present analysis theory does neither suggest an ordering of the research variables nor that contemporaneous shocks to the variables are uncorrelated.[67] Therefore, we employ the generalized impulse response (GIR) analysis suggested by Pesaran/Shin (1998) because it overcomes the mentioned shortcomings of the orthogonalized impulse responses. This choice is consistent with the methodological implementations in recent research (e.g., Chordia/Sarkar/Subrahmanyam (2005), Griffin/Nardari/Stulz (2007) and Kavussanos/Visvikis (2004)). In order to facilitate the comparison and interpretation of the results, we follow Griffin/Nardari/Stulz (2007) and scale the impulse responses by the standard deviation of the residual of the variable's regression equation.[68]

Correlations of the research variables

In order to complement the results obtained from the Granger-causality and impulse response analysis we analyze the correlations of the research variables by employing a moving-window correlation estimation methodology using the past month's values. While the correlations do not provide additional insights with respect to the *lead-lag* dependencies between the variables, they facilitate the analysis of the direction and magnitude of the *linear* relationship.

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[64] In the following the terms impulse and innovation are used synonymously.

[65] Cf. Pesaran/Shin (1998), p. 17.

[66] Cf. Griffin/Nardari/Stulz (2007), p. 918.

[67] In fact, a correlation of shocks is rather likely for several variables (e.g., sovereign and bank CDS).

[68] Cf. Griffin/Nardari/Stulz (2007), p. 918 as well as Lütkepohl (2007), pp. 51-54 and pp. 321-322.

5 EMPIRICAL DATA

In this chapter we describe the empirical data analyzed in this thesis. Firstly, we describe the bank sample used in the empirical application of the ESS-methodology and, secondly, the data employed in the analysis of banking sector risk contagion dependencies is specified. The observation horizon of the analyses in this thesis comprises the time period between October 1st, 2005 and April 30th, 2011.[69] In order to facilitate an intertemporal analysis of the data and analysis results we divide the overall sample period into the following four sub-periods which are subsequently referenced: the *'pre-crisis' period 1* ranges from October 1st, 2005 to February 28th, 2007; the *'subprime and beginning financial crisis' period 2* ranges from March 1st, 2007 to July 31st, 2008; *'the core financial crisis' period 3* ranges from August 1st, 2008 to December 31st, 2009; *'the sovereign debt crisis' period 4* ranges from January 1st, 2010 to April 30th, 2011.

5.1 ESS-ANALYSIS[70]

The ESS-methodology described in the previous chapter can in principle be applied to any portfolio of companies with publicly traded equity and available CDS data. As the focus of the present analysis is the measurement of systemic risk and the assessment of systemic importance in global and regional financial markets, we select bank holding companies according to the following data availability criteria: (I) available CDS spreads, (II) publicly available equity prices, (III) publicly available liability data. By applying these data availability criteria we obtain a global sample of 83 banks from 28 countries covering the following four regional sub-samples: America (12 banks), Asia-Pacific (24 banks), Europe (38 banks), Middle East and Russia[71] (9 banks).

We compute equity returns from equity market prices provided by Thomson Datastream in order to estimate the equity return correlations required in the computation of the ESS-indicator. CDS spreads are obtained from CMA Market Data and Thomson Reuters using the mid-spread of the 5-year senior unsecured CDS spread to compute the corresponding risk-

[69] A longer sample period was not feasible due to data limitations.

[70] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2011a).

[71] We summarize these two regions as one 'region' as neither of them could be unambiguously allocated to any of the other regions and because they are individually too small in terms of available sample data.

neutral default probabilities.[72] As the LGDs used by market participants for pricing the CDS are not available in these databases we assume an LGD of 55% to compute the risk-neutral default probabilities.[73] Total liabilities of the sample bank holding companies are obtained from the Thomson Worldscope database. A linear gradient is assumed between available liability dates to obtain the amount of total liabilities per day during the observation period.

We conduct the analysis both for the global sample *and* for the four regional sub-samples individually which is also reflected in the subsequent elaboration: we first describe the data for the global sample and then proceed with the regional sub-samples before conducting a comparative analysis between the individual samples. The elaboration is structured so that the reader can also focus on specific samples only without loss of continuity.

5.1.1 Global sample

The lower panel of Table 1 shows the 28 countries of the banks in the global sample as well as the total liabilities of the sample banks per country and their average (liability-weighted) CDS spreads. The total liabilities of the banks covered in the analysis amount to 35.8 trillion EUR with an average of 1.3 trillion EUR per country. The countries with the highest total bank liabilities are France, Germany, Switzerland, the United Kingdom and the United States. From period 1 to period 4 the average CDS spread of all banks increases from 13 to 139 basis points. In period 4 the countries with the highest average bank CDS spreads are Greece, Ireland, Kazakhstan and Portugal whereas Denmark, Malaysia, Singapore and Sweden have the lowest bank CDS spreads. The ranking of the countries with respect to their banks' CDS spreads changes over time and the changes from period 3 to period 4 reflect the impact of the euro zone sovereign debt crisis (e.g., the Greek banks' average CDS spread increases more than ten-fold from 72 to 778 basis points).

Table 2 shows the same parameters as Table 1 on a bank level. The total liabilities per bank average 431 billion EUR. The largest banking groups in terms of total liabilities are Barclay's, BNP Paribas, Deutsche Bank and Royal Bank of Scotland. In period 4 Greece's Alpha Bank and EFG Eurobank, Ireland's Allied Irish Banks and Kazakhstan's Kazkommertsbank have the highest CDS spreads whereas the three Singaporean banks and Sweden's Svenska

[72] We use the 5-year senior unsecured CDS spread as this is the most frequently traded CDS type (cf. Hull/Predescu/White (2004), p. 2794).

[73] The empirical results are robust to alternative assumptions for the LGD.

Handelsbanken have the lowest CDS spreads. The ranking of the banks according to their CDS spreads is time-variant with the biggest changes occurring from period 3 to period 4.

Table 3 shows the sample banks' equity return correlations[74] as well as their end-2008 shareholder's equity on a country-level. The total equity of the sample banks adds up to 1.5 trillion EUR with a country average of 54 billion EUR. The countries with the highest average correlation of their sample banks' equity returns are France, Germany, Italy and Switzerland. On a bank level, Barclay's, BNP Paribas, Crédit Agricole and Societé Generale have the highest correlation as shown in Table 4. The evolution of the equity return correlation of the global sample is shown in the lower panel of Figure 1. It averages 24 percent in the period before August 2007. In August 2007 the correlation increases significantly to an average value of 37 percent in the period until November 2008. In addition to the elevated level of the average correlation, the standard deviation of the correlation also increases considerably. From December 2008 until April 2010 the average equity return correlation decreases to an average of 28 percent before rising to an average of 33 percent in May 2010. From June 2010 until the end of the observation period average correlations decrease to 26 percent, slightly above the pre-crisis average.

The upper panel of Figure 1 shows the liability-weighted average risk-neutral default probabilities of the banking groups in the global sample during the observation period. Before July 2007 the average risk-neutral default PDs are below 0.5 percent. Following the freezing of three investment funds by BNP Paribas in August 2007 the default probabilities are elevated before reaching a local maximum of 2.9 percent after the takeover of Bear Stearns by JP Morgan in March 2008. In the aftermath of the collapse of Lehman Brothers in September 2008, average risk-neutral PDs reach a second peak at 3.6 percent on September 29th, 2008. Following the financial stability measures in Europe and the United States taken in early October 2008, the default probabilities decline to a lower level before reaching an observation-period maximum of 4.4 percent on March 09th, 2009. After the G20 Summit in London in April 2009, the risk-neutral default probabilities fall again below two percent on average. At the time of the aggravation of the euro sovereign debt crisis in May 2010 the average PDs increase again sharply and remain at two percent until the end of the observation period which is significantly above pre-crisis levels.

[74] Computed as the mean of the daily pairwise stock return correlations between the respective bank and all other banks.

5.1.2 American sub-sample

The American sub-sample is represented by 12 banks from the United States as no other bank from the American continent meets the described data availability criteria. The total liabilities of the American banks amount to 6.9 trillion EUR with an average of 577 billion EUR as shown in Table 1. Table 2 shows that the largest US sample banks in terms of total liabilities are Bank of America, Citigroup and JP Morgan. The average CDS spreads of the American sample increased from 16 basis points in period 1 to 214 basis points in period 3 and decreased to 134 basis points in period 4. The US banks with the highest CDS spreads in period 4 are MetLife, Morgan Stanley and Citigroup whereas American Express, JP Morgan and Wells Fargo have the lowest CDS spreads.

Table 5 shows the equity as of end-2008 and the average correlations of the American sample banks. In total, the US sample banks have a combined equity of 465 billion EUR with a mean of 39 billion EUR. In period 4 Bank of America, JP Morgan and Wells Fargo are the banks with the highest correlation. The lower panel of Figure 2 shows the average equity return correlation of the American sub-sample during the observation horizon. From October 2005 until July 2007 the average correlation is 62 percent. During the financial crisis period between August 2007 and July 2009 equity return correlations in the US sub-sample hike to an average of 76 percent and return to a lower level of 59 percent from August 2009 until April 2010. Thereafter, average correlations increase by ten percentage points and maintain this level until the end of the observation period.

The upper panel of Figure 2 shows the liability-weighted average risk-neutral default probabilities of the US sample banks during the observation period. In the period between October 2005 and July 2007 the average risk-neutral default PDs are below 0.5 percent. The default probabilities are significantly elevated as of August 2007 and reach a local maximum of 3.7 percent in March 2008. In the aftermath of the collapse of Lehman Brothers in September 2008, the mean PD of the US sample banks reaches two local maxima on September, 17th 2008 (5.9 percent) and on October, 10th, 2008 (6.0 percent). At a level of 6.6 percent the US banks reach their observation-period maximum on March 09th, 2009. Thereafter, the average PD decreases to a value of 2 percent in end-April 2010. Afterwards it begins to rise again and reaches a local maximum on June 10th, 2010 at 3.3 percent. Until the end of the observation period, the default probability averages 2.3 percent which is the

quintuplicate of the pre-crisis average. In addition to the elevated *level* of the PDs during the financial crisis period, the dispersion[75] of the PDs is higher during this period.

5.1.3 Asian-Pacific sub-sample

The total liabilities of the Asian-Pacific banks amount to 5.2 trillion EUR with an average of 218 billion EUR per bank as shown in Table 1. The Australian, Chinese and Japanese banks have the highest total liabilities in this sub-sample. The average CDS spreads of the banks in the Asian-Pacific sample increase from 19 basis points in period 1 to 169 basis points in period 3 before decreasing to 108 basis points in period 4. In period 4 the countries with the highest average CDS spreads are China, India and Kazakhstan. The ranking of the countries with respect to their average CDS spreads is rather stable over time. Table 2 shows that Bank of China, Mizuho Financial Group and Sumitomo Mitsui Bank have the highest total liabilities in this sample. The Asian-Pacific banks with the highest CDS spreads in period 4 are India's ICICI Bank as well as Kazakhstan's Halyk Bank and Kazkommertsbank whereas the three Singaporean sample banks have the lowest CDS spreads.

Table 6 shows the end-2008 equity and the average correlations of the Asian-Pacific sub-sample on a country and bank level. The Asian-Pacific banks have a combined equity of 264 billion EUR with a mean of 11 billion EUR. In period 4 the countries with the highest average correlation are Australia, Korea and Singapore. On a bank-level Australia's Commonwealth Bank, Macquarie Bank and National Australia Bank and Korea's Kookmin Bank have the highest average correlation. The equity return correlation of the Asian-Pacific sub-sample banks during the sample period are shown in the lower panel of Figure 3. The average correlation is 26 percent in the period between October 2005 and June 2007. During the crisis period between July 2007 and July 2009 equity return correlations increase to an average of 33 percent. From August 2009 until the end of the observation period, the average correlations decrease to 24 percent which is even below the pre-crisis average.

The average risk-neutral default probabilities of the banks from the Asia-Pacific region during the observation period are shown in the upper panel of Figure 3. Before August 2007 the risk-neutral PDs average 0.3 percent. The default probabilities are elevated as of August 2007 and reach a local maximum of 2.7 percent in March 2008. Until mid-September 2008 average PDs amount to 1.8 percent and reach a local maximum of 4.7 percent on October 29th, 2008. The

[75] We measure dispersion as the standard deviation of all observations at a particular point in time.

observation period maximum of 4.8 percent is reached on March 10th, 2009 and until the end of the observation period the risk-neutral PDs average 1.9 percent.

5.1.4 European sub-sample

The total liabilities of the banks in European sub-sample amount to 23.3 trillion EUR with an average of 613 billion EUR per country as shown in Table 1.[76] The largest European countries in terms of their sample banks' total liabilities are France, Germany and the United Kingdom. The average CDS spreads of all sample banks increase markedly from 10 basis points in period 1 to 145 basis points in period 4. The countries with the highest average bank CDS spreads in period 4 are Greece, Ireland and Portugal. These countries also show the strongest increase in their bank CDS spreads from period 3 to period 4 reflecting the impact of the euro zone sovereign debt crisis (e.g., Greece' average bank CDS spreads increase from 72 to 778 basis points). The largest banking groups in the European sample in terms of total liabilities are Barclay's, BNP Paribas, Deutsche Bank and Royal Bank of Scotland as shown in Table 2. The banks with the highest CDS spreads in period 4 are Greece's Alpha Bank and EFG Eurobank, Ireland's Allied Irish Banks and Portugal's Banco Commercial and Espirito Santo.

Table 7 shows the end-2008 total equity of the European sample banks and their average correlations during the four sample periods on a country level. The European sample banks have a combined equity of 744 billion EUR with an average of 53 billion EUR per country. The sample countries with the highest average equity return correlations in period 4 are France, Italy and Spain. Table 8 shows that the equity per bank averages 20 billion EUR and that the banks with the highest average correlations in period 4 are France's BNP Paribas and Societé Generale as well as Spain's Grupo Santander. The progress of the equity return correlation of the European sample banks is shown in the lower panel of Figure 4. It averages 41 percent in the period before August 2007. In August 2007 the correlation increases significantly to a mean value of 61 percent in the period until November 2008. In addition to the elevated level of the average correlation, the standard deviation of the correlation also increases considerably.[77] From December 2008 until April 2010 the average equity return correlation decreases to 49 percent before rising again to a higher level as the euro sovereign

[76]The majority of the banks from the European Union were also covered in the stress test conducted by the Committee of European Banking Supervisors published in July 2010 which applied stress scenarios to the positions of individual institutions.

[77] This conclusion is drawn by considering the underlying data of Figure 4.

debt crisis materializes in May 2010. From October 2010 until the end of the observation period the average correlations decrease again to the pre-crisis average.

The upper panel of Figure 4 shows the average risk-neutral default probabilities of the sample banks during the observation period. Before July 2007 the average risk-neutral default PDs are low at below 0.5 percent. After the freezing of three investment funds by BNP Paribas in August 2007 the default probabilities are elevated before reaching a local maximum of 2.7 percent after the takeover of Bear Stearns by JP Morgan in March 2008. Subsequent to the collapse of Lehman Brothers in September 2008, average risk-neutral PDs reach a second peak at 3.3 percent on September 29th, 2008. Afterwards, the default probabilities decline to a lower level before reaching an observation-period maximum of 3.6 percent on March 12th, 2009. From April 2009 to April 2010 the average PDs average out 1.9 percent. Due to the aggravation of the euro sovereign debt crisis in May 2010 the average PDs increase again sharply to an average of 2.6 percent until the end of the observation period.

5.1.5 Middle Eastern and Russian sub-sample

The Middle Eastern and Russian (MER) sub-sample consists of nine banks, six from the Middle Eastern region and three banks from Russia as shown in Table 2.[78] We summarize these two regions in our analysis as neither of them could be unambiguously allocated to any of the other regions and because they are individually too small in terms of available sample data. The total liabilities of the MER banks amount to 354 billion EUR with an average of 39 billion EUR per bank (Table 1). Russia's WTB and Sberbank and the UAE's[79] Abu Dhabi Commercial bank are the largest banks in terms of total liabilities in this sub-sample.

The average CDS spreads in the MER sub-sample increase from 69 basis points in period 1 to 526 basis points in period 3 but decrease again to an average of 279 basis points in period 4. The banks with the highest CDS spreads in period 4 are Russia's Bank of Moscow and the UAE's Dubai Islamic Bank and Mashreqbank. Table 9 shows the end-2008 equity and the average correlations of the banks in the sub-sample. The total equity in this sample amounts to 40.6 billion EUR and averages 4.5 billion EUR per bank. The banks with the highest correlation in the last period are Bank of Moscow, Commercial Bank of Qatar and National Bank of Abu Dhabi. The lower panel of Figure 5 shows the average equity return correlation

[78] Due to the small sample size a *country level* analysis is not conducted for this sub-sample.

[79] UAE = United Arab Emirates.

of the MER sub-sample during the observation period. The average correlation is 21 percent in the period between October 2005 and June 2007. During the crisis period between July 2007 and July 2009 equity return correlations *decrease* to an average of 17 percent. From August 2009 until the end of the observation period, the average correlations increase slightly to 19 percent which is still below the pre-crisis average.

The average risk-neutral default probabilities of the banks from the Middle East and Russia sub-sample during the observation period are shown in the upper panel of Figure 5. Before July 2007 the risk-neutral PDs average 1.1 percent. Between July 2007 and August 2008 the default probabilities rise to an average of 2.6 percent and reach an observation-period maximum of 14.2 percent on October 24th, 2008. After this extreme hike, the risk-neutral PDs remain elevated until April 2009 (10 percent on average) and then return to lower levels until the end of the observation horizon (5 percent on average).

5.1.6 Comparative analysis

Following the above description of the global sample and the four regional sub-samples we conduct a comparative analysis of the liability size, default probabilities and average correlations between the samples in this section.

From Table 1 it can be gathered that from the 37.8 trillion EUR total liabilities of the global sample, Europe is the largest sub-sample with a total of 23.3 trillion EUR (65 percent of total) followed by the American sample with total liabilities of 6.9 trillion EUR (19 percent). The Asian-Pacific sub-sample ranks third with 5.2 trillion EUR (15 percent) and the Middle Eastern and Russian sample is the smallest sub-sample with 354 billion EUR (1 percent). Due to these significant size differences of the sub-samples we focus the comparison of the sample-specific results on the relative ESS-indicator and relative changes over time.

The upper panel of Figure 6 shows the average risk-neutral default probabilities of the global sample and the four sub-samples. The MER sub-sample has the highest average default-probability of all samples over time (3.7 percent), followed by the American (1.8 percent), the global and Asian-Pacific samples (both 1.5 percent) and the European (1.4 percent) sub-samples. It is interesting to note that all samples except for the MER sub-sample reach their observation period maximum in March 2009 after the stock-market low and not – as one may have expected – following the Lehman bankruptcy and the subsequent events in September and October 2008. It can further be observed that the default-probability (and respectively the CDS spreads) of the American sample banks exhibit the highest volatility between September

2008 and September 2009. The default probabilities of the European and Asian-Pacific sub-samples move closely together from October 2005 until September 2008. The default probabilities of the banks from the Asia-Pacific region react more strongly and are more elevated than the PDs of the European banks between October 2008 and June 2009. From July 2009 until April 2010 the Asian-Pacific and European default probabilities move again together and the American banks' average default probability is slightly higher. As the euro sovereign debt crisis aggravated in May 2010, the European banks' default probabilities upswing strongly and also the PDs from the other sub-samples increase slightly. The PD increase of the non-European sub-samples can probably be explained by the market uncertainty with respect to the global effects of the euro sovereign debt crisis and the extent of exposure of banks around the globe to debt from financially frail euro zone countries. The euro zone sovereign debt crisis also has another notable impact: the European sub-sample is the only sample whose average default probabilities increase in period 4with respect to the average in period 3.[80]

The lower panel of Figure 6 shows the average correlations of the global sample and the four sub-samples. At an average level of 68 percent, the banks from the American sample have the highest average correlation of all sub-samples during the observation period. This is no surprise, however, because the American sample is the most homogeneous sub-sample as it is composed of major US banks exclusively. The average correlation of the American banks is always above that of the European banks except for the time between May 11th, 2010 and June 18th, 2010 where the comovement of European banks' equity prices was particularly strong due to the market dislocations caused by the euro zone sovereign debt crisis.

The European banks' average equity return correlations are at an average level of 50 percent the second highest of all sub-samples and are above the average correlations of the Asian-Pacific banks (28 percent) which applies also on a daily level except for six outlier days in March 2011. As the European sub-sample comprises mainly banks from an integrated economic and currency area (however with varying differences between the member countries), the ordering of its average correlations below the homogeneous American sub-sample and above the heterogeneous Asia-Pacific sub-sample appears adequate. The Middle East & Russia sample has the lowest average correlation among the sub-samples (19 percent)

[80] This conclusion is more obvious when the respective CDS spreads tables are compared.

which is amongst others due to the fact that the sample banks are heterogeneous and stem from emerging markets with specific characteristics.

There is a strong comovement in the equity return correlations of the American, Asian-Pacific and European sub-samples whereas the European and (particularly) Asian-Pacific sub-samples' correlations respond with more delay to the financial crisis events than the American correlations. The correlations of these three sub-samples increase even jointly in May 2010 in response to the European sovereign debt problems whereas the increase of the European sample's correlations is strongest. However, from June 2010 until the end of the observation period the comovement relationship breaks down and correlations appear to be determined mainly by region-specific factors.

The global sample has an average correlation of 29 percent during the observation period. As the average correlations are computed from the average of the correlations of one bank with all other banks and bearing in mind the number and heterogeneity of the banks and countries covered in the global sample it is obvious that high average correlations are rare. In fact, the global sample's average correlation reaches a value of 50 percent only once in the observation period on September 22nd, 2008. The average correlation of the global sample has a strong comovement with the American, Asian-Pacific and European sub-samples, particularly in the time period before June 2010.

5.2 BANKING SECTOR RISK CONTAGION DEPENDENCIES

In this section we discuss the empirical data employed in the analysis of banking sector risk contagion dependencies.

5.2.1 Inter-regional systemic risk contagion[81]

In order to analyze the inter-regional systemic risk contagion we employ the relative ESS-indicator elaborated in section 6.1 for the regional sub-samples America, Asia-Pacific, Europe as well as Middle East and Russia. In a separate analysis we employ the liability-weighted average bank CDS spreads of these four sample regions. In terms of the notation employed in the elaborated VAR model we use the relative ESS-indicator and respectively the weighted bank CDS spreads of one region as $y_{1,t}$ ('*caused* systemic risk') and the relative ESS-indicator and respectively the weighted bank CDS spreads of the other regions as $y_{2,t}$ ('*causing* systemic risk') so as to capture all possible regional combinations.

The evolution of the ESS-indicator in Figure 22 shows that the indicator is at a very low level in all regions before the crisis and that it adequately captures the financial crisis events with 'global importance' as well as the region-specific crisis events. In particular, the ESS-indicator shows peaks for *all samples* in March 2008 after the Bear Stearns takeover, in September 2008 after the Lehman default, in March 2009 after the stock market low and in May 2010 at the time of the aggravation of the euro debt crisis. On the regional level, the ESS-indicator captures the region-specific crisis events such as the Russian bank funding crisis in October 2008 and the natural disaster in Japan in March 2011.

Figure 7 shows the evolution of the weighted[82] CDS spreads of the sample banks for each sample region. The peaks of the curves reflect the financial crisis events with global importance as well as the regional events. During the full observation period the European bank sample has the *lowest* average CDS spreads followed by the Asia-Pacific, American and MER samples. However, at the end of the observation period, the European banks have the second *highest* CDS spreads due to the euro zone sovereign debt crisis. Table 1 shows the average bank CDS spreads on the regional and country level during the four sub-periods. In period 4 the sample banks from Portugal, Ireland, Kazakhstan and Greece have the highest

[81] The elaborations in this section are (also literally) based on Lahmann (2012b).

[82] We use the banks' total liabilities weights in order to weight the CDS spreads. We find that the empirical results are also robust when *unweighted* bank CDS spreads are used.

CDS spreads whereas the banks from Singapore, Malaysia and Sweden have the lowest CDS spreads.

5.2.2 Sovereign risk vs. banking sector risk contagion[83]

In the analysis of inter- and intra-*regional* sovereign risk vs. systemic risk contagion we use the weighted[82] bank CDS spreads for the four regional samples America, Asia-Pacific, Europe and Middle East & Russia described in the previous section as a (proxy) measure of regional systemic risk.[84] The sovereign sector credit risk is measured by CDS spreads as these are superior measures of credit risk compared to bond and loan spreads.[85] Consistent with the bank CDS spreads, we use the spreads of the *5-year senior unsecured* sovereign CDS as this is the most liquid and most frequently studied CDS type.[86] We employ the sovereign CDS spreads from the same 28 countries covered in the bank sample and compute the weighted average of these CDS spreads for the four sample regions.[87] In terms of the notation of the elaborated VAR model we use the regional bank CDS spreads as $y_{1,t}$ and the regional sovereign CDS spreads as $y_{2,t}$ for all possible combinations of regional bank and sovereign CDS spreads. For the analysis of *country*-specific sovereign risk vs. banking sector risk we use the country-level weighted average bank CDS spread as $y_{1,t}$ and the corresponding sovereign CDS spread as $y_{2,t}$.

Table 10 shows the average sovereign CDS spreads of the countries covered in the analysis during the respective sub-periods. In period 4 Greece, Ireland and Portugal have the highest sovereign CDS spreads whereas Denmark, Singapore and Sweden are the countries with the lowest CDS spreads. Figure 8 shows the evolution of the sovereign CDS spreads per region over time. The countries in the MER sample exhibit the highest average sovereign CDS spreads during the observation period followed by the Asia-Pacific, European and American

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[83] The elaborations in this section are (also literally) based on Lahmann (2012a).

[84] This step is motivated by the finding in section 6.1 that the bank CDS spreads are a first-order approximation of the relative ESS-indicator.

[85] See section 4.1.2 for related references.

[86] Cf. Hull/Predescu/White (2004), pp. 2790-2792.

[87] We use the country's sample banks' liability weights to compute the weighted average in order to ensure consistency with the weighting of the bank CDS. We find that the empirical results are also robust when *unweighted* sovereign (or bank) CDS spreads are used.

sample. In period 4, the European countries have the second-highest average sovereign CDS spreads due to the euro zone sovereign debt crisis.

5.2.3 Banking sector risk vs. corporate sector risk contagion[88]

In the analysis of banking vs. non-bank corporate sector risk contagion we consider both the credit and equity side of the sample entities in the regions America, Asia-Pacific and Europe within an intra-regional analysis.[89] In order to analyze the contagion effects in *credit* markets we employ CDS spreads as these are superior measures of credit risk compared to bond and loan spreads.[85] Consistent with the bank CDS, we use the spreads of the *5-year senior unsecured* CDS of the non-bank corporate sample firms as this is the most liquid and most frequently studied CDS type.[86] For the analysis of banking vs. corporate sector contagion effects in *equity* markets we employ market equity prices. In terms of the notation employed in the elaborated VAR framework we use the corporate CDS spreads (equity returns) as $y_{1,t}$ and the weighted[90] bank CDS spreads (equity returns) of the same region as $y_{2,t}$.

The bank sample comprises the regional sub-samples America, Asia-Pacific and Europe described in the previous section.[89] Figure 11 shows the indexed regional bank equity prices used in the analysis which exhibit a high degree of comovement before and during the crisis . After the crisis, the recovery is strongest for the stocks of the Asia-Pacific banks whereas the American and particularly the European banks' equity prices are significantly below their pre-crisis levels. The stock prices of the banks in the Middle East & Russia sample exhibit the highest volatility of all regional samples and the decline during the crisis as well as the post-crisis increase is strongest for this sample.[91]

We select a*ll* non-bank corporate sample entities subject to available CDS and equity data in Thomson Reuters Datastream during the sample period. Each entity is unambiguously assigned to one of the three sample regions and one of nine industry clusters. Table 11 shows the composition of the non-bank corporate sample as well as the average daily CDS spreads

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[88] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2012).

[89] The region Middle East and Russia is not considered due to lack of available data for the non-bank corporate firms in this sample.

[90] We use the banks' total liabilities weights in order to weight the CDS spreads. We find that the empirical results are also robust when *unweighted* bank CDS spreads are used.

[91] The stock prices for the MER sample shown in the figure are not considered in this analysis and are included only for comparison and reference purposes.

per region and industry cluster.[92] Across all regions and industry clusters we cover 352 firms, of which 157 are from the (North) American continent, 68 from the Asia-Pacific region and 127 from Europe.[93] In the American sample the automotive firms have the highest average CDS spreads (424 bps) whereas the firms in the 'industrial' cluster have the lowest CDS spreads (63 bps) in period 4. In the Asia-Pacific sample the firms in the construction and logistics cluster have the highest average CDS spreads (183 bps) whereas the automotive firms have the lowest CDS spreads (73 bps) in period 4. The automotive firms in the European sample exhibit the highest CDS spreads (163 bps) whereas the firms in the chemicals, healthcare and pharma cluster have the lowest CDS spreads (60 bps) in period 4. These differences in industry- and region-specific firm CDS spread levels provide further reasoning for the separate analysis of industry and regional samples.

The upper panel of Figure 9 shows the evolution of the corporate CDS spreads per *industry* across all regions. It is striking that the automotive firms have by far the highest average CDS level. For the financial crisis period this reflects the severe impact of the financial crisis on this industry: The large peaks for the automotive cluster result mainly from the high CDS spreads of the US automotive firms (e.g., Ford Motors' average CDS spread in December 2008 amounted to a stunning 68 *percent*). The CDS of companies from the industry clusters basic materials and financial services (excl. banking) were also particularly affected by the financial crisis whereas the firms from the other industries show a high degree of comovement at comparatively low CDS levels. The lower panel of Figure 9 shows the evolution of the average corporate CDS spreads per *region* across all industries. It shows that the average corporate CDS spreads in the American sample are the highest followed by the Asian-Pacific and the European sample. At the end of the sample period, the firms in the European sample have the highest average CDS spread.

The upper panel of Figure 10 shows the indexed equity prices of the sample entities for each *industry* across all regions. The equity prices of firms from the automotive and basic materials industries show a high degree of independent movement relative to the other industries which have a high degree of comovement.[94] The stock prices of the financial services (excl.

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[92] The averages for the non-bank corporate sample (CDS spreads and equity returns) are computed as *unweighted* averages due to the differences in balance sheet structure across industries. We find that the empirical results are also robust when the values are weighted by total liabilities (similarly as for banks).

[93] A list of the sample entities is shown in Appendix B.

[94] The extreme hike in the automotive industry cluster on October 28th, 2008 is due to the speculation-induced share price increase of the Volkswagen stock (attempted takeover by Porsche Group).

banking) companies were hit most by the crisis and are the lowest at the end of the observation period whereas the basic materials companies' stocks show the highest relative post-crisis level. The lower panel of Figure 10 shows the evolution of the *regional* cross-industry indexed equity prices. Compared to their pre-crisis peaks, the stock prices of the Asian-Pacific and European companies show the *strongest* declines. By contrast, the stock prices of the American sample are lowest at the end of the sample period relative to the initial level. Table 12 shows the industry-specific equity returns for the sample regions during the four sub-periods. In period 4 the equity prices of the companies in the American sample increased strongest and on a cross-regional industry basis the Automotive companies' equity return was highest in this period.

6 EMPIRICAL RESULTS

6.1 EXPECTED SYSTEMIC SHORTFALL INDICATOR[95]

The ESS-methodology is applied separately to the global sample and the four regional sub-samples to obtain the expected systemic shortfall indicator which is then analyzed with respect to its input variable determinants (section 6.1.1).[96] As the ESS-indicator is a risk-neutral measure, we further analyze its risk premium determinants in section 6.1.2. The relative systemic risk contributions of individual countries and banks are elaborated in section 6.1.3. In each section of this chapter we describe the global sample as well as the four sub-samples and conduct a comparative analysis at the end of each section. As in the previous chapter, the elaboration is structured such that the reader can also focus on specific samples without loss of continuity.

6.1.1 The aggregate ESS-indicator

In this section we describe the results from applying the ESS-methodology as well as the input factor determinants of the ESS-indicator for each sample before comparing the sample-specific results. As outlined in section 4.1.3 the absolute ESS-indicator represents the probability of the portfolio losses exceeding the systemic loss threshold multiplied by the expected tail loss in case this systemic default event occurs. The *relative* ESS-indicator denotes the ratio of the absolute ESS-indicator to the total liabilities outstanding. In order to determine the end of the *international* financial crisis effects by means of the ESS-indicator for each sample we define the end of the financial crisis period as the time period when the relative ESS-indicator is below a third of its crisis peak for three consecutive months.[97]

6.1.1.1 Global sample

The evolution of the ESS-indicator of the global sample over time is shown in Figure 12. Before the first indication of the sub-prime and financial crisis became evident in July 2007

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[95] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2011a).

[96] The robustness of the results is confirmed by repeating the simulation using the Beta distribution suggested by Loeffler/Posch (2010) for the LGD instead of the triangular distribution.

[97] It should be noted that this definition is somewhat arbitrary but facilitates an approximate assessment of the crisis end which is defined as a period rather than a point in time.

the ESS-indicator was at a very low level, i.e., below 10 billion EUR (0.1 percent of total liabilities).[98] The indicator increased sharply to 59 billion EUR (0.2 percent) after the freezing of the BNP Paribas funds on August 16th, 2007. Thereafter the indicator rose steadily until it reached a first local maximum of 255 billion EUR (0.7 percent) on March 17th, 2008 after the arranged takeover of Bear Stearns by JP Morgan. Reflecting the crisis response of central banks and governments around the globe, the indicator decreased again to a local minimum of 86 billion EUR (0.3 percent) on May 2nd, 2008 when the central banks of the European Union, Switzerland and the United States jointly announced an expansion of liquidity-enhancing measures.[99]

On September 17th, 2008 – two days after the collapse of Lehman Brothers – the ESS-indicator jumps to a level of 413 billion EUR (1.1 percent). The sample period maximum is reached on September 29th, 2008 at a level of 446 billion EUR (1.2 percent) which reflects the market uncertainty and dislocation after the Lehman default. In the fourth quarter 2008 frail financial institutions around the globe were supported or rescued by unprecedented government measures: amongst others the US government introduced the troubled asset relief program (TARP), France approved a 360 billion EUR rescue package, the German government rescued Hypo Real Estate and Her Majesty's Treasury forced capital injections into major UK banking groups. Subsequent to these measures the ESS-indicator decreased to 223 billion EUR (0.6 percent) on average until February 2009.

The systemic risk in the global sample reaches another local maximum of 368 billion EUR (1.0 percent) on March 9th, 2009, three days after global stock markets hit their crisis lows. In the subsequent 12 months after the G20 summit in London on April 2nd, 2009 the indicator decreased to an average value of 128 billion EUR (0.4 percent) which is only slightly above the average during the 12 months before the Lehman default.

Along with the exacerbation of the euro zone sovereign debt crisis in May 2010, the absolute ESS-indicator of the global financial system reached its second highest value during the observation period on June 8th, 2010 at 379 billion EUR (1.0 percent). After the EU government interventions, the global ESS-indicator returned to an average level of 234 billion EUR (0.6 percent) in the third quarter 2010. In the fourth quarter 2010 the ESS-measure decreased further to 110 billion EUR (0.3 percent) on November 15th, 2010 before rising

[98] Relative ESS values are shown in brackets in the subsequent text.

[99] Cf. US Federal Reserve (2008).

again sharply to 238 billion EUR (0.6 percent) in response to market uncertainty regarding the solvency of additional euro member states (Ireland, Portugal, Spain).

By applying our definition for the end of the financial crisis, we come to the conclusion that the financial crisis effects in the global financial system abated in the fourth quarter 2009. However, at the end of the observation period, the global systemic risk remains significantly elevated (relative ESS of 0.4 percent compared to 0.01 percent at the beginning of the sample period) which reflects a high degree of remaining market uncertainty regarding the prospects of financial institutions around the world in the face of unsolved sovereign problems in the euro zone and an overarching re-assessment with respect to the risk associated with financial institutions debt amongst others.

The development of the factors constituting the ESS-indicator, the probability of systemic default (PSD) and the expected tail loss (ETL), of the global sample during the observation period are shown in Figure 13. The PSD reaches its peaks at the same points in time as the ESS-indicator whereas the ranking of the peaks differs slightly. The PSD increases from 0.1 percent at the beginning of the period to 6.1 percent in March 2009. At the end of the sample period, the PSD of the global sample amounts to *23 times* its initial average value. The ETL denotes the expected loss in case the systemic default event occurs and hence is an absolute measure. At the beginning of the sample period the ETL amounts to 3.4 trillion EUR and increases to 7.8 trillion EUR on September 22nd, 2008. From April 2009 to April 2010 the ETL averages 5.5 trillion EUR and increases markedly again in July 2010 to an average of 7.6 trillion EUR. The evolution of the ETL shows that the expected loss in case of a systemic default event increased significantly during the financial crisis and euro zone's sovereign debt crisis. At the end of the observation period it has about *twice* its initial value.

As a further step, we conduct regression analysis to identify the input factor determinants of the relative ESS-indicator as shown in Table 13. Not surprisingly, the average risk neutral default probability is the most relevant single variable explaining 89 percent of the total variation of the indicator. Average correlation alone does not explain sufficiently the variation in the ESS-indicator (R^2 of 0.23). However, when added as explanatory variable to the risk-neutral default probability, the correlation improves the explanatory power of the regression equation whereas the PD remains the dominant explanatory variable: a PD increase by one percentage point raises the relative ESS-indicator by 21 basis points, whereas the same increase in average correlations only leads to a two basis points increase. The dispersion in risk-neutral default probabilities has a negative coefficient which means that a larger

heterogeneity in the default probabilities of the sample banks leads ceteris paribus to a lower level of systemic risk. The regressions show that the default probabilities (or CDS spreads) could be used as a 'quick' approximation of the aggregate systemic risk measure.

6.1.1.2 American sub-sample

Figure 14 shows the evolution of the ESS-measure for the American sub-sample. The absolute ESS-indicator has an average value of 6 billion EUR (0.1 percent of total liabilities) until June 2007. From July 2007 it rises steadily until it reaches a local maximum of 32 billion EUR (0.5 percent) on August 16th, 2007 after the subprime-related freezing of BNP Paribas funds. From this local peak the ESS-indicator rises continuously with minor interruptions until it reaches another local maximum of 100 billion EUR (1.7 percent) on March 14th, 2008 amid market rumors about the financial difficulties of major US investment banks and just before the arranged takeover of Bear Stearns by JP Morgan. From April through June 2008 the ESS-indicator decreases to an average of 49 billion EUR (0.3 percent) with a local minimum of 37 billion EUR (0.6 percent) on May 2nd, 2008 as the Federal Reserve and other central banks announced the expansion of their measures aimed at enhancing market liquidity for certain asset types.[97]

Despite the coordinated actions by central banks and governments around the world, the ESS-indicator for the American sample increases steadily until it culminates on September 17th, 2008 at a level of 178 billion EUR (2.7 percent) two days after the collapse of Lehman Brothers and amid news about a potential bankruptcy of American International Group (AIG).[100] After a slight decrease, the indicator peaks again on October 10th, 2008 at a level of 163 billion EUR (2.4 percent) and on November 21st, 2008 at 155 billion EUR (2.3 percent) reflecting the market uncertainty and an increased risk aversion with respect to exposures to financial institutions. In the aftermath of these peaks, the ESS-indicator remains elevated and reaches its observation period maximum of 222 billion EUR (3.1 percent) on March 9th, 2009 just after the Dow Jones Industrial Average and the S&P 500 reach their crisis lows.

After another peak on March 31st, 2009 and the financial stability measures decided at the G20 summit in London on April 2nd, 2009, the ESS-indicator in the American sub-sample decreases to an average of 82 billion EUR (1.2 percent) in the period until April 2010 with the lowest post-crisis ESS value reached at 48 billion EUR (0.6 percent) on April 14th, 2010. The

[100] The AIG default was averted on the same evening by a liquidity facility from the Federal Reserve Bank of New York as the US government became AIG's largest shareholder.

increase of the ESS-indicator in May 2010 and the local maximum of 113 billion EUR (1.4 percent) reached on June 10th, 2010 are most likely to be explained by the euro zone sovereign debt problems, especially the market uncertainty with respect to the exposure of US banks to debt originating from euro zone crisis countries.[101]

According to our definition of the end of the financial crisis period, the curve of the ESS-indicator permits the conclusion that the financial crisis effects in the American sample subsided in the last quarter 2009. However, the elevated level of the ESS-indicator at the end of the observation period (relative ESS of 0.8 percent vs. 0.1 percent at the beginning) points to a persisting increased level of systemic risk, a reassessment with respect to the risk posed by debt issued by banks and potentially also an uncertainty regarding effects of the European sovereign debt crisis on US banks.

The development of the factors constituting the ESS-indicator, the probability of systemic default (PSD) and the expected tail loss (ETL), in the American financial system during the observation period are shown in Figure 15. The PSD reaches its peaks at the same points in time as the ESS-indicator whereas the ranking of the peaks differs slightly, especially in September 2008: while the ESS-indicator reaches its highest value on September 29th, 2008 the PSD observed after the Lehman default on September 17th, 2008 is higher than the PSD on September 29th, 2008. The PSD at the beginning of the period averages 0.6 percent which compares to an observation period maximum of 12 percent on March 9th, 2009. The PSD at the end of the sample period amounts to the *sixfold* of its initial value. The ETL of the American sub-sample averages around one trillion EUR until February 2007. Interestingly, the ETL increases already during March 2007 and reaches a value of 1.5 trillion EUR on April 11th, 2007 at a time when the PSD is only slightly elevated. At a level of 2.1 trillion EUR, the ETL reaches its maximum on July 2nd, 2010. At the end of the sample period, the ETL is about 60 percent higher than at the beginning.

In order to identify the input factor determinants of the relative ESS-indicator we conduct regression analysis as shown in Table 13. The average risk-neutral default probability is the most relevant single variable explaining 99 percent of the ESS-indicator's total variation for the American sub-sample. Average correlation alone does not explain sufficiently the variation in the ESS-indicator (R^2 of 0.17) and only has a negligible positive coefficient when included in the regression equation with the PD. The dispersion in risk-neutral default

[101] This presumption is analyzed in the banking sector risk contagion analysis in this thesis.

probabilities has a negative coefficient which means that a larger heterogeneity in the default probabilities of the sample banks leads ceteris paribus to a lower level of systemic risk. The regression results show that the default probabilities (or CDS spreads) could be used as a first order approximation of the systemic risk measure.

6.1.1.3 Asian-Pacific sub-sample

The development of the ESS-indicator in the Asian sub-sample over time is shown in Figure 16. The ESS-measure averages 2.8 billion EUR (0.1 percent of total liabilities) until June 2007. In July 2007 the indicator starts to rise which culminates in a peak of 6.1 billion EUR (0.2 percent) on August 21st, 2007 after BNP Paribas announces the closing of three funds due to subprime-related problems. In the time after this peak the ESS-indicator rises steadily with few interruptions and reaches a local maximum of 29.7 billion EUR (0.6 percent) on March 18th, 2008 after the government-mediated acquisition of Bear Stearns by JP Morgan. In the aftermath of the Bear Stearns takeover the indicator first declined and then increased as of July 2008 in spite of the international financial market support measures.

After the Lehman Brothers bankruptcy and government support measures for the banks in the Asia-Pacific region[102] the ESS-indicator has multiple peaks in October 2008 at levels of around 65 billion EUR (1.3 percent), culminating at a level of 69 billion EUR (1.4 percent) on October 29th, 2008. Until the end of the year 2008, the trajectory of the ESS-indicator is highly erratic and elevated with peaks at levels of around 67 billion EUR (1.3 percent). These elevated ESS levels in the fourth quarter 2008 reflect the global market uncertainty and risk aversion in the aftermath of the Lehman Brothers default but also the specific events in the Asia-Pacific region as major banks in the region announced large layoffs and regional economies slid into recession. The observation period maximum of the ESS-indicator in the Asia-Pacific sample is observed on March 10th, 2009 at a level of 75 billion EUR (1.5 percent) briefly after the Hang Seng as well as other Asian and global stock markets hit their financial crisis lows.

Subsequent to the announcement of comprehensive measures to stabilize the global financial system at the G20 summit on April 2nd, 2009 the ESS-indicator in Asia-Pacific decreases to an average of 24 billion EUR (0.4 percent) until early May 2010. On June 9th, 2010 the ESS-indicator increases strongly to a value of 47 billion EUR (0.7 percent) which is presumably in

[102] E.g., China cut its interest rate on September 15th, 2008 for the first time since 2002 and other APAC countries also provided liquidity support to their banks.

response to the European sovereign debt crisis and the market uncertainty regarding the exposure of Asian-Pacific banks to affected euro zone countries and their banks.[101] After returning again to 22 billion EUR (0.3 percent) in November 2010, the indicator increases again whereas it is unclear if this increase is also due to the European debt crisis events. The devastation and market uncertainty caused by the earthquake and tsunami hitting Japan on March 11th, 2011 is reflected in the ESS-indicator as of March 15th, 2011 when the indicator increased substantially by 23 percent to 46 billion EUR (1 percent) and climbed even further as the disaster of Japan's Fukushima nuclear plant evolved and the severe impact of the natural and nuclear catastrophes on Japan's economy became palpable.[103]

By interpreting the curve of the relative ESS-indicator using our definition of the financial crisis end we conclude that the financial crisis effects in the Asian-Pacific sub-sample subsided in the last quarter 2009. The elevated level of the ESS-measure at the end of the observation period (relative ESS of 0.7 vs. 0.1 percent at the beginning) represents a persisting increased level of systemic risk in the Asian-Pacific financial sector which is among other things explained by the imponderables resulting from the impact of the natural and nuclear disaster on Japan's economy and financial markets.

The gradient of the probability of systemic default (PSD) and the expected tail loss (ETL) in the Asian-Pacific sample during the observation period are shown in Figure 17. The PSD reaches its peaks at the same points in time as the ESS-indicator whereas the ranking of the peaks differs slightly, especially in October 2008 and April 2011. The PSD increases from an initial value of 0.4 percent to an observation period maximum of 8.4 percent on March 11th, 2009. The PSD at the end of the sample period equals more than *seven times* of its initial value. The ETL first increases after the Lehman Brothers default in September 2008 from 800 billion EUR to 1 trillion EUR. Afterwards, the ETL decreases slightly and remains relatively constant before increasing further in the fourth quarter 2010. It hikes to its sample period maximum above 1.2 trillion EUR in March 2011 after Japan's tsunami. At the end of the sample period, the ETL is about 60 percent higher than at the beginning.

We conduct regression analysis to identify the input factor determinants of the relative ESS-indicator as shown in Table 13. The average risk-neutral default probability is the most important single variable explaining 97 percent of the total variation of the indicator for the

[103] As Japan is the largest country in the Asian-Pacific sub-sample in terms of total liabilities, changes of its banks' CDS spreads and equity return correlations have a significant impact on the whole sub-sample.

American sub-sample. Average correlation alone does not explain sufficiently the variation in the ESS-indicator (R^2 of 0.12). When the correlation is included in the regression equation together with the PD, it only has a negligible positive coefficient. The dispersion in risk-neutral default probabilities has a negative coefficient which means that a larger heterogeneity in the default probabilities of the sample banks leads – other things being equal – to a reduced level of systemic risk. According to the regression results, the default probabilities (or CDS spreads) could be used as a first order approximation of the systemic risk measure.

6.1.1.4 European sub-sample

The evolution of the ESS-indicator of the European sample is shown in Figure 18. Before the first indication of the sub-prime and financial crisis became evident the ESS-indicator is at a very low level, i.e., below 10 billion EUR (0.1 percent of total liabilities). The indicator increased sharply to 57 billion EUR (0.3 percent) after the freezing of the BNP Paribas funds on August 16th, 2007. Thereafter the indicator rose steadily until it reached first a local maximum of 254 billion EUR (1.1 percent) on March 17th, 2008 following the arranged takeover of Bear Stearns by JP Morgan. Reflecting the crisis response of central banks and governments around the globe, the indicator decreased again to about 120 billion EUR (0.5 percent) in mid-July 2008.

Two weeks after the collapse of Lehman Brothers the indicator hikes to an observation period maximum of 343 billion EUR (1.4 percent) on September 29th, 2008. This sharp increase reflects the post-Lehman market anxiety and uncertainty, which led globally to increased risk aversion especially towards debt issued by banks. In the fourth quarter 2008 frail financial institutions in Europe were supported or rescued by unprecedented government measures: amongst others France approved a 360 billion EUR rescue package, the German government rescued Hypo Real Estate and Her Majesty's Treasury forced capital injections into major UK banking groups. After these measures the ESS-indicator decreased to 150 billion EUR (0.6 percent) on average until February 2009. It reached another local maximum of 261 billion EUR (1.2 percent) on March 12th, 2009, one week after the Eurostoxx 50 and other global stock markets hit rock bottom. In the subsequent 13 months after the G20 summit in London on April 2nd, 2009 the ESS-indicator in the European sample decreased to an average value of before the Lehman Brothers default.

The curve of the relative ESS-indicator shows that according to our definition the effects of the *international* financial crisis in the European financial system subsided in the fourth

quarter 2009. However, subsequent to the exacerbation of the euro zone sovereign debt crisis in general and the support measures for Greece in particular the European financial system experienced its *specific* financial crisis: the absolute ESS-indicator reached its second highest value in the observation period on June 8th, 2010 at 341 billion EUR and the relative ESS-measure even marginally exceeded the value reached on September 29th, 2008 (1.43 vs. 1.41 percent). After markets were reassured by euro zone government measures to stabilize frail member countries by means of the provisional European Financial Stabilization Mechanism (EFSM), the ESS-indicator returned to an average level of 200 billion EUR (0.8 percent) in the third quarter 2010. In the fourth quarter 2010 the ESS-measure decreased further to 121 billion EUR (0.5 percent) on November 15th, 2010 before rising again sharply to 264 billion EUR (1.1 percent) in response to market uncertainty regarding the solvency of additional euro member states (Ireland, Portugal, Spain) and the sufficiency of the provisional EFSM to stabilize additional needy euro zone countries.

As euro zone governments prepared the implementation of a permanent EFSM which was agreed upon by the euro zone finance ministers on March 21st, 2011, the ESS-measure declined again while remaining at a substantially elevated level towards the end of the observation period (relative ESS-indicator of 0.6 versus 0.03 percent at the beginning) which most likely embodies the sustained market uncertainty with respect to the stability of the euro currency and the solvency of certain euro zone countries.[101]

The development of the factors constituting the ESS-indicator, the probability of systemic default (PSD) and the expected tail loss (ETL), during the observation period are shown in Figure 19. The PSD reaches its peaks at the same points in time as the ESS-indicator whereas the ranking of the peaks differs slightly. While the absolute ESS-measure reaches its maximum in September 2008, the PSD in June 2010 is slightly higher than the PSD values observed in September 2008 and March 2009. Initially, the average PSD equals 0.2 percent and it reaches its observation period maximum at a level of 5.8 percent on May 7th, 2010. At the end of the observation period the PSD amounts to the *twentyfold* of its initial value. The ETL averages below 3 trillion EUR until July 2007 and increases to a peak of 6.3 trillion EUR on September 26th, 2008. . The curve of the ETL shows that the expected loss in case of a systemic default event increased significantly during the financial crisis period *and* the euro zone's sovereign debt crisis. At the end of the observation period the ETL is about 80 percent higher than initially.

As a further step, we analyze the input factor determinants of the relative ESS-indicator by means of regression analysis whose results are presented in Table 13. As expected, the average risk neutral default probability is the most relevant single variable explaining 92 percent of the total variation of the indicator. Average correlation alone does not explain sufficiently the variation in the ESS-indicator (R^2 of 0.29). When added as explanatory variable to the risk-neutral default probability, the correlation improves the explanatory power of the regression equation whereas the PD remains the dominant explanatory variable: a PD increase by one percentage point raises the relative ESS-indicator by 32 basis points, whereas the same increase in average correlations only leads to a one basis point increase. The coefficient of the dispersion in risk-neutral default probabilities is slightly negative which means that a larger heterogeneity in the default probabilities of the sample banks leads ceteris paribus to a lower level of systemic risk. The regressions show that the default probabilities (or CDS spreads) could be used as a first order approximation of the ESS-indicator.

6.1.1.5 Middle Eastern and Russian sub-sample

Figure 20 shows the evolution of the ESS-indicator for the Middle Eastern and Russian (MER) sample. From October 2005 until October 2007, the indicator averages below 1 billion EUR (0.5 percent of total liabilities). The indicator begins to rise in November 2007 and reaches a local maximum of 4.4 billion EUR (1.6 percent) on March 31st, 2008 – first two weeks after the arranged takeover of Bear Stearns by JP Morgan. In the period until June 2008 the ESS-indicator decreases again along with the calming of the global market sentiment at the time.

Thereafter, the indicator rises continuously and jumps to 9 billion EUR (2.6 percent) after the Lehman Brothers default on September 17th, 2008 before reaching an observation period maximum of 23.7 billion EUR (6.9 percent) on October 24th, 2008. The gradient of the ESS-indicator and the high average level of 15 billion EUR (4 percent) from September 2008 to March 2009 reflect both the global financial crisis events and – even more so – the specific events in Russia (the largest country in this this sub-sample): Trading on Russian exchanges was suspended repeatedly in September and October 2008 due to extraordinary declines of the main Russian stock indices, the Russian government saw itself forced to provide several emergency liquidity facilities to Russian banks; on October 23rd, 2008 Standard & Poor's (S&P) changed its rating outlook for Russia's sovereign rating from stable to negative (amid worries that the support measures for the banking sector could overburden the financial

capacity of the Russian government) and on December 8th, 2008 S&P downgraded Russia's currency rating.[104]

The MER ESS-indicator has a local maximum on March 9th, 2009 at 17 billion EUR (4.9 percent) after global stock markets reached their financial crisis lows. Following the announcement of comprehensive financial stability measures at the G20 summit on April 2nd, 2009 the ESS-indicator decreases to an average value of 8 billion EUR (2.4 percent) until early September 2009 and reaches a local minimum of 4.5 billion EUR (1.3 percent) on October 16th, 2009. At the end of November 2009, the indicator rises again as a result of the debt problems of the Emirate Dubai which also increases the risk premiums for debt of entities from other Middle Eastern countries. Following a decline until April 2010, the ESS-indicator rises again in May 2010 (likely in response to the euro zone sovereign debt crisis) and remains heightened (5 billion EUR, 1.2 percent) at the end of the observation period.

By applying our definition of the crisis end to the relative ESS curve of the MER sample we conclude that the financial crisis effects in this region abated in the fourth quarter 2009. The elevated level of the ESS-measure at the end of the observation period (relative ESS of 1.2 percent vs. 0.5 percent at the beginning) points to a slightly increased level of systemic risk in the MER banking sector.

The gradient of the probability of systemic default (PSD) and the expected tail loss (ETL) in the MER financial system during the observation period are shown in Figure 21. The PSD reaches its peaks at the same points in time as the ESS-indicator and also the rankings of the peak heights are largely consistent. At the beginning of the sample period the PSD amounts to 2.3 percent and increases tenfold to a dramatic 23 percent at the peak of the crisis in October 2008. The PSD at the end of the sample period equals about three times its initial value. The ETL increases from its initial value of 40 billion EUR with minor interruptions until it reaches a peak of 102 billion EUR in October 2010. At the end of the sample period, the ETL is about twice as high as at the beginning.

We conduct regression analysis to identify the input factor determinants of the relative ESS-indicator in the MER sample as shown in Table 13. The risk-neutral default probability is the most important single variable and explains 97 percent of the total variation of the relative ESS-indicator. Average correlation alone does not explain sufficiently the variation in the MER ESS-indicator. When correlation is included in the regression equation together with the

[104] Cf. Fidrmuc/Suess (2009) for a detailed elaboration of the financial crisis impacts on Russia.

PD, it slightly increases the explanatory power of the regression equation and the correlation has a marginally positive coefficient. The dispersion in risk-neutral default probabilities has a coefficient of -0.2 which means that a larger heterogeneity in the default probabilities of the sample banks leads ceteris paribus to a reduced level of systemic risk. According to the regression results, the default probabilities (or CDS spreads) could be used as a first order approximation of the systemic risk measure.

6.1.1.6 Comparative analysis

In the following we conduct the comparative analysis between the above ESS results for the individual samples.

Level and evolution of the ESS-indicator

Figure 22 shows the development of the absolute and relative ESS-indicator for all samples over time. The ranking of the *average* absolute ESS-indicator reflects as expected the ranking of the total liabilities of the respective samples. What is more remarkable is that the level of the absolute ESS-indicator of the European sub-sample *for certain time periods* is equal to or slightly greater than the absolute ESS-indicator of the global sample (e.g., March till July 2008 and November 2010 till March 2011). This can be explained by the different levels of correlations and risk-neutral default probabilities as shown in Figure 6: During the whole sample period, the average correlations of the European sub-sample are significantly higher than the correlations of the global sample (50 vs. 29 percent) which also leads to a higher correlation of the samples drawn in the ESS simulation and consequently to more correlated outcomes (particularly in times of elevated default probabilities). This effect is even increased when the average risk-neutral PDs of the European sub-sample are higher than the average PDs of the global sample which is the case for the last nine months of the observation period as the analysis in section 5.1.6 has shown. This impact of the correlations shows that the ESS-methodology adequately captures the ‘benefits of diversification’ resulting from a more heterogeneous ‘sample bank portfolio’ and that a more heterogeneous financial system is favorable versus a more homogeneous financial system with respect to the resulting level of systemic risk.

In order to ensure comparability, we use the results of the relative ESS-indicator to describe the differences in the evolution of the systemic risk in the samples over time. The MER sample has the highest *average* relative ESS level (1.4 percent), followed by the American sample (0.8 percent), the European sample (0.4 percent), the Asian-Pacific sample (0.35

percent) and the global sample (0.3 percent). This ranking applies also to the relative ESS levels of the samples at the end of the observation period. A closer examination of the default probabilities shows, however, that this ranking can only partly be explained on grounds of the PDs: While the MER as well as the American sub-samples have the highest average PDs, the default probability of the European sample is lower than the PDs of the global and Asia-Pacific sample which again reflects the impact of correlations on the ESS-indicator.

The evolution of the relative ESS for the MER sample appears somewhat decoupled from the other samples' ESS-indicator until March 2008. As of September 2008 the gradient of the curve shows the Russia-specific effects of the financial crisis on the systemic risk in the MER sample. A closer look at the data underlying Figure 22 shows that the global financial crisis effects are first observed in the American sample which provides a tentative confirmation for the observation that the global financial crisis spread out from the US financial system. [105] The relative ESS-indicator of the Asia-Pacific sample exhibits a high degree of comovement with the European and global samples apart from a few outliers which are observed mainly in the fourth quarter 2008.

While a casual look at Figure 22 may suggest that the Middle Eastern and Russian as well as the American financial systems were most affected by the financial crisis, Figure 24 (which shows the relative change of the ESS-indicator with respect to its initial three months average for all samples) contradicts this conclusion. It shows that - relative to the sample period average - the European and global financial systems were affected most by the financial crisis: *at the peak of the crisis* the relative ESS-indicator of the global (European) sample equals 85 times (46 times) its initial value which compares to a multiple of 24 for the American, 17 for the Asian-Pacific and only 13 for the MER sub-sample (the averages of the relative change *over time* have the same ranking). The 'repricing of systemic financial sector risk' was particularly strong for the global sample because the ESS-indicator for this sample was particularly low at the beginning of the sample (among other things due to very low correlations) so that the relative impact of the subsequent financial crisis (on correlations and PDs) was all the more pronounced.

We observe that the financial crisis effects subside in all samples in the fourth quarter 2009 according to our definition of the crisis end. It is noteworthy that the relative ESS-indicator has returned to lower levels (albeit not pre-crisis levels) at the end of the observation period

[105] This presumption is analyzed in the banking sector risk contagion analysis in this thesis.

only for the American, Asian-Pacific and MER samples (2-8 times initial average) whereas it is still strongly elevated for the European sub-sample and the global sample (about twentyfold of initial average).[106] The strong relative increase and the sustained elevated level of systemic risk in the European and global financial system may suggest that the systemic risk in these financial systems was particularly 'underpriced' before the financial crisis. This conclusion is not meant to overshadow the fact that the systemic risk in the MER and the American financial systems (measured in terms of the relative ESS-indicator) is still the *most elevated* of all samples at the end of the sample period.

Level and evolution of the probability of systemic default and the expected tail loss

Figure 23 shows the evolution of the components of the ESS-indicator, the probability of systemic default (PSD) and the expected tail loss (ETL) for all samples over time. The ranking of the PSD values (average and end of period) of the samples is consistent with the ranking of the relative ESS-indicator, i.e., the PSD of the MER and the American samples are highest (average value of 5.9 and 3.4 percent), followed by the European (2.1 percent), Asia-Pacific (2.2 percent) and global sample (1.7 percent). The upper panel of Figure 25 shows that the relative change of the PSD is the main driver of the strong relative change of the ESS-indicator over time. At the end of the sample period, the PSDs of the European and the global samples amount to the *twentyfold* of their initial value whereas the relative increase of the other samples is below the factor *eight*.

The development of the ETL is shown for all samples in the lower panel of Figure 23. As the absolute values are strongly determined by the sample's total liabilities it is more insightful to consider the relative changes of the ETL in the lower panel of Figure 25. At a multiple of 2.3 with respect to its initial average value, the MER sub-sample shows the highest increase at the end of the sample period whereas the expected tail loss of the other samples are at about 1.5 to 1.7 times of their initial average value. This sustained elevated level of the ETL shows that the expected loss in case of a systemic default event increased significantly during the sample period. In conjunction with the elevated level of the PSD this finding also explains the persistent increased level of the ESS-indicator.

[106] The elevated level in the global sample is of course driven by the increased level in the European sample.

Input factor determinants

A comparison of the regression results in Table 13 shows that the average risk-neutral default probability is the single variable with the highest 'positive' impact on the relative ESS-indicator for all samples, i.e., the higher the average PD, the higher the systemic risk measure. Another feature of all sample regressions is that the dispersion in default probabilities has a significant *negative* coefficient which means that the higher the heterogeneity of the sample banks' risk-neutral PDs (or their CDS spreads), the lower is the relative ESS-indicator. Average correlation alone does not have sufficient explanatory power for the relative ESS-indicator whereas when it is included in the regression equation together with other variables it has a significant positive coefficient which suggests that a higher correlation leads ceteris paribus to a higher level of systemic risk.

6.1.2 Risk premium determinants of the ESS-indicator

As described in section 4.1 the default probabilities computed from CDS spreads are *risk-neutral*, i.e., they contain not only the expectation about the *actual* probability of default but also risk premium components such as the default risk premium and the liquidity risk premium. Since the ESS-indicator is computed using these risk-neutral default probabilities, it is by construction also a risk-neutral measure of systemic financial sector risk. Therefore, it is worthwhile to further analyze the individual risk premium determinants of the ESS-indicator.

As the default risk premiums on credit markets are not directly observable, adequate proxy measures need to be employed in this analysis. We use Moody's seasoned Baa-Aaa bond index spread and the TED spread as proxies for the credit default risk premium. Moody's Baa-Aaa bond spread is the difference between the average yields of Moody's seasoned Baa and Aaa corporate bond indices. The TED spread is the difference between the 3-month LIBOR rate and the yield of a 3-month US Treasury Bill. While both spreads are a market-based measure of the risk premiums for differences in credit quality, Moody's Baa-Aaa bond spread measures the credit spread differences between corporate bond ratings of higher and lower quality[107], whereas the TED spread measures the differences in credit quality between debt issued by major financial institutions and the – by assumption – riskless US Treasury

[107]Cf. Chen/Collin-Dufresne/Goldstein (2009), p. 3367-3368.

Bills.[108] In the following we refer, therefore, to the Baa-Aaa spread also as 'corporate default risk premium' and to the TED spread also as 'bank default risk premium'.[109]

In order to proxy the liquidity risk premium component we use the term spread which we define as the difference between the market yields of the 10-year and the 3-month US Treasury Bills. The term spread provides a market assessment for the compensation, which market participants require for holding a long-maturity versus a short-maturity asset with the same underlying characteristics. For the expected *actual* default rates, Moody's Expected Default Frequencies (EDF) or physical default probabilities from company ratings would be adequate proxy measures. However, as these measures are proprietary products which were unavailable for the present research, a measure for the expected actual default rates cannot be included in our analysis.

We perform regression analysis separately for each sample using the relative ESS-indicator as dependent variable and the Baa-Aaa spread, the TED spread and the term spread both individually and together as independent variables (Table 14). In order to further analyze the time-varying impact of the three spreads on the ESS-indicator we insert the actual values of the spreads into the estimated regression equation comprising all variables and obtain a specific area diagram for each sample (Figure 26).

In the following sections we elaborate the analysis results for each sample separately and conduct a comparative analysis among all sample-specific results in the last section.

6.1.2.1 Global sample

The regression results for the global sample in Table 14 show that the corporate default risk premium has a significant positive coefficient of 27 basis points and it explains 46 percent of the variation in the relative ESS-indicator. By contrast, the bank default risk premium alone does not have sufficient explanatory power (R^2=0.19) whereas its coefficient is also positive. The liquidity risk premium is the risk premium component with the highest explanatory power of the spreads in the regression analysis and shows as expected a positive coefficient. By including all risk premium components in the regression equation, the explanatory power is significantly increased (adjusted R^2 of 0.72) and the corporate default risk and the liquidity risk premiums turn out to be the risk premium components with the highest impact on the

[108] The TED spread is also used as a measure for the availability of bank wholesale funding.

[109] These notions are somewhat stereotypical because the Baa-Aaa spread also includes debt issued by financial institutions (amongst others).

relative ESS-indicator (coefficient of 0.16 and 0.10, respectively) whereas the bank default risk premium also has a significant positive coefficient of two basis points.

The global sample chart of Figure 26 shows the time-varying impact of the risk premium determinants on the relative ESS-indicator for the global sample. Until July 2007 the Baa-Aaa spread is the component with the highest impact on the relative ESS-measure and the other spreads are of minor importance. From August 2007 until April 2009, the impact of the other risk premium components increases whereas the corporate default risk premium remains the variable with the strongest influence. Interestingly, the bank default risk component has a significant impact on the relative ESS-indicator only during the 'core' financial crisis period, i.e., from August 2007 until April 2009. From May 2009 until the end of the observation period, the liquidity risk premium has the dominant impact on the relative ESS-indicator whereas the importance of the corporate default risk premium decreases to its pre-crisis level. The time-varying impact of the corporate default and liquidity risk premium components shows a relative increase of the liquidity risk aversion and a relative decrease in the default risk aversion among market participants during the financial crisis which persists at the end of the observation period.

6.1.2.2 American sub-sample

The risk premium determinants regression results for the American sample are shown in Table 14. The corporate default risk premium alone has the highest coefficient (0.76) and the highest explanatory power (R^2=0.62) of all *individual* risk premium components. The liquidity risk premium has the second highest coefficient (0.32) and explanatory power (R^2=0.65) of the single variables whereas the bank default risk premium alone has no sufficient explanatory power (R^2=0.18) although its coefficient is still significantly positive. Regression 4 shows the results obtained by including all risk premium components in the regression equation: The corporate default risk and the liquidity risk premium influence the relative ESS-indicator most strongly (coefficient of 0.54 and 0.22, respectively) whereas the bank default risk premium coefficient is only marginally positive (0.02).

The area diagram for the American sample in Figure 26 shows that in the period until August 2007, the impact of the bank default risk and liquidity risk premium is negligible while the corporate default risk premium exerts the strongest influence on the relative ESS-indicator. The impact of the liquidity risk premium increases as of October 2007 and exceeds even the impact of the corporate default risk premium at the end of the sample period. The impact of

the bank default risk premium is only discernible in the time period between August 2007 and March 2009. The increase of the liquidity risk premium's impact relative to the corporate default risk premium's impact during the financial crisis (which is sustained at the end of the observation period) reflects a change in risk aversion by market participants during the financial crisis.

6.1.2.3 Asian-Pacific sub-sample

The regression results for the Asian-Pacific sample in Table 14 show that the corporate default risk premium has a significant positive coefficient of 0.41 and it explains alone 71 percent of the variation in the relative ESS-indicator. By contrast, the bank default risk premium alone does not have sufficient explanatory power (R^2=0.17) whereas its coefficient is also significantly positive (0.09). The liquidity risk premium alone has a coefficient of 0.15 and explains 45 percent of the variation of the relative ESS-indicator. By including all risk premium components in the regression equation, the explanatory power is significantly increased (adjusted R^2 of 0.84) and the corporate default risk and the liquidity risk premiums are the only risk premium components which impact the relative ESS-indicator (coefficient of 0.33 and 0.09, respectively) while the coefficient of the bank default risk premium is not significantly different from zero.

The Asian-Pacific sample chart of Figure 26 shows the time-varying impact of the risk premium determinants on the relative ESS-indicator. Until July 2007 the Baa-Aaa spread is the component with the highest impact on the relative ESS-measure and additionally only the liquidity risk premium has some impact. From August 2007 until April 2009, the impact of the liquidity risk premium component increases whereas the corporate default risk premium remains the variable with the strongest influence. Interestingly, the bank default risk premium has a significant impact on the relative ESS-indicator only during the 'core' financial crisis period. From May 2009 until the end of the observation period, the impact of the liquidity risk premium increases while the corporate default risk premium decreases so that both premium components have roughly the same impact at the end of the observation period. The bank default risk premium has no discernible impact in the Asian-Pacific sample. The time-varying impact of the corporate default and liquidity risk premium components shows a relative increase of the market's liquidity risk aversion and a decrease in the default risk aversion between the beginning and the end of the financial crisis which persists at the end of the observation period.

6.1.2.4 European sub-sample

The risk premium determinants regression results for the European sample are shown in Table 14. In the single-variable regressions, the liquidity risk premium has the highest explanatory power (R^2=0.55) and a regression coefficient of 0.19. The corporate default risk premium has the highest coefficient (0.26) and an explanatory power of 26 percent whereas the bank default risk premium alone has no sufficient explanatory power (R^2=0.11) while its coefficient is positive (0.08). Regression 4 shows the results from including all risk premium components in the regression equation: The liquidity risk premium and the corporate default risk premium influence the relative ESS-indicator most strongly (coefficient of 0.16 and 0.09, respectively) whereas the bank default risk premium coefficient is at 0.02 only slightly positive.

The area diagram for the European sample in Figure 26 shows the time-varying impact of the risk premium components during the observation period: While the corporate default risk premium has the largest average impact on the relative ESS-indicator until July 2007, the impact of the liquidity risk premium increased considerably since August 2007 and exceeds the impact of the default risk components as of April 2008. Notably, the bank default risk premium is only significant during the financial crisis period. The increase of the liquidity risk premium's impact relative to the corporate default risk premium's effect during the financial crisis period reflects a change in risk aversion by market participants.

6.1.2.5 Middle Eastern and Russian sub-sample

The regression results for the MER sample in Table 14 show that the corporate default risk premium has a strongly positive coefficient of 1.67 and it explains alone 83 percent of the variation in the relative ESS-indicator. By contrast, the bank default risk premium alone does not have sufficient explanatory power (R^2=0.15) whereas its coefficient is also significantly positive. The liquidity risk premium alone has a coefficient of 0.50 and explains 37 percent of the variation in the relative ESS-indicator. By including all risk premium components in the regression equation, the explanatory power is significantly increased (adjusted R^2 of 0.90) and the corporate default risk and the liquidity risk premiums turn out to be the only risk premium components which positively impact the relative ESS-indicator (coefficient of 1.49 and 0.24, respectively). The bank default risk premium's coefficient is marginally negative at -0.04.

Figure 26 shows the time-varying impact of the risk premium determinants on the relative ESS-indicator for the MER sample. Until August 2007 only the corporate default risk premium significantly impacts the relative ESS-indicator. From September 2007 until the end

of the observation period the impact of the liquidity risk premium increases. The area diagram shows that the bank default risk premium has no discernible impact on the ESS-indicator. While the corporate default risk premium still has the largest impact during the last months of the sample period, it can be noted that the liquidity risk premium increased substantially over time. This time-varying impact of the risk premium components shows a relative increase of the liquidity risk aversion and a relative decrease of the default risk aversion among market participants during the observation period.

6.1.2.6 Comparative analysis

In the following we compare the risk premium analysis results of the individual samples. Due to the different levels of the relative ESS-indicator across the samples we will focus the comparison on the *ranking* of the respective risk premium proxy coefficients and the comparison of the risk premium impact over time as shown in Figure 26.[110]

A comparison of the regional results in Table 14 shows that the corporate default risk premium is the risk premium component which has the highest explanatory power for the relative ESS-indicator and the largest average regression coefficient across all samples except for the European relative ESS-indicator which is best explained by the liquidity risk premium. The liquidity risk premium ranks second in terms of explanatory power and average regression coefficient across all samples. By contrast, the regression results for the bank default risk premium show that this variable alone has no sufficient explanatory power for the relative ESS-indicator and in combination with the other risk premium components, the resulting coefficients are only marginally positive (if at all).

The area diagrams in Figure 26 emphasize the dominant impact of the corporate default risk premium over time for all samples with the exception of the European sample for which the liquidity risk premium is more dominant. A pattern which is observable in all area charts is the increased importance and level of the liquidity risk premium since the beginning of the financial crisis and the relative decrease of the corporate default risk from the peak of the financial crisis until the end of the observation period. This observation is tantamount to an increase of the liquidity risk aversion and a decrease of the credit risk aversion among market participants. While further research is required to explain this effect in more detail, this development may be due to two common observations from the financial crisis: firstly, during

[110] By contrast, a comparison of the level values of the coefficients will not be conducted due to the significant differences between the samples' coefficients.

the financial crisis market participants were most concerned with credit defaults which in fact did not occur as strongly as suggested by the increase in CDS spreads;[111] secondly, the financial crisis exposed the importance of asset liquidity in a drastic fashion as markets for certain assets dried up in a matter of days which increased the demand for liquid assets and is reflected in the sustained elevated level of the liquidity risk premium.[112]

6.1.3 Relative contribution to the ESS-indicator

While the ESS-indicator measures the *aggregate* systemic risk prevailing in the respective banking sector, the understanding of the relative contributions of countries and individual institutions to this aggregate financial sector risk is also highly relevant not least from a regulatory point of view. As described in section 4.1.3 we compute the contribution of individual banking groups to the ESS-indicator by determining the share of the total portfolio loss by individual banking groups when the portfolio loss exceeds the systemic loss threshold. By aggregating the bank-specific systemic loss contributions on a country level we obtain the measure for a country's systemic risk contribution over time. In order to understand the drivers for the relative systemic risk contribution by banks we conduct regression analysis using bank-specific parameters (e.g., risk-neutral default probability, correlation, liability weight and interaction terms) as explanatory variables. In the following we describe the results for each sample individually and conduct a comparative analysis in the last section.

6.1.3.1 Global sample

Table 15 shows the relative systemic loss contributions on a *country* level for the global sample. The results show that the systemic risk contributions are time-variant whereas the ranking is relatively stable over time. The countries with the highest average systemic loss contributions during the sample period are France, the United States and the United Kingdom (in ascending order of the systemic loss share). In period 4 France even has a higher systemic loss contribution than the United States. By considering Table 1 and Table 3 it becomes evident that these results are consistent with the CDS spreads, correlations and liabilities of these countries: while the US banks have the highest total liabilities and their average CDS spreads are slightly above those of their UK counterparts, their average equity return

[111] Cf. Huang/Zhou/Zhu (2010a), pp. 18-19.
[112] Cf. Taylor (2009), p. 18; Moessner/Allen (2011), pp. 2-3.

correlations are significantly lower than the correlations of the British and French banks. Kazakhstan, Malaysia, Singapore, Bahrain, Qatar and the UAE have a relative systemic loss contribution of below 0.3 percent which is in fact negligible.

A few notable observations can be made by considering the changes in the systemic loss contributions between period 3 and period 4. Among the countries with total liabilities above two trillion EUR, Germany, Switzerland and the US have reduced their systemic loss contributions whereas France and the UK increased theirs. The countries whose systemic loss contribution increased by at least 40 percent from period 3 to period 4 are China, Greece, Portugal and Spain. While in China's case this is due to an increase of total liabilities and correlations, the increase for the European countries can be explained by the severe increase in CDS spreads due to the euro sovereign debt crisis (e.g., the share of Greece increased fivefold, albeit on a low level). The fact that the systemic risk contribution of Ireland has not increased from period 3 to period 4 despite the increase of its CDS spreads can be explained by a decrease in Ireland's total liabilities and its correlations in this period. Korea, Malaysia and Singapore are the countries which decreased their systemic risk contributions most from period 3 to period 4 (relative decrease by 60-65 percent).

The relative systemic loss contributions for the individual *banks* in the global sample are shown in Table 16 which shows that the above general conclusions for the country level also apply on the bank level. The banks with the highest relative systemic risk contribution in period 4 are Barclay's, Deutsche Bank, Royal Bank of Scotland, Lloyds Banking Group and BNP Paribas. It should be noted that the strong increase in the systemic risk contribution of Bank of America in period 3 is due to its takeover of Merrill Lynch and the increase in the systemic risk share of Lloyds Banking Group in period 4 is due to its acquisition of HBOS. The actuality that no US banks are among the top five can be explained on grounds of the relatively low correlations of the US banks vis-à-vis their European counterparts.

The banks with the strongest increase in systemic loss contributions from period 3 to period 4 are the banks from euro zone countries with sovereign debt issues. All banking groups with total liabilities exceeding one trillion EUR have decreased their relative contribution from period 3 to period 4 with the notable exceptions of the French banks BNP Paribas, Crédit Agricole and Societé Generale. By defining systemic loss contribution thresholds of

one/three/five percent one can conclude that 23/12/6 banking groups in the global sample exceed this threshold in period 4.[113]

Table 24 shows the regression results for the determinants of the relative systemic risk contribution in the global sample. The liability weight turns out to be the single variable with the highest impact on a bank's systemic risk contribution. In regressions 2, 3 and 4 the estimated coefficient for the liability weight is even above one, which means that a one percentage-point increase of a bank's liability weight leads to a disproportionate increase in its relative contribution to the systemic risk. This finding corroborates the common concern that a bank's size is the main driver for the risk it poses to the financial system ('too big to fail'). Regression 4 exposes that correlations also have a 'positive' impact on banks' systemic risk contribution which confirms the previous descriptions. Regression 1 shows that the bank-specific risk-neutral default probability alone has no sufficient explanatory power for the relative systemic risk contributions. Regressions 5 and 6 expose, however, that the interaction between liability weight and risk-neutral PD has a significant positive coefficient as does the interaction between the average correlation and the liability weight.[114]

6.1.3.2 American sub-sample

Table 17 shows the relative systemic loss contributions for the bank holding companies in the American sample. The results show that the systemic risk contributions vary over time whereas the ranking is largely constant. The banks with the highest ESS-contribution in period 4 *and* during the whole sample period are JP Morgan, Bank of America and Citigroup (in ascending order of their systemic loss share). It should be noted that the strong increase in the systemic risk contribution of Bank of America in period 3 is due to its acquisition of Merrill Lynch. The banks which increased their systemic loss share most from period 3 to period 4 are Bank of America, JP Morgan and Wells Fargo (multiple of 1.1–1.3) whereas American Express, Goldman Sachs and PNC Financial Services significantly decreased their systemic risk contribution (factor of 0.6–0.8). By defining systemic loss contribution thresholds of five (ten) percent we conclude that seven (three) banking groups in the American sample exceed this threshold in period 4.

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[113] This result will be revisited in the next section concerning the policy implications of the empirical results.

[114] The conclusions from regression 6 need to be interpreted with some caution, however, as the variance inflation factors indicate the presence of multicollinearity.

Table 25 shows the regression results for the determinants of the relative systemic risk contribution in the American sample. The liability weight is the single variable with the highest impact on a bank's systemic risk contribution. The estimated coefficient for the liability weight is even above one in regressions 2 to 6, which means that a one percentage-point increase of a bank's liability weight causes a disproportionate increase in its relative contribution to systemic risk. This conclusion confirms common opinion that a bank's size strongly determines the risk it poses to the financial system. Regression 6 exposes that correlations also have a 'positive' impact on banks' systemic risk contribution whilst the negative coefficient for the correlation in regression 4 is likely caused by an omitted variable bias. The bank-specific risk-neutral default probability alone has no sufficient explanatory power for the relative systemic risk contributions which is shown by regression 1. However, regressions 5 and 6 expose that the interaction between liability weight and risk-neutral PD has a significant positive coefficient.

6.1.3.3 Asian-Pacific sub-sample

Table 18 shows the relative systemic loss contributions on a *country* level for the Asian-Pacific sample. The results show that the systemic risk contributions are time-variant whereas the ranking is relatively constant over time. The countries with the highest average systemic loss contributions during the observation period are China, Australia and Japan (in ascending order of the systemic risk contribution). In period 4 China ranks even ahead of Australia which is due to a strong relative increase of its total liabilities in this period. The countries with the lowest systemic risk contribution are Kazakhstan, Malaysia and Hong Kong.

Interestingly, China and Australia are also the countries which increased their systemic risk contribution most from period 3 to period 4 which is driven by the growth of the total bank liabilities of these two countries (multiple of 1.4 and 1.3, respectively). By contrast, the relative systemic loss contribution of Hong Kong, Korea and Singapore halved from period 3 to period 4. Overall, these changes increased the combined systemic loss share of Australia, China and Japan from 80 percent in period 3 to 90 percent in period 4.

The relative systemic loss contributions for the *banks* in the Asian-Pacific sample are shown in Table 19. In period 4 the banks with the highest systemic risk contribution are the Commonwealth Bank, Westpac Banking Corp, Sumitomo Mitsui Banking, Bank of China and Mizuho Financial Group. ANZ Banking Group, Westpac Banking Corp and Bank of China increased their systemic loss contribution most from period 3 to period 4 (multiple of 1.4-1.5)

whereas India's ICICI Bank, Halyk Bank of Kazakhstan and Korea's Shinhan Group decreased their systemic risk contribution most (relative decrease of 60 percent). By defining systemic loss contribution thresholds of five (ten) percent the results show that six (three) banking groups in the Asian-Pacific sub-sample exceed this threshold in period 4.

Table 26 shows the regression results for the determinants of the relative systemic risk contribution in the Asian-Pacific sample. The liability weight turns out to be the single variable with the highest impact on a bank's systemic risk contribution. In all regressions where the liability weight is included, its estimated coefficient is even above one, which means that an increase of a bank's liability weight leads to a disproportionate increase in its systemic risk contribution. This finding confirms the common proposition that a bank's size is the main driver for the risk it poses. Regression 1 shows that the bank-specific risk-neutral default probability alone has no sufficient explanatory power for the relative systemic risk contributions whereas in conjunction with the liability weight and the average correlation it has a significant positive coefficient as does the correlation. The coefficients of the interaction terms in regressions 5 and 6 need to be interpreted with some caution as the variance inflation factors indicate the presence of multicollinearity.

6.1.3.4 European sub-sample

The relative systemic loss contributions by *country* for the European sample are shown in Table 20. The systemic risk contributions vary over time, the ranking is rather constant. Switzerland, Germany, France and the UK are the countries with the highest average systemic loss contribution during the observation period (in ascending order of systemic risk contribution). However, in period 4 Germany, Spain, France and the UK have the highest systemic risk contributions with a combined total of 74 percent. The Netherlands, Denmark and Greece have the lowest systemic loss contribution.

The countries which increased their relative systemic loss share most from period 3 to period 4 are Spain, Portugal and Greece due to their sovereign debt issues (multiplier of 1.4 to 3.5). One may wonder why Ireland's share even decreased slightly in period 4 despite the increase of its average CDS spreads: this can be explained by the reduction of its total liabilities[115] and the decrease in Ireland's correlations which may be due to the fact that the Irish government acquired major stakes in its banks during the financial crisis which 'decoupled' the Irish

[115] The reduction in total liabilities is also caused by a deleveraging of the Irish sample banks.

banks' stock prices somewhat from equity prices of other European banks. Denmark, Sweden and Switzerland are the countries which decreased their systemic risk contributions most from period 3 to period 4.

Table 21 shows the systemic risk contributions of the *banks* in the European sample. Crédit Agricole, Royal Bank of Scotland, BNP Paribas and Lloyds Banking Group are the banks with the highest systemic risk contributions in period 4. From period 3 to period 4 the banks which increased their systemic risk contributions most are the Greek and Portuguese banks. The strong increase in systemic risk contribution of Lloyds Banking Group in period 4 is due to its takeover of HBOS. The banks which decreased their systemic risk contributions most from period 3 to period 4 are Germany's IKB, Denmark's Danske Bank and Switzerland's UBS. By applying systemic loss contribution thresholds of one (five) percent the results show that 18 (9) banking groups in the European sub-sample exceed this threshold in period 4.

The regression results for the determinants of the relative systemic risk contribution in the European sample are shown in Table 27. The liability weight is the single variable with the highest impact on a bank's systemic risk contribution. In regressions 3 and 4 the estimated coefficient for the liability weight is even above one, which means that an increase of a bank's liability weight leads to a disproportionate increase in its systemic risk contribution. This finding confirms the common claim that a bank's size is the main driver for the risk it poses to the financial system. Regression 1 shows that the bank-specific risk-neutral default probability alone has no sufficient explanatory power for the relative systemic risk contributions whereas in conjunction with the liability weight and the average correlation it has a significant positive coefficient as does the correlation. The interaction terms of default probability, correlation and liability weight also have as expected significant positive coefficients in regressions 5 and 6.[116]

6.1.3.5 Middle Eastern and Russian sub-sample

Table 22 shows the relative systemic loss contributions by country for the MER sample. The systemic risk contributions are time-variant whereas the ranking is relatively stable over time. Russia and the United Arab Emirates are the countries with the highest systemic risk contribution (combined share of 98 percent), Bahrain and Qatar only have minor systemic risk shares. The Middle Eastern countries have the strongest increase in systemic risk contribution

[116] The conclusions from regression 6 need to be interpreted with some caution, however, as the variance inflation factors indicate the presence of multicollinearity.

from period 3 to period 4 (relative increase from 14 to 28 percent) while the share of Russia slightly decreases in this time. This can also be explained by the sustained high CDS levels of the UAE banks since Dubai's sovereign debt problems in the fourth quarter of 2009.

The systemic risk contributions of the individual banks in the MER sample are shown Table 23. Bank of Moscow, WTB and Sberbank have the highest systemic loss contribution in period 4 whereas the Commercial Bank of Qatar, Arab Banking Corp and Mashreqbank contribute least to the systemic risk in this sub-sample. The largest increase in the systemic risk contributions from period 3 to 4 are observed for Arab Banking Corp, Abu Dhabi Commercial Bank and Mashreqbank whereas WTB, Bank of Moscow and Dubai Islamic bank reduce their systemic loss contribution in period 4.

Table 28 shows the regression results for the determinants of the relative systemic risk contribution in the MER sample. The liability weight is the single variable with the highest impact on a bank's systemic risk contribution. In all regressions where the liability weight is included, its estimated coefficient is even above unity, which means that an increase of a bank's liability weight leads to a disproportionate increase in its systemic risk contribution. This finding confirms the claim that the size of a bank determines its riskiness for the aggregate financial system. Regression 1 shows that the bank-specific risk-neutral default probability alone has no sufficient explanatory power for the relative systemic risk contributions whereas in conjunction with the liability weight and the average correlation it has a significant positive coefficient as does the average correlation. The coefficients of the interaction terms in regressions 5 and 6 are to be interpreted with some caution, though, as the variance inflation factors indicate the presence of multicollinearity.

6.1.3.6 Comparative analysis

Across all samples we observe that the banks with the highest (smallest) relative systemic loss contribution are also the largest (smallest) in their sample in terms of total liabilities. Furthermore, at a similar level of relative liability share, the banks with the higher CDS spreads contribute more to the systemic risk. The strongest increase in systemic risk contribution from period 3 to period 4 is observed for the banks affected by 'special circumstances' such as the euro zone sovereign debt crisis which strongly increased the risk contribution of Greece, Portugal and Spain as well as Dubai's sovereign debt problems which substantially increased the systemic risk contributions of the UAE (amongst other reasons).

The above observations are confirmed by comparing the regression analysis results concerning the determinants of the relative systemic risk contributions in Table 24 to Table 28. We find that the risk-neutral default probability alone has no sufficient explanatory power whereas together with the liability weight and the average correlation it has as expected a positive coefficient. The liability weight has the strongest impact on the relative ESS-contribution with an average coefficient of even above one. This finding confirms the common concern that the higher a bank's size, the greater is the risk it poses to the financial system ('too big too fail'). A higher average equity return correlation also increases the bank's systemic risk contribution in all samples except for the American sample. The coefficients of the interaction terms between average correlation, risk-neutral probability and liability weight are positive on average whereas the interpretation of the results of regression 5 and 6 needs to be conducted with some caution due to the presence of multicollinearity.

6.1.4 Discussion in the context of related research

As this is the first published study of systemic risk in the *global* financial system, comparisons can be drawn only for sub-samples of our analysis. To this end we compare the analysis of systemic risk in the US banking sector by Huang/Zhou/Zhu (2010b) with our results for the American sample and the analysis by Huang/Zhou/Zhu (2010a) of bank holding companies in the Asia-Pacific region with our results for the Asian-Pacific sample.[117]

A comparison of the trajectory of the distress insurance premium (DIP) systemic risk measure for the US financial system in Figure 2 of Huang/Zhou/Zhu (2010b) with the gradient of the ESS-indicator of the American sample in Figure 14 between October 2005 and December 2009 exposes a consistency for *both* the peak points in time as well as for the ranking of the peak heights for the absolute and relative measures alike. With respect to the input factor determinants regression, the results for the American sub-sample in Table 13 are consistent with the regression results of Huang/Zhou/Zhu (2010b) in Table 2. As for the determinants of the systemic risk contributions by individual institutions, the results (in terms of estimated

[117] While there are also other studies of systemic risk in the American financial sector, Huang/Zhou/Zhu (2010b) provide the only comprehensive results which are comparable to our findings.

coefficients and coefficient rankings) from regressions 4 and 6 in Table 25 are consistent with the results of regression 1 and 3 in Table 5 of Huang/Zhou/Zhu (2010b).[118]

By comparing the gradient of the DIP measure for the Asian-Pacific banks in Figure 3 of Huang/Zhou/Zhu (2010a) with the ESS results for the Asian-Pacific sub-sample in Figure 16 between October 2005 and May 2009 we observe that the peaks are at the same points in time whereas the ranking of the peak heights differs slightly: the peaks of the ESS-indicator in November and December 2008 are stronger than the DIP peaks in Huang/Zhou/Zhu (2010a). As regards the input factor determinants, our results for the Asian-Pacific sub-sample in Table 13 are consistent with the results in Table 3 of Huang/Zhou/Zhu (2010a) in terms of coefficient rankings.[119] With respect to the determinants of the relative systemic risk contributions by individual institutions we find that our results of regression 4 in Table 26 are consistent with regression 1 in Table 6 of Huang/Zhou/Zhu (2010a) whereas the results differ between our regression 6 and the relative-term DIP regression 3 (while the reasons cannot be explored further, multicollinearity in both regression equations is a likely cause[120]).

In summary we can state that the our ESS results for the American and Asian-Pacific sub-samples are consistent with the findings of Huang/Zhou/Zhu (2010b) and Huang/Zhou/Zhu (2010a), respectively. As the ESS-indicator is computed on a daily basis whereas the DIP is computed on a weekly basis only, the gradient of the ESS-indicator is more erratic and reacts faster to the financial crisis events then the DIP measure. Minor differences exist with respect to certain regression results which is not surprising as the methodologies and input parameters employed in the studies are different.[121]

6.1.5 Policy implications and recommendations

The recent financial crisis has exposed the need for macroprudential regulation, which seeks to enhance the stability of the *overall* financial system in addition to microprudential measures which focus on the stability of *individual* institutions. The Basel III regulatory

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[118] Minor differences apply as Huang/Zhou/Zhu (2010b) also include the recovery rates in the regressions. Also, Huang/Zhou/Zhu (2010b) apply a different methodology to compute *marginal* risk contributions using importance sampling techniques.

[119] As Huang/Zhou/Zhu (2010a) use the absolute DIP as dependent variable, the levels of the coefficients are naturally hardly comparable.

[120] Unfortunately Huang/Zhou/Zhu (2010a) do not provide variance inflation factors in their regressions in order to further analyze this claim.

[121] A comparison of our results from the regression analysis of the risk premium determinants was not feasible due to different proxy measures for the risk premium components.

framework released in December 2010 was devised bearing in mind this guiding principle. Therefore, the extended and new regulatory measures such as increased capital requirements, countercyclical capital buffers and the liquidity standard serve both macroprudential and microprudential purposes.[122] Regarding the treatment of SIFIs, the Basel III standard contains so far no specific provisions but states that the work on an "integrated approach" for the regulation of these entities is in progress.[123] The proposals under discussion comprise bail-in debt, capital surcharges, conditional capital and resolution mechanisms as potential measures for regulating systemically important banks.[124]

Irrespective of the precise measures taken to regulate SIFIs, the first step in regulating these entities is to adequately identify them. Among the current proposals for the identification of SIFIs one can discern an inclination to asses a bank's systemic importance based on its ranking in terms of *size* (an example of this is BIS (2011)). However, the use of a transparent, well-defined and accepted metric based on capital market data has obvious advantages. We suggest the use of the relative contribution to the ESS-indicator in order to assess a bank's systemic importance. We consider the measure to be a suitable indicator for systemic importance as it directly incorporates the bank's size and also its interconnectedness and overall risk-profile are reflected as the ESS-indicator is based on capital market data.[125]

The implementation could be conducted in a binary fashion by declaring all banking groups systemically important whose relative ESS-contribution exceeds a certain threshold. For instance, by setting the relative ESS-contribution threshold at 1 (3) percent on the *global* level, our analysis in Table 16 shows that during period 4 of the observation period 23 (12) out of the 83 banking groups are globally systemically important.[126] Moreover, the ESS-contribution could be translated into a discrete or continuous measure of systemic importance to facilitate the differentiation of degrees of systemic importance and a corresponding differentiation of regulatory measures. Applying this concept to the empirical results for the global sample could mean, for instance, that the 12 banks whose systemic risk contribution

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[122] Cf. BIS (2010), pp. 1-4.

[123] While specific provisions for systemically important financial institutions are yet pending, certain new capital requirements decrease the incentive of mutual exposures among global financial institutions.

[124] Cf. BIS (2010), pp. 6-8.

[125] As the availability of capital market data is a precondition for the application of the ESS methodology our recommendation is based on the assumption that the relevant data is available for systemically important financial institutions.

[126] Period 4 ranges from January 1st, 2010 to April 30th, 2011.

exceeds 3 percent could be subjected to additional regulatory measures (discrete approach) or that the capital surcharges are scaled by the extent of which a bank's relative ESS-contribution exceeds 1 percent (continuous approach). Under the latter approach, systemically important banks could take measures to mitigate their systemic importance, e.g., by reducing their balance sheet or overall risk profile, in order to achieve a more favorable regulatory treatment. As the continuous implementation approach would lead to efficient risk-taking incentives for the subjected financial institutions we consider this a particularly favorable implementation for regulating systemically important banks.

In assessing the systemic importance of banks we suggest to distinguish different layers of systemic importance and apply the ESS methodology to the geographical focus of interest in the way we analyzed the regional sub-samples. While the current regulatory discourse is focused on banking groups with systemic importance for the *global* financial system, *regional* and *national* systemically important banking groups should potentially be considered as well. The reasoning behind this proposal is that certain banks may be highly important for the functioning of regional or national financial sub-systems, while not being necessarily considered systemically important on a global scale.[127] Applying this proposal to our empirical results could take the following shape: while none of the banking groups from the Asian-Pacific region are systemically important on the global scale according to the above exemplary one percent threshold, Bank of China as well as Japan's Mizuho Financial Group and Sumitomo Mitsui Banking should be considered systemically important in the Asia-Pacific region and their countries of residence as their systemic loss contribution in the Asian-Pacific sub-sample lies above 15 percent.

Our analysis of the determinants of the relative risk contributions shows that a bank's size is the most important determinant of a bank's systemic importance. While the size is already captured in the bank's relative contribution to the ESS-indicator (and hence in our proposed approach for the assessment of systemic importance), regulators may want to consider additional limitations on the maximum size of banking groups. In fact, such a provision was made in the Dodd-Frank Act ("Wall Street Reform") by stating that an acquisition or merger

[127] As our ESS-indicator can be implemented only for banks with publicly traded CDS spreads and equity the implementation of this proposal may require the use of additional metrics. This would be the case, e.g., for state banks ("Landesbanken") in Germany.

of financial companies shall not be permitted if the resulting entity would have more than 10% of the total financial sector liabilities.[128]

The development of the ESS-indicator during the observation period shows that the aggregate level of risk in the financial system varies significantly over time. Consequently, central banks and regulators could use the ESS-indicator with a relevant geographical focus in order to enhance their ongoing financial stability monitoring and early warning systems.

Consequently, both the ESS-indicator and the relative ESS contribution can be helpful in the context of macroprudential regulation whereas further work is necessary to elaborate an operational policy framework.

[128] Cf. SEC (2010), section 622 (b), p. 258.

6.2 BANKING SECTOR RISK CONTAGION DEPENDENCIES

In this chapter we describe the results from analyzing the banking sector risk contagion dependencies. The results from the unit-root and cointegration tests are shown in the appendix. In the subsequent elaboration we assume the presence of a dependency between two variables if the corresponding F-Statistic is significant at least at the five percent level.

6.2.1 Inter-regional systemic risk contagion[129]

6.2.1.1 Econometric results

Inter-regional ESS-indicator

The upper panel of Table 29 shows the Granger-causality test results for the inter-regional systemic risk (regional ESS-indicator) analysis excluding control variables. We find that in period 1, i.e., before the crisis, there is evidence for a lead-lag relationship between the relative ESS-indicators of Europe and Asia-Pacific as well as between Middle East & Russia (MER) and Europe. During the subprime crisis period 2 the systemic risk in America Granger-causes the systemic risk in Europe and there is a feedback relation between the systemic risk in Asia-Pacific and Europe. Moreover, the relative ESS-indicator in the European sample Granger-causes the systemic risk in MER.

In the 'core financial crisis' period 3 we find that the lead-lag relationships between the relative ESS-indicators of the individual regions became more pronounced. The systemic risk in the American sample Granger-causes the systemic risk in all other regions. By contrast, the American relative ESS-indicator is only led by the MER relative ESS-indicator in this period which is likely due to the UAE's sovereign debt crisis. Moreover, we find that the MER systemic risk leads the Asian-Pacific systemic risk and that the European systemic risk is informative for the MER systemic risk. Apart from the dependency between the regional ESS-indicator in MER and America, the same dependencies found in period 3 apply also in period 4 whereas the F-statistics and p-values vary.

Figure 27 shows the generalized impulse response functions (GIRFs) for four inter-regional relative ESS combinations for which we find significant Granger-causality relations at least during two sub-periods. We follow standard practice and exhibit the four possible impulse response functions for each bivariate dependency between the impulse and response variables

[129] The elaborations in this section are (also literally) based on Lahmann (2012b).

in one panel. Each sub-panel exhibits four lines referring to the GIRFs scaled by the standard deviation of the impulse variable's regression equation during the four sub-periods observed over 10 trading days (the contemporaneous response is captured in period 1 and the ensuing responses are traced in subsequent periods).

The results of the GIRF analysis are consistent with the findings in the Granger-causality analysis.[130] Specifically, the GIRF analysis confirms that innovations in the American relative ESS-indicator have a positive and lasting effect on the systemic risk in all other regions since the subprime crisis whereas the opposite relation is only observed for MER in period 3. Also, the lasting positive impact of shocks in the European relative ESS-indicator on the Asian-Pacific systemic risk can be observed. The effects of the impulse decay over time which is consistent with the stationarity of the variables found in the unit root tests.[131]

The upper panel of Figure 29 shows the average correlations of the regional relative ESS-indicator with the relative ESS-indicator in other regions. In periods 1 and 2 the correlations were at a comparatively low level (0.12). Since period 3 the correlations more than doubled (0.27) at which the systemic risk in the US exhibits the highest average correlation (0.41), followed by Europe (0.29), MER (0.23) and Asia-Pacific (0.16). Not surprisingly, the correlations exhibit a high degree of comovement since the subprime crisis period.

Inter-regional bank CDS

The upper panel of Table 30 shows the Granger-causality test results for the inter-regional bank CDS analysis excluding control variables. In period 1 we find evidence that the bank CDS in Europe lead the bank CDS in America and MER. Moreover, changes in the American bank CDS Granger-cause the bank CDS in MER and there is a feedback relation between Asia-Pacific and European bank CDS. In period 2 we find evidence that the American bank CDS are informative for both the Asia-Pacific and European bank CDS and that there is a feedback relation between the bank CDS of Asia-Pacific and Europe.[132]

During the 'core financial crisis' period 3 the American bank CDS Granger-cause the bank CDS of Asia-Pacific and Europe. Moreover, there are feedback relations between i) the bank CDS of America and MER, ii) the bank CDS of Asia-Pacific and Europe and iii) the bank

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[130] Additionally, the dependency between American vs. Asia-Pacific systemic risk is observed already during period 2 in the GIRF analysis whereas it is significant only periods 3 and 4 in the Granger-causality test.

[131] This interpretation is consistent with the conclusion in Roll/Schwarz/Suess (2007), pp. 2217-2218.

[132] We reach the conclusion concerning the feedback relation by considering the results excluding *and* including control variables.

CDS of Europe and MER. Besides, the bank CDS of the European sample Granger-cause the bank CDS of the MER sample. Moreover, the MER bank CDS lead the Asia-Pacific bank CDS in period 3. During the sovereign debt crisis period the same causality relations apply with the following exceptions: The MER bank CDS no longer Granger-cause the bank CDS in America whereas there is an additional lead-lag relationship between the European and the American bank CDS.

Figure 28 shows the generalized impulse response functions (GIRFs) for four inter-regional bank CDS combinations for which we find significant Granger-causality relations at least during two sub-periods. The results from the GIRF analysis are consistent with the findings in the Granger-causality analysis. Specifically, the GIRF analysis confirms that innovations in the American bank CDS have a positive and lasting effect on the bank CDS in all other regions since the subprime crisis period. The same holds for the feedback relation between the bank CDS in Asia-Pacific and Europe since period 2. The effects of the impulses decay over time which is consistent with the stationarity of the variables found in the unit root tests.[131]

The lower panel of Figure 29 shows the average correlations of the regional bank CDS spreads with the bank CDS spreads in other regions. In periods 1 and 2 the average correlations across all regions were at a comparatively low level (0.29). Since period 3 the correlations increased markedly (0.51) at which the US exhibits the highest average correlation (0.57), followed by Europe (0.54), Middle East & Russia (0.50) and Asia-Pacific (0.43). Not surprisingly, the correlations exhibit a high degree of comovement since the subprime crisis period.

The lower panels of Table 29 and respectively Table 30 shows the Granger-causality test results for the inter-regional systemic risk analysis and respectively inter-regional bank CDS analysis where the global stock index and the federal funds rate are included as exogenous control variables. The findings are consistent with the results excluding control variables whereas the strength of the dependency (as measured by the p-value of the F-statistic) varies slightly. Minor deviations[133] exist only in the controlled results for the bank CDS spreads in periods 1 and 2 (Asia-Pacific vs. Europe) and period 3 (Europe vs. America). The same

[133] Minor deviations describe the case when dependencies observed *with* control variables are significant at a significance level up to five percent *higher* than dependencies found *without* control variables (or *equivalently* five percent *lower* when the controlled results show dependencies not observed without control variables).

applies to the results obtained when only one control variable, i.e., stock index *or* federal funds rate, is included in the regression.[134]

6.2.1.2 Evaluation of initial hypotheses

In this section we evaluate our initial hypotheses based on the econometric results using first the relative ESS-indicator and then outlining differences from analyzing the regional bank CDS. We can largely confirm hypothesis A1 since before the financial crisis the inter-regional systemic risk dependencies are negligible. The hypothesis A2 concerning the lead-lag relation between the systemic risk in America and the other regions is fully confirmed first in period 3 while in period 2 the American systemic risk depends only the European systemic risk. This may be explained by the more intensive linkages between the American and the European financial systems. However, the systemic risk in America is not led by other regions before period 4 which shows that the US banking sector risk leads the systemic risk in other regions while itself being not susceptible to banking sector risk in other regions. Additionally, the systemic risk in Europe leads the MER systemic risk as of period 2.

The feedback relations postulated in hypothesis A3 are only observed for the inter-regional relative ESS-indicator between America and MER which is likely due to the UAE's sovereign debt crisis in period 3. Consequently, hypothesis A3 is rejected by the empirical results. By comparing the results between periods 3 and 4 we note that the lead-lag relations observed in period 3 are indeed persistent in period 4 (with the exception of the dependency between MER and America) which reflects the enduring impact of the financial crisis on the inter-regional banking sector sensitivities and confirms hypothesis A4.

The findings for the inter-regional bank CDS largely confirm the results for the inter-regional relative ESS-indicator whereas a few exceptions apply. In period 1 five inter-regional dependencies in the bank CDS are observed which contradicts hypothesis A1 stronger than for the regional ESS-indicator. Hypothesis A2 is additionally verified for the America vs. Asia-Pacific bank CDS dependency in period 2. The feedback dependencies hypothesized in A3 are in fact found for all inter-regional bank CDS dependencies except for Asia-Pacific vs. America and Asia-Pacific vs. MER in period 3. In period 4, hypothesis A4 concerning the persistence of the effects observed since period 3 is confirmed for all dependencies except for MER vs. America bank CDS spreads. This is likely due to the fact that this dependency was

[134] These results are omitted due to space considerations.

caused by the severe bank funding crisis in Russia and the sovereign debt crisis in the UAE and the associated difficulties for Arab banks in the fourth quarter 2008.

Discussion in the context of related research

As pointed out in the literature review there is yet no research concerning the inter-regional contagion effects of regional systemic financial sector risk or alternatively regional banking sector CDS spreads. Therefore, a discussion of our results in the context of findings by other authors is unfortunately not feasible.

6.2.2 Sovereign risk vs. banking sector risk contagion[135]

In this chapter we describe the results from applying the econometric methodology to the region- and country-level sovereign and bank CDS data.

6.2.2.1 Region-level analysis

6.2.2.1.1 Econometric results

The upper panel of Table 31 shows the Granger causality test results for the intra- and inter-regional sovereign CDS and bank CDS analysis excluding control variables.

For the *American sovereign credit risk*, i.e., the sovereign CDS of the United States, we find feedback relationships with the American and European bank CDS in period 1. Moreover, we find that the American sovereign risk Granger-causes the Asia-Pacific bank CDS in the pre-crisis period. We observe a lead-lag relationship between the American bank CDS and the American sovereign CDS in periods 2, 3 and 4. In period 3, there is a feedback dependency between the American sovereign CDS and the Asia-Pacific bank CDS. During the sovereign debt crisis period, the American sovereign risk Granger-causes the Asian-Pacific, European and Middle East & Russia (MER) bank CDS.

The *Asia-Pacific sovereign risk* leads the bank CDS in Europe and is Granger-caused by the MER bank CDS spreads in period 1. In period 2, we observe feedback relationships between the Asia-Pacific sovereign risk and the Asia-Pacific bank CDS. Moreover, the Asia-Pacific sovereign risk is led by the American and European bank CDS spreads during the subprime crisis period. In period 3, the same dependencies as in period 2 are observed whereas additionally the Asia-Pacific sovereign CDS spreads exhibit a feedback relation with the

[135] The elaborations in this section are (also literally) based on Lahmann (2012a).

MER bank CDS.[136] During the sovereign debt crisis period the same dependencies as in period 3 are observed with the following exceptions: the dependency between Asia-Pacific bank vs. sovereign CDS spreads is no longer found and a new dependency between Asia-Pacific sovereign and European bank CDS is observed.

The *European sovereign risk* exhibits no interdependencies with bank CDS spreads in period 1. In period 2 there is a feedback dependency between the European sovereign risk and the MER bank CDS. During the financial crisis period the European sovereign credit spreads Granger-causes the Asia-Pacific bank credit spreads. Furthermore, the European bank CDS lead the European sovereign risk in this period. In period 4 there are feedback relationships between the European sovereign and the American and European bank CDS. Additionally the European sovereign CDS lead both the Asia-Pacific and MER bank CDS.

For the *Middle East & Russian sovereign CDS spreads* we find these to be Granger-caused by the American and European bank CDS in period 1. Besides, the MER sovereign CDS are informative for the MER bank CDS. In period 2 the same lead-lag relationships as in period 1 are observed whereas the dependency between the European bank vs. MER sovereign CDS is no longer significant. In period 3 we observe feedback dependencies between the MER sovereign CDS and the American and MER bank CDS and also the MER sovereign CDS Granger-cause the Asia-Pacific bank CDS and are *led* by the European bank CDS spreads. During the sovereign debt crisis period the MER sovereign CDS lead the Asia-Pacific and the MER bank CDS. Besides, the American bank CDS Granger-cause the MER sovereign CDS.

The lower panel of Table 31 shows the Granger-causality test results for the inter- and intra-regional sovereign vs. bank CDS analysis where the global stock index and the federal funds rate are included as exogenous control variables. The findings are consistent with the results excluding control variables whereas the strength of the dependency (as measured by the p-value of the F-statistic) varies slightly. Minor deviations[137] exist for the American sovereign risk in period 2, for the Asia-Pacific sovereign risk in periods 1 and 4, for the European sovereign CDS in period 4 and for the MER sovereign risk in period 3. The same applies to

[136] The dependency between Asia-Pacific bank and sovereign risk is only significant at the 6 percent level.

[137] Minor deviations describe the case when dependencies observed *with* control variables are significant at a significance level up to five percent higher than dependencies found *without* control variables (or *equivalently* five percent lower when the controlled results show dependencies not observed without control variables).

the results obtained when only one control variable, i.e., stock index *or* federal funds rate, is included in the regression.[138]

Figure 30 shows the generalized impulse response functions (GIRFs) for four inter-regional sovereign CDS vs. bank CDS combinations for which we find significant Granger-causality relations at least during two sub-periods. We follow standard practice and exhibit the four possible impulse response functions for each bivariate dependency between the impulse and response variables in one panel. Each sub-panel exhibits four lines referring to the GIRFs scaled by the standard deviation of the impulse variable's regression equation during the four sub-periods observed over 10 trading days (the contemporaneous response is captured in period 1 and the ensuing responses are traced in subsequent periods).

The results from the GIRF analysis are consistent with the findings in the Granger-causality analysis. Specifically, innovations in the Asia-Pacific sovereign CDS have a positive and lasting influence on the Asia-Pacific bank CDS since period 3. Also, shocks in the European sovereign CDS have a positive and enduring impact on European bank CDS in period 4. The lasting impact of impulses in the American bank CDS on the MER sovereign CDS is confirmed during all periods. Moreover, the feedback relation between MER sovereign and bank risk in period 3 is confirmed in the GIRF analysis. The effects of the impulse decay over time which is consistent with the stationarity of the variables found in the unit root tests.[131]

Figure 31 shows the average correlations between the regional sovereign CDS spreads and the cross-regional bank CDS spreads. In periods 1 and 2 the correlations are at a relatively low level with an average value of 0.15. Since the financial crisis period the correlations increase markedly to an average of 0.49 and the MER sovereign CDS has the highest correlation (0.58), followed by Asia-Pacific (0.53), Europe (0.48) and America (0.38).[139] This ordering may be explained by the fact that risk premiums for emerging market debt are driven by similar factors determining banking sector credit spreads whereas risk premiums for debt of large industrialized countries do not share this feature.[140] Further research is necessary in order to adequately explain this finding, though.

Table 32 provides a more granular view on the correlations between sovereign and bank CDS during the four sub-periods. The highest correlations are observed for the regions where

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[138] These results are omitted due to space considerations.

[139] The same ordering applies for periods 1 and 2 whereas the average values are correspondingly lower.

[140] This assessment is somewhat simplifying as the Asia-Pacific sample also includes Australia and Japan.

sovereign debt problems materialized, i.e., for Middle East & Russia in period 3 and Europe in period 4. Apart from these prominent results it can be noted that the average correlations increased substantially over time and that there is a strong variation between the intra-regional correlations across the sample regions.

6.2.2.1.2 Evaluation of initial hypotheses and overarching considerations

The econometric results confirm hypothesis B1 which states that the sovereign risk in America and Europe does not impact the bank default risk before the crisis whereas few exceptions apply: in period 1 the American sovereign risk impacts the bank credit risk in America, Asia-Pacific and Europe. Moreover, the European sovereign risk impacts the MER bank CDS (in period 2). The lead-lag relation between the 'emerging market'[141] sovereign and bank credit risk formulated in B2 cannot be considered as confirmed: the hypothesized dependency is found only with respect to few bank CDS spreads in periods 2 and 3.

Since the sovereign debt crisis the impact of sovereign default risk on bank credit risk has increased substantially and hypothesis B3 applies fully for Asia-Pacific and Europe as the sovereign risk in these regions depends the bank CDS in all other regions in period 4. This finding confirms the common perception that the euro sovereign debt crisis impacts financial sector risk around the globe.[142] For the American sovereign risk we find the hypothesized dependency for all regions except for the American bank default risk. The MER sovereign risk exhibits the dependency only with respect to the Asia-Pacific and MER bank CDS.

Hypothesis B4 which states that the bank CDS lead the sovereign CDS in the same region since period 3 applies only to America and Europe whereas for MER this dependency is only found in period 3 and it does not apply at all for Asia-Pacific. This finding appears plausible as government bail out of the financial sector during the crisis relative to GDP[143] has been indeed larger in America and Europe than in the other regions. Hence, the contingent liability of the sovereign for the banking sector is likely higher in these countries which is reflected in the higher sensitivity of sovereign default risk to changes in bank default risk.

In addition to the evaluation of the initial hypotheses we discuss overarching observations in the following. While we hypothesized an intra-regional dependency between bank and

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[141] The term ‚emerging market' refers to the sample countries from Asia-Pacific and Middle East & Russia which is simplifying since sample countries such as Australia and Japan do not meet this classification.

[142] This hypothesis is formulated amongst others in Lahmann/Kaserer (2011a).

[143] Cf. Taylor (2009).

sovereign CDS since the financial crisis, this dependency is observed in the US already since the first sub-period. This finding may reflect the major importance of the financial sector for the US economy as well as a pre-crisis market assessment of the contingent liability which the state would bear for the banking sector. Moreover, the strong lead-lag relation between the bank default risk in America and Europe and the Asia-Pacific sovereign risk since the subprime crisis period is remarkable. A possible explanation for this dependency is a market anticipation of the detrimental impact which the financial crisis in America and Europe would have on the world economy, exports from the Asia-Pacific region and thereby eventually affect the credit risk of the region's sovereign debt. Alternatively, the reason for this dependency may be a market anticipation of the impact of the American and European financial crises on the Asia-Pacific banking sector, potential government support measures for the banking sector and ensuing sovereign credit risk debilitations. For the dependency between the American bank CDS and the MER sovereign CDS since period 2 similar arguments can be applied. Further research is necessary to adequately classify these dependencies, though.

Discussion in the context of related research

As pointed out in the literature review there is yet no research concerning the inter- or intra-*regional* contagion effects between sovereign and banking sector CDS spreads. Therefore, a discussion of the above results in the context of findings by other authors is not feasible.

6.2.2.2 Country-level analysis

In this section we elaborate the country-level sovereign vs. bank CDS analysis which represents a more granular analysis of the intra-regional analysis in the preceding section.

6.2.2.2.1 Econometric results

The upper panel of Table 33 shows the Granger causality test results for the intra-country sovereign CDS and bank CDS analysis excluding control variables.

For the United States we find a feedback relation between the sovereign and bank CDS in period 1 and during the subsequent periods the bank CDS Granger-cause the sovereign CDS.

In Australia the sovereign CDS Granger-cause bank CDS in periods 2, 3, and 4. For China, the results are more mixed: The bank CDS Granger-cause the sovereign CDS in period 1; in period 2 and 4, there is a lead-lag relation between the sovereign and bank CDS in addition to a feedback relation in period 3. For the Hong Kong market, feedback interdependence exists

in period 3 and a lead-lag relation between bank and sovereign CDS is found in period 4. In India, a feedback relation is found between sovereign and bank CDS in period 1 and in periods 2 and 3 there are lead-lag relationships between the bank CDS and the sovereign CDS. In the Japanese market a Granger-causality dependence between bank and sovereign CDS is present in period 3 and in period 4 the sovereign CDS spreads lead the bank CDS. With respect to the Kazakhstan sovereign risk it is found that it depends the bank default risk in period 2. In Korea we observe that the sovereign CDS Granger-cause the bank CDS in periods 1, 2 and 4 and that in period 3 there is a feedback interdependence between the variables. For the Malaysian market a lead-lag relation between sovereign and bank CDS is found in periods 1 and 3 and the reverse dependence is observed in period 4. In Singapore we find a feedback dependence between sovereign and bank CDS in period 1 and also the bank CDS Granger-cause the sovereign CDS in periods 2 and 3.

For Austria we find feedback relationships between the sovereign and bank CDS in periods 3 and 4 whereby the effect of the sovereign on the bank CDS is stronger than vice versa. No significant lead-lag relationships are found for Belgium. In Denmark we find a lead-lag relation between bank and sovereign CDS in period 1 whilst in period 3 the opposite effect is observed. During the sovereign debt crisis period, a feedback relation between sovereign and bank CDS is found. A lead-lag relationship between sovereign vs. bank CDS is found in France in period 4. For Germany we note that the sovereign CDS are informative for bank CDS in periods 1 and 3 whereas in period 4 the opposite dependence occurs. Feedback interdependence is observed for Greece in period 1 while in period 4 we find that the bank CDS Granger-cause the sovereign CDS. The Irish bank CDS exhibit a lead-lag relationship with the sovereign CDS in period 3 whereas the opposite effect occurs in period 4. In Italy we find that the bank CDS lead the sovereign CDS in periods 2 and 3 whereas a feedback relation exists in period 4. For the Netherlands, sovereign risk Granger-causes bank default risk in period 1 and feedback relation between both variables is found in period 4. In Portugal the bank CDS show a lead-lag relationship with the sovereign CDS in period 2 and a feedback interdependence is found between sovereign and bank CDS in period 4. The Spanish bank CDS lead the sovereign CDS in periods 1 and 3 whereas during the sovereign debt crisis the reverse dependence is highly significant. For Sweden we find that the sovereign CDS lead the bank CDS in periods 3 and 4. The bank CDS in Switzerland are informative for the Swiss sovereign CDS spreads in periods 3 and 4. The UK bank CDS Granger-cause the sovereign CDS in period 1 and during the financial crisis period a feedback relationship is observed.

The bank CDS in Bahrain lead the sovereign CDS in period 1 and the opposite effect is observed in period 3. Moreover, a feedback relation between sovereign and bank CDS is found during the sovereign debt crisis period in Bahrain. In Qatar, the bank CDS lead the sovereign CDS in period 2 and in period 4 the opposite effect occurs. For the UAE we find that the sovereign CDS lead the bank CDS in periods 3 and 4. In Russia the sovereign CDS are informative for the bank CDS in periods 1 and 4 whereas there is a feedback interdependence in period 3.[144]

The lower panel of Table 33 shows the Granger-causality test results for the country-level sovereign vs. bank CDS analysis where the global stock index and the federal funds rate are included as exogenous control variables. The findings are largely consistent with the results excluding control variables whereas the strength of the dependency (as measured by the p-value of the F-statistic) varies slightly. The same applies to the results obtained when only one control variable, i.e., stock index *or* federal funds rate, is included in the regression.[145]

6.2.2.2.2 Evaluation of initial hypothesis and overarching considerations

In this section we consider the country-level sovereign vs. bank default risk results as a further level of granularity of the above intra-regional results. The focus of the subsequent elaboration is on the results in periods 3 and 4.

For *Asia-Pacific* we find that five of the nine countries (Australia, China, Hong Kong, Korea and Malaysia) exhibit the lead-lag relation between sovereign and bank default risk also observed on the regional level in period 3. However, six countries (China, Hong Kong, India, Japan, Korea and Singapore) also show a lead-lag relationship between bank and sovereign CDS in period 3 as postulated in hypothesis B4. We attribute this finding to the market's perception of the contingent liability of the state towards the banking sector in these countries which in turn may have been caused by a more dominant banking sector in these countries (relative to the other countries). During the sovereign debt crisis period we find the (strong) lead-lag relation between sovereign and bank default risk (observed on the regional level) in Australia, China, Japan and Korea which confirms hypothesis B3. The opposite dependency is only observed in Hong Kong and Malaysia (for Kazakhstan and Singapore no interdependencies between sovereign and bank default risk are observed). These results show

[144] The findings from the generalized impulse response functions are consistent with the results of the Granger-causality analysis. Due to space considerations the GIRFs are not shown on the country level.

[145] These results are omitted due to space considerations.

that the impact of sovereign risk on bank default risk clearly increased in period 4 also for the Asia-Pacific countries which is likely the result of an overall reevaluation of sovereign debt risk premiums due to the euro zone sovereign debt crisis. Additional research is necessary to validate these explanations, though.

For the European sample we find the impact of bank default risk on sovereign default risk observed on the regional level in period 3 for six European countries, namely Austria, Germany, Ireland, Italy, Spain, Switzerland and the UK which reflect the substantial contingent liability of these countries for their banking sectors and confirming hypothesis B3. In fact, all of these countries apart from Italy and Spain provided massive financial support to their financial institutions. The banks in Italy and Spain were not so much *directly* affected by the financial crisis than by the crisis' 'collateral damage' such as the bursting of housing bubbles due to strained funding markets (amongst others).

The European country level analysis also exposes that *during the financial crisis period* the bank default risk became more sensitive with respect to sovereign default risk in Austria, Denmark, Sweden and the UK. The resulting feedback relations between sovereign and bank default risk in Austria and the UK reflect two dimensions of the relation between governments and banks during the crisis: firstly the banking sectors in these countries was safeguarded by government support and hence a decrease in the government's capacity to bail out the financial sector (as measured by its sovereign CDS spread) would also lead to increased default risk of the country's banks. Secondly, an increase in the banks' default risk entails an increased likelihood of state intervention due to the reluctance of governments to let their financial institutions fail which in turn increases sovereign default risk.

During the sovereign debt crisis period the feedback relation between sovereign and bank default risk observed on the regional level is found for the countries Austria, Denmark, Italy, the Netherlands and Portugal. For these feedback relations it should be noted that the effect of changes in the sovereign default risk on the bank default risk is far stronger than the opposite dependency (measured in terms of the F-Statistic). Moreover, sovereign risk impacts bank default risk in France, Germany, Ireland, Spain and Sweden (confirming hypothesis B4) whereas the opposite dependency is observed for Greece and Switzerland in period 4. Given the effects of the euro zone sovereign debt crisis on global financial markets it is plausible that a euro zone country's sovereign risk also impacts on the default risk of its banks. By contrast, the factors that determine in which of these countries the bank default risk also affects the sovereign risk (in addition to the aforementioned contingent liability) are not fully

transparent and require further research. Similarly, further research is necessary to understand why the bank default risk in Greece actually *leads* the sovereign risk during the sovereign debt crisis period (as the opposite dependency would likely have been expected). The unidirectional dependency between bank vs. sovereign default risk for Switzerland can be explained by the size of Swiss banks and the bank rescue packages relative to the Swiss economy whilst the Swiss sovereign risk has been largely unaffected during the financial and sovereign debt crises as markets perceived Switzerland (and the Swiss franc) as a safe haven.

In Middle East & Russia, the feedback relationship between sovereign and bank default risk on the regional level in period 3 is also significant for Russia on the country level which can be explained along the same lines as for the feedback relations in Austria and the UK above. By contrast, in Bahrain and the UAE the sovereign default risk leads the bank default risk (and not vice versa) in period 3 which is most likely due to the UAE's sovereign debt problems. During the sovereign debt crisis period the region-level finding that the sovereign risk leads the bank default risk applies to all MER sample countries which corroborates hypothesis B3.[146]

Discussion in the context of related research

Among the research described in the literature review only the Granger-causality analysis of sovereign and *individual* bank CDS spreads in Alter/Schueler (2011) is approximately comparable to our findings for the seven euro zone countries[147] covered in their analysis. The overall tendency observed by Alter/Schueler (2011), namely that in the period prior to the financial sector bailouts changes in bank credit risk mostly affected changes in sovereign credit risk whereas in the post-bailout period the opposite effect occurred, is confirmed in our analysis for the respective countries.[148]

[146] In Bahrain even a feedback relationship is observed the reasons for which require further explanation.

[147] Alter/Schueler (2011) analyze France, Germany, Ireland, Italy, Netherlands, Portugal and Spain.

[148] This conclusion is obtained by comparing the findings in Alter/Schueler (2011), p.28 (Table 2), with our country-level Granger-causality results.

6.2.3 Banking sector risk vs. corporate sector risk contagion[149]

In this chapter we describe the results from analyzing the bank vs. non-bank corporate risk contagion dependencies.

6.2.3.1 Econometric results

6.2.3.1.1 CDS spreads

The upper panel of Table 34 shows the test results for the banking vs. non-bank corporate sector CDS Granger causality analysis excluding control variables.

In the *American sample* we find that the banking sector CDS lead the overall non-bank corporate sector CDS since in period 2, whereas in period 1 the opposite dependence is observed. In the following we describe the specific industry-level results which *deviate* from this cross-industry finding. For the automotive firms, no lead-lag relationship is observed in period 1. The CDS of the firms in the basic materials industry cluster are Granger-caused by bank CDS in period 1 (and not vice versa) and additionally a feedback relation is observed in period 4. In the case of the chemicals, healthcare and pharma as well as the construction and logistics firms' CDS we do not observe that these Granger-cause the bank CDS in period 1. For the energy and utilities firms' CDS we find *feedback* relationships with the bank CDS in periods 2 and 3 whereas the lead-lag relationship in period 1 is not observed. The CDS of financial services firms do not Granger-cause the bank CDS in period 1 and in period 3 there is a feedback interdependence. The results for the 'industrial' firms' CDS are consistent with the overall results except for period 4 where a feedback relation exists. The CDS of telecommunications, media and technology (TMT) firms are led by the bank CDS in period 1 whereas in period 3 no interdependence is observed.

In the *Asia-Pacific* sample we observe that the bank CDS lead the overall corporate sector CDS in period 2. In period 3 there is a feedback dependency between the corporate and bank CDS whereas the impact of bank default risk on corporate default risk is stronger than vice versa. By contrast, in period 4 the corporate CDS lead the bank CDS. On the industry-level the results are more heterogeneous than in the American sample and the *deviations* from the cross-industry findings are described in the following. For the automotive firms' CDS we find these not to be Granger-caused by bank CDS in period 3. The CDS of the basic materials companies are informative for the bank CDS in period 1 and in period 4 the bank CDS

[149] The elaborations in this section are (also literally) based on Lahmann/Kaserer (2012).

Granger-cause this industry's CDS. The chemical, healthcare and pharma firms' CDS show no interdependence with the bank CDS except for period 4 where they lead the bank CDS. The results for the commerce and consumer, construction and logistics as well as the energy and utilities firms' CDS deviate from the overall results only in period 4 where they are led by the bank CDS (and not vice versa). The financial services industry CDS deviate from the overall results as they have a feedback dependence with the bank CDS in period 4. The industrial firms' CDS deviate from the overall results in period 4 where they are Granger-caused by the bank CDS. The CDS of the TMT firms differ from the overall results in period 4 because the Granger-causality relation with respect to the bank CDS is not significant.

The cross-industry result in the *European* sample shows that the non-bank corporate CDS lead the bank CDS in period 1 and 2 whereas the opposite dependence occurs in period 3. In period 4 a feedback interdependence between bank and corporate CDS is observed. In the following we describe the *deviations* from this cross-industry finding for the respective industries. For the automotive firms' CDS the dependence with respect to bank CDS is not observed in period 1. The basic materials firms' CDS results deviate significantly from the overall results as they exhibit only one Granger-causality relation versus the bank CDS in period 2. The findings for the chemicals, healthcare and pharma as well as the commerce and consumer firms' CDS are consistent with the overall findings except for period 3 where no dependence is found. The CDS of the construction and logistics firms deviate from the overall results in period 1 as no corresponding dependence is found. The energy and utilities firms' CDS Granger-cause the bank CDS in periods 1 and 2 whereas no dependence is found in periods 3 and 4. The financial services firms' CDS have feedback relations with the bank CDS in periods 1 and 3 whereas the results for the other sub-periods are consistent with the cross-industry perspective. The results for the (other) 'industrial' firms deviate from the overall results in period 1 where the industry CDS are Granger-caused by the bank CDS. TMT firms' vs. bank CDS dependencies are consistent with the overall results only in period 2 as no other interdependencies are found for this industry cluster.

The lower panel of Table 34 shows the Granger-causality test results for intra-regional banking vs. corporate CDS analysis where the global stock index and the federal funds rate are included as exogenous control variables. The findings are consistent with the results excluding control variables whereas the strength of the dependency (as measured by the p-

value of the F-statistic) varies slightly. Minor deviations[150] exist only on the industry-level for the Asia-Pacific sample (periods 1 to 4) and in the European sample (period 3). The same applies to the results obtained when only one control variable, i.e., stock index *or* federal funds rate, is included in the regression.[151]

Figure 32 shows the generalized impulse response functions (GIRFs) for the estimated bank vs. overall (i.e., cross-industry) corporate CDS equations for the three sample regions. We follow standard practice and exhibit the four possible impulse response functions for each bivariate dependency between the impulse and response variables in one panel. Each sub-panel exhibits four lines referring to the GIRFs scaled by the standard deviation of the impulse variable's regression equation during the four sub-periods observed over 10 trading days (the contemporaneous response is captured in period 1 and the ensuing responses are traced in subsequent periods).

The results from the GIRF analysis largely confirm the findings in the Granger-causality analysis. For the American sample the GIRFs show a lasting and positive impact of innovations in the bank CDS on the corporate CDS since period 2. Moreover, the analysis of the full model dynamics shows that changes in corporate CDS are informative for bank CDS in period 1 and additionally it obtains that innovations in the corporate CDS are informative for the bank CDS in period 2. In Asia-Pacific the innovations of bank CDS have a lasting and positive impact on the corporate CDS since period 2 and the opposite impact is observed for corporate credit spreads since period 2. The GIRFs in the European sample confirm that shocks in the bank CDS are informative for the corporate CDS since the subprime crisis period. The effects of the impulse decay over time which is consistent with the stationarity of the variables found in the unit root tests.[131]

The upper panel of Figure 34 shows the average correlations between the regional bank and (overall) corporate CDS spreads. Before July 2007 the regional average correlations show a high degree of individual movement whereas after the crisis a strong comovement can be observed. The average correlation level rises from 0.46 in periods 1 and 2 to 0.76 in periods 3 and 4. The European sample exhibits the highest average correlation (0.85) followed by Asia-Pacific (0.73) and America (0.70) in periods 3 and 4. The industry-specific bank vs. corporate

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[150] Minor deviations describe the case when dependencies observed *with* control variables are significant at a significance level up to five percent *higher* than dependencies found *without* control variables (or *equivalently* five percent *lower* when the controlled results show dependencies not observed without control variables).

[151] These results are omitted due to space considerations.

CDS correlations are shown in Table 36 and exhibit the same trends as described for the overall corporate data. Moreover, it can be noted that the cross-industry variation of the correlations is particularly low during periods 2 and 3.

Impact of systemic risk on the strength of the causality relation

As a further step we examine the explanatory power of the regional ESS-indicator for the strength of the Granger-causality relation between bank and corporate CDS. To this end we conduct our previous Granger-causality time series regression analysis for the regional bank and corporate CDS spreads using an estimation window of 250 trading days which we roll forward from the beginning until the end of the sample period. As before, the resulting p-values of the F-statistic measure the strength of the observed Granger-causality dependency. We employ the p-values for each region as dependent variables in linear regressions using as independent variables the regional relative ESS-indicator (as measure of systemic risk) alone and together with the regional stock index and the federal funds rate as control variables.

The results of this regression are shown in Table 38. In the American and European sample we find that the coefficient of the regional relative ESS-indicator has a strongly significant negative sign both without and with control variables. This translates into the following relation in these two regions: When the systemic risk *increases*, the significance of the Granger-causality between bank and corporate CDS spreads also *increases* (because the p-value of the F-statistic *decreases*). For Asia-Pacific the coefficient of the regional relative ESS-indicator is only significantly negative when no control variables are included whereas the coefficient is no longer significant when control variables are included in the regression. While the results for Asia-Pacific are mixed it can be noted that the findings for America and Europe clearly validate the claim that systemic risk impacts the real economy.

6.2.3.1.2 Equity prices

Table 35 shows the results for the banking vs. non-bank corporate sector equity return Granger causality analysis excluding control variables. For the *American* sample we find that the non-bank corporate equity returns lead the bank equity returns in periods 2 and 3. In the following we describe the industry-specific *deviations* from this cross-industry result. For the automotive as well as the construction and logistics firms we find no significant interdependency with the bank equity returns. The equity returns of the basic materials firms do not Granger-cause the bank equity returns in period 3 but in period 4. For the chemicals, healthcare and pharma as well as for the commerce and consumer companies we find that

their equity returns lead the bank equity returns in period 3 (but not in period 2). The results for the equity returns of the energy and utilities firms differ from the overall findings in period 3 where they are led by the bank equity returns. Regarding the other industrial firms' equity returns we find these do not depend the bank equity returns in period 3.

Among the *Asia-Pacific* firms we find that the corporate equity returns lead the bank equity returns in periods 2 and 3 and in period 4 a feedback relation between bank and non-bank equity prices exists. In the following we describe the deviations from this cross-industry finding for the respective industry clusters. For the automotive firms' equity returns we find them to be Granger-caused by bank equity returns in period 2 whereas they do not lead the bank equity returns in any period. The equity returns of the basic materials firms' have a feedback relation with the bank equity returns in period 3. Concerning the chemicals, healthcare and pharma equity returns it can be noted that these Granger-cause the bank equity returns only in period 3. By contrast, the commerce and consumer firms' equity returns are informative for the bank equity returns in periods 3 and 4 (but not in period 2). The equity returns of the construction and logistics firms have predictive power for the bank equity returns in period 1 (but not in periods 2 and 3). The results for the energy and utilities firms deviate from the cross-industry results in that a lead-lag relation between the industries' and bank equity returns is found in period 1 and a feedback relation is observed in period 3. The equity returns of the financial services firms lead the banks' equity returns in period 1 whereas no other lead-lag relation is observed for this industry cluster. Concerning the other industrial firms' equity returns, a feedback relationship with the bank equity returns is observed in period 2; in period 3 the bank equity returns lead the industrial firms' equity returns. The results for the TMT firms are largely consistent whereas in period 4 only the TMT firm equity returns are informative for the bank equity returns (but not vice versa).

In *Europe* we observe that the non-bank corporate equity returns Granger-cause the bank equity returns in period 2 whereas no other dependencies are observed. The industry-level deviations from these overall results are elaborated in the following. The results for the following industry-clusters deviate from the overall results as they do *not* show any dependencies with the bank equity returns: automotive, chemicals, healthcare and pharma, construction and logistics, energy and utilities as well as financial services. The equity returns of the commerce and consumer firms lead the bank equity returns in period 4 (however not in periods 2 and 3). The equity returns of the (other) industrial firms are Granger-caused by the

bank equity returns in period 3. With respect to the TMT firms we find their equity returns to lead the bank equity returns in period 4 (however not in period 3).

The lower panel of Table 35 shows the Granger-causality test results for intra-regional bank vs. corporate equity returns analysis where the global stock index and the federal funds rate are included as exogenous control variables. The main findings are consistent with the results excluding control variables whereas the strength of the dependency (as measured by the p-value of the F-statistic) varies slightly. Minor deviations[150] exist in the American sample (periods 1 to 3), Asia-Pacific and Europe (both period 3). The same applies to the results obtained when only one control variable, i.e., stock index *or* federal funds rate, is included in the regression.[152]

Figure 33 shows the generalized impulse response functions (GIRFs) for the bank vs. overall (i.e., cross-industry) corporate equity returns equations for the three sample regions. The results from the GIRF analysis largely confirm the findings in the Granger-causality analysis. For the American sample the GIRFs confirm that innovations in corporate equity returns are informative for bank equity returns in periods 2 and 3. In Asia-Pacific the GIRF analysis confirms that shocks in bank equity returns have predictive power for the corporate equity returns in period 4 and that the opposite relation exists since period 2. The GIRFs for the European sample show that innovations in corporate equity returns are (slightly) informative for bank equity returns. The effects of the impulse decay over time which is consistent with the stationarity of the variables found in the unit root tests.[131]

The lower panel of Figure 34 shows the average correlations between the regional bank and (overall) corporate equity returns. The average correlation level *decreases* slightly from 0.84 in periods 1 and 2 to 0.80 in periods 3 and 4. This decrease may reflect the market's perception during the crisis that banks have somewhat decoupled from the 'real economy' whereas further research is necessary to explain this observation. At a level of 0.80 the correlations in Asia-Pacific and Europe are highest in periods 3 and 4 compared to 0.76 in America. Table 37 shows the industry-level bank vs. corporate equity return correlations. In America and Europe the financial services industry cluster firms' equity returns have the highest correlations with the bank equity returns whereas in Asia-Pacific the TMT firms' equity prices exhibit the highest correlations with the bank equity returns.

[152] These results are omitted due to space considerations.

6.2.3.2 Evaluation of initial hypotheses

In this section we evaluate the initial hypotheses based on the preceding econometric results.

6.2.3.2.1 CDS spreads

In the *American* sample we find that the bank default risk does indeed lead corporate default risk since period 2 as posited in hypothesis C1 and that the strength of this dependency increased during the financial and sovereign debt crisis periods. By contrast, in period 1 the corporate CDS lead the bank CDS. A possible explanation for the change in the bank vs. corporate default risk dependency in period 2 may be that before the financial crisis the 'real economy' (represented by the non-bank corporate firms) played a larger role for the American banking sector whereas since the onset of the subprime crisis, markets noticed that the banking sector has become somewhat decoupled from the real economy because of its exposure to structured assets and derivatives (rather than loans) as well as the high correlation of banks' asset and funding risks. In this sense, the American banking sector itself became a potential risk for the non-bank corporate sector which is also reflected by the economic crisis which followed the financial crisis. Moreover, the results could provide evidence for the impact of the crisis-related increase in bank funding costs on non-bank corporate firms and their default risk. Further research is necessary, though, to adequately classify this finding.

A closer examination of the industry-level results shows that the observed dependency between corporate and bank default risk in period 1 results from the commerce and consumer as well as the industrial firms whereas the CDS of firms in other industries have either no dependency with the bank CDS or are actually impacted on by the bank CDS (basic materials and TMT). As of period 2 the industry-level results are largely consistent with the overall findings whereas in some periods the credit risk of certain industries also impacts on the banking sector risk (energy and utilities, financial services, industrial) or no dependency is observed (TMT). While the feedback relation between the default risk of banks and other financial services firms can be explained by the close mutual dependency of these sectors due to similarities in financing and investment activities, further research is necessary to understand the industry-specific determinants for the sensitivity of firm default risk to bank default risk in the American sample. The default risk of the firms from the automotive, commerce and consumer, financial services as well as the other industry clusters are affected most by the bank default risk in periods 3 and 4 (measured in terms of the F-statistics).

In the *Asia-Pacific* sample we find the dependency formulated in hypothesis C1 validated in period 2 and 3 whereas in period 3 there is also a dependency from the corporate sector CDS to the bank CDS (albeit less significant). During the sovereign debt crisis period the latter dependency became more pronounced and the impact of bank vs. corporate default risk is no longer significant. Interestingly, no dependency is observed during period 1 which can possibly be explained by the low level and volatility of CDS spreads in the Asia-Pacific sample before the crisis.

The change in the dependency direction in the Asia-Pacific sample from period 3 to period 4 requires some classification. On the industry-level we find that in period 4 the credit risk of several industries is still significantly influenced by the bank default risk whereas the dependency in the other direction has overall become more dominant. A possible explanation for this could be that banks in the Asia-Pacific region focused again more on their core function after the financial crisis, the provision of credit, which made their credit risk more susceptible to changes in the default risk of non-bank corporate firms. It is not transparent, however, why the importance of the banking sector risk for the corporate default risk can no longer be observed during the sovereign debt crisis period, particularly since the financial crisis exposed the relevance of systemic financial sector risk for the real economy. Consequently, further research is necessary to adequately explain the observed effects.

The overall corporate sector results for Asia-Pacific in periods 2 and 3 are largely confirmed by the industry level results whereas for certain industries (automotive, chemicals/healthcare/ pharma, financial services) the dependency is not found in all periods. In period 4 the default risk of the financial services firms and the bank default risk exhibits a feedback relation which reflects the strong interdependence of these sectors. The companies which are affected most by bank default risk in Asia-Pacific in periods 3 and 4 are those from the industrial clusters basic materials, commerce and consumer as well as energy and utilities.

In the European sample we can confirm hypothesis C1 regarding the impact of the banking sector default risk on the corporate sector credit risk in periods 3 and 4. However, in periods 1 and 2 the opposite dependency is observed. We would explain this observation using the same argument employed for the American sample in period 1 whereas in Europe the market's perception that the banking sector has decoupled from the real economy occurred first during the core financial crisis period (and not already during the subprime crisis period). It should be noted that during the sovereign debt crisis period the corporate sector default risk also impacts the banking sector default risk in Europe. Two alternative explanations could be put

forward for this observation. Firstly, it could be that the change of banks' business models towards more stable and politically desired lending activities[153] after the crisis exposed it stronger to the credit risk of corporate firms. Secondly, the euro zone sovereign debt crisis may have contributed to a higher mutual sensitivity between bank and corporate default risk (which should be observed particularly on a cross-country basis between banks in stable euro zone countries versus firms in euro zone countries with sovereign debt problems). A validation of these explanations requires further research, though.

The overall corporate results for the *European* sample in period 2 are fully confirmed on the industry level and in period 4 only three industries (basic materials, energy and utilities, TMT) do not exhibit the feedback interdependency with the bank default risk. The largest deviations between the overall corporate results and the industry-level results default risk dependencies are observed in periods 1 and 3. The default risk of the firms from the automotive, construction and logistics, financial services and industrial segments is affected most by the bank default risk in Europe in periods 3 and 4.

In the following we compare the overall bank vs. corporate default risk dependency results for the respective sample regions. Before the onset of the subprime crisis the corporate default risk impacted on the banking sector CDS in America and Europe whereas in Asia-Pacific no significant dependency is observed. In period 2 the bank default risk leads the corporate default risk in America and Asia-Pacific whereas in Europe the opposite relation exists. During the financial crisis period 3, the bank CDS lead the corporate CDS in *all* regions which confirms the common perception that during the financial crisis the banking sector risk spread to the real economy.[154] By contrast, the results are mixed in period 4: while the American sample still exhibits the bank vs. corporate default risk dependency, the opposite relation is observed in Asia-Pacific and in Europe a feedback relation between bank and non-bank corporate default risk exists.

On a cross-regional basis we compare the bank vs. corporate default risk dependencies for the respective industries. In periods 3 and 4 the sensitivity of the corporate default risk with respect to the bank default risk is highest for the automotive, commerce and consumer, financial services and industrial industry segments across all regions as measured by the

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[153] In fact, after the crisis governments and regulators in Europe (but also in other countries) pushed banks to provide more lending to the economy and refocus their business models.

[154] Further evidence for this is provided in the above regression using the p-values and the regional relative ESS-indicators.

average p-values of the F-statistics. By contrast, for periods 1 and 2, a consistent cross-regional industry ranking with respect to the sensitivity of the firm's default risk to the bank default risk is not feasible. The financial services firms' default risk exhibits the most *feedback relations* with the banking sector default risk in all regions which can be explained by the common exposures and financing channels pertinent to all financial services firms.

6.2.3.2.2 Equity prices

In the *American* sample we find that hypothesis C2, according to which the corporate equity returns lead the bank equity returns, does indeed apply in periods 2 and 3. By contrast, in period 1 no dependency is observed and in period 4 the lead-lag relation only applies for the basic materials industry cluster. One may wonder why the dependency between corporate and bank equity returns is only observed during the subprime and financial crisis periods. It could be argued that during the crisis when financial institutions faced substantial losses from their investment banking activities already, the additional deterioration in the business prospects of corporates (as measured amongst others by corporate equity prices) increased the loss potential for financial institutions and hence affected their equity prices. However, additional research needs to be conducted to adequately explain this observation.

On the industry level we find that the equity returns of firms from four industries (automotive, basic materials, construction and logistics, industrial) show no interdependency with bank equity returns in period 2. In period 3 we observe no dependency between corporate and bank equity returns in five industries (automotive, basic materials, commerce and consumer, construction and logistics, industrial) and additionally we find that the bank equity returns impact the equity returns of energy and utilities firms.

In the *Asia-Pacific* sample we find that the corporate equity returns impact on the bank equity returns in periods 2, 3 and 4, thereby confirming hypothesis C2. In period 4 we observe an additional dependency between bank and corporate equity prices. By contrast, in period 1 no dependency between bank and corporate equity returns can be observed.

A closer examination of the Asia-Pacific industry-level results reveals that the overall results are observed only for few industries in periods 2 and 4. In period 2, only the equity returns for the industrial and TMT firms do actually lead the bank equity returns whereas the other industries' firms do not exhibit this dependency. Moreover, the automotive and industrial firms exhibit a dependency in the opposite direction in period 2. In period 4 the equity returns of commerce and consumer, industrial and TMT firms impact the bank equity returns whereas

the opposite dependency is observed for industrial firms. The industry-level results in period 3 largely confirm the overall findings whereas for the basic materials and the energy and utilities firms feedback interdependencies are found and the industrial firms' equity returns are led by bank equity returns.

In the *European* sample we find that the overall corporate sector equity prices lead the bank equity returns confirming hypothesis C2 only in period 2. On the industry-level these results are also found for the firms from the basic materials, industrial and TMT industry clusters.[155] During the other periods we find no significant overall dependencies between banking and corporate sector equity returns. Exceptions apply at the industry-level, though: in period 3 bank equity returns depend corporate equity returns and in period 4 the opposite dependency applies for the commerce and consumer as well as the TMT firms.

By comparing the regional results one can note a substantial deviation in the overall regional results. Corporate equity returns lead bank equity returns in all regions in period 2 whereas in period 3 only America and Asia-Pacific share this property. While the bank and corporate equity returns in Asia-Pacific have feedback interdependencies in period 4, no significant dependencies are observed for America and Europe in this period. The industry-specific results across all regions show that the equity returns of the industrial and TMT firms have the highest impact on the bank equity returns (in terms of the average p-values of the F-statistics) whereas for the other industries no clear pattern can be observed.

Comparative discussion

A comparison of the causality test results for bank vs. non-bank corporate sector dependencies shows the opposite dependencies for CDS and equity prices: while the banking sector CDS spreads mostly lead the non-bank corporate CDS spreads, the opposite dependency is found for equity prices in most periods. For the CDS spreads this dependency can be explained amongst others by the funding channel since banks provide lending to firms and thus changes in funding costs of banks should impact on the funding costs of non-bank corporate firms. In case of the equity returns, the analysis of the results is more ambiguous: while the observed dependency can be explained by the relationship between a bank's profitability and the credit quality of its loan portfolio (a possible measure for which is the corporate sector equity performance) the opposite dependency could also be argued as well by

[155] At the six percent significance level this result also applies to the commerce and consumer as well as the energy and utilities firms.

the role of the banking sector for the overall economy. This ambiguity is also reflected in the fact that the average strength of the dependency (as measured by the average p-values of the F-statistic) is higher for the CDS spread analysis than for the equity return analysis.

Another striking feature of the CDS and equity banking vs. corporate sector time series analyses alike is that the overall findings are most pronounced for the American market whereas for Asia-Pacific and Europe the results are more heterogeneous. On the industry-level the cross-regional analysis for the CDS spreads shows that the automotive, commerce and consumer, financial services and industrial industry clusters are affected most by the bank CDS spreads whereas for the equity analysis a consistent conclusion for the industry-specific sensitivity cannot be drawn.

Discussion in the context of related research

As pointed out in the literature review there is yet no research concerning the contagion effects between the banking sector and non-bank corporate sector CDS spreads or respectively equity returns. Therefore, a discussion of our results in the context of findings by other authors is unfortunately not feasible.

7 CONCLUSION

7.1 SUMMARY AND IMPLICATIONS

In this thesis we developed a new framework for measuring systemic risk and assessing systemic importance, the 'expected systemic shortfall' (ESS) methodology. We applied the ESS-methodology in a comprehensive empirical analysis of systemic risk and systemic importance in global and regional financial markets. Moreover, we conducted a comprehensive analysis of banking sector risk contagion effects using state-of-the-art econometric time series methods.

In chapter 2 we described the related literature on the topics covered in this thesis. Firstly, we defined systemic risk and systemic importance in the context of the related literature and provided a structured elaboration of the existing measurement approaches for these concepts. Also, we elaborated the contribution of our ESS-methodology to the existing literature. Secondly, we presented the relevant literature on contagion transmission channels in financial markets and on the relevant banking sector risk contagion effects. The hypotheses examined in the analysis of banking sector risk contagion dependencies were elaborated in chapter 3.

In chapter 4 we presented the methodology employed in this thesis. Firstly, we derived our ESS-framework by constructing a hypothetical bank liability portfolio and described the employed credit portfolio model whose input parameters are estimated from capital market data. Using standard measures from financial institution risk management, we obtained the *aggregate* ESS-indicator which represents the probability of a systemic default event in the financial sector and the expected loss when this event occurs. Also, we derived the *relative* ESS-contribution by individual institutions. A technical comparison of the ESS-methodology with other measures of systemic risk concluded our description of the ESS-indicator. Secondly, we elaborated the econometric methods employed for measuring banking sector risk contagion effects which involve Granger-causality tests and the analysis of generalized impulse response functions in vector autoregressive frameworks.

Chapter 5 described the empirical data analyzed in this thesis which covers the observation horizon between October 1st, 2005 and April 30th, 2011. The global bank sample comprises 83 banking groups from 28 countries and is the most comprehensive data set ever considered in an analysis of systemic risk and systemic importance. We divided the global sample into the four regional sub-samples America, Asia-Pacific, Europe and Middle East & Russia. CDS

spreads and equity returns are used to estimate the input parameters of the ESS-methodology, the risk-neutral default probability and the equity return correlation, for each sample. The sovereign sample comprises the CDS spreads of the 28 origin countries of the sample banks. The non-bank corporate sample covers the CDS spreads and equity returns of 352 companies from the regions America, Asia-Pacific and Europe.

In chapter 6 we presented the results of the empirical analysis. Firstly, we described the results from applying the ESS methodology. The evolution of the ESS-indicator captures both the crisis events with global importance as well as region-specific crisis events. An analysis of the input factor determinants showed that the default probability is the most important explanatory variable of the ESS-indicator. Regarding the risk premium determinants of the ESS-indicator we found that the corporate default risk premium and the liquidity risk premium exhibit the highest explanatory power across all samples. The analysis of the relative ESS-contribution by individual institutions showed that this varies over time whereas the ranking is relatively stable. We found a confirmation of the 'too big to fail' claim because the size of the bank's total liabilities was found to be the most important explanatory variable for its relative systemic risk contribution. Based on the empirical results we derived the policy implications and outlined how the ESS-methodology can be used to monitor systemic risk and to assess the systemic importance of banking groups.

Secondly, we described the results from analyzing the banking sector risk contagion dependencies. For the inter-regional systemic risk contagion effects we found that the systemic risk in the American financial system mostly leads the systemic risk in the other regions since the subprime crisis period. Moreover, the analysis exposed new inter-regional systemic risk dependencies which have not been described previously. The analysis of sovereign vs. banking sector risk contagion showed a strong increase of the interdependencies between sovereign and banking sector credit spreads since the financial crisis. The impact of sovereign on bank default risk even increased during the sovereign debt crisis period. The analysis of bank vs. non-bank corporate risk contagion effects exposed that changes in the banks' default risk depend changes in the default risk of the corporate sector during the financial crisis period in all regions, corroborating the claim that banking sector risk impacts the real economy. By contrast, the analysis of bank vs. non-bank corporate equity returns showed that bank equity returns *are mostly led* by corporate equity returns whereas the opposite dependency is only rarely observed.

7.2 OUTLOOK

We derived the ESS-methodology as a new approach for measuring systemic risk and assessing systemic importance in the financial sector. The derivation and technical implementation of the ESS-framework employs standard methods for credit risk modeling which are also used in the current literature and by practitioners. While we confirmed the adequacy and robustness of the empirical results, the ESS-methodology can be enhanced on the modeling side and also alternative empirical analyses could be considered.

Modeling aspects

In the modeling of portfolio credit risk, different models could be employed to model the credit risk of the hypothetical debt portfolio used in the derivation of the ESS-methodology. In particular, the recent advances in credit risk modeling by means of enhanced structural models and reduced-form models offer potential pathways for future extensions. A comprehensive survey on the current work and open topics in credit risk modeling is provided by Hao/Alam/Carling (2009).

The estimation of asset return correlations within the credit risk model of the ESS-framework can be developed further in two directions. Firstly, the estimation of asset return correlations from equity returns can be extended by enhancements in correlation estimation methodology. Engle (2009) exhibits an extensive survey on the available models and areas for future research in this econometric field. Secondly, estimation methodologies which are based not only on equity returns but also on credit spreads to estimate the asset return correlations could offer a means for enhancing asset correlation estimates.[156] However, corresponding methodologies are to our best knowledge not yet available. Furthermore, different approaches for the estimation of default probabilities could be considered. For instance, the ESS-indicator could be computed using real-world default probabilities obtained from debt rating models. Similarly, the computation of physical default probabilities from credit spreads by isolating risk premium components is an interesting area for future research.

Empirical analyses

As we conducted the most comprehensive analysis of systemic risk and systemic importance in global and regional financial markets to date, an extension of the empirical analysis by including more sample banks is likely only feasible at the expense of shortening the

[156] This is due to the fact that under constant leverage both equity and debt returns can be used to proxy asset returns (as shown in Appendix A).

observation horizon. However, the concept of systemic financial sector risk could be analyzed using the ESS-framework in a broader perspective by also including other relevant types of financial market participants, such as asset management and insurance companies, in the analysis. In so doing, the comparability and consistency of the results due to different business practices and balance sheet structures of the sample companies would need to be ensured, though. In addition, further research could focus on applying the concept of systemic risk to other industries.

Although we have shown the robustness of the results in our analysis of banking sector risk contagion effects by conducting several robustness tests, there are opportunities for future research using upcoming econometric methodology and conducting additional empirical analyses in this rather new field of financial research.

Econometric methodology

The banking sector risk contagion effects were analyzed using the latest methods from time series econometrics. As econometric methodology is evolving continuously along with the advances in analytical frameworks and computational capacities (amongst others), an update of the analyses in this thesis by means of future econometric methods appears worthwhile.

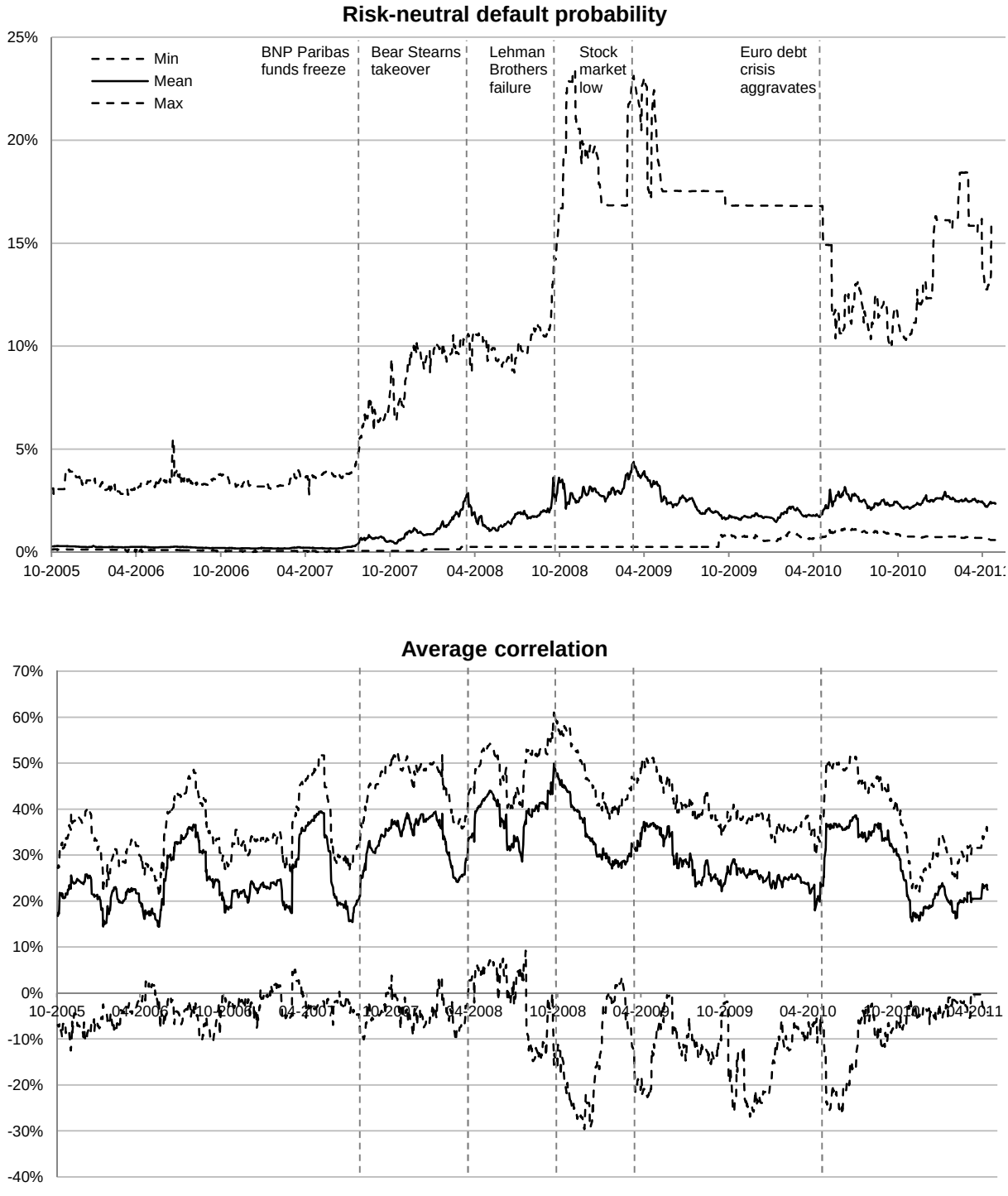
Empirical analyses

While the conducted empirical analyses of banking sector risk contagion effects are quite extensive, further research is necessary to extend this rather new area of financial research. For instance, future empirical implementations could consider a higher granularity of the sample data, e.g., by analyzing country- and firm-level data in addition to region- and industry-level data. Moreover, along with the development of financial markets, further sample data should become available, e.g., from emerging markets, which could be included in future empirical analyses on banking sector risk contagion effects.

Besides, we already outlined in the description of the empirical results that an adequate explanation of certain observed dependencies (e.g., industry-level deviations from overall corporate results) provides a large field for future research. Moreover, further research is required in order to better understand the channels by which the observed banking sector risk contagion dependencies are actually transmitted. In a related strain of research, potential regulatory measures aimed at mitigating certain banking sector risk contagion effects could be developed theoretically and evaluated empirically.

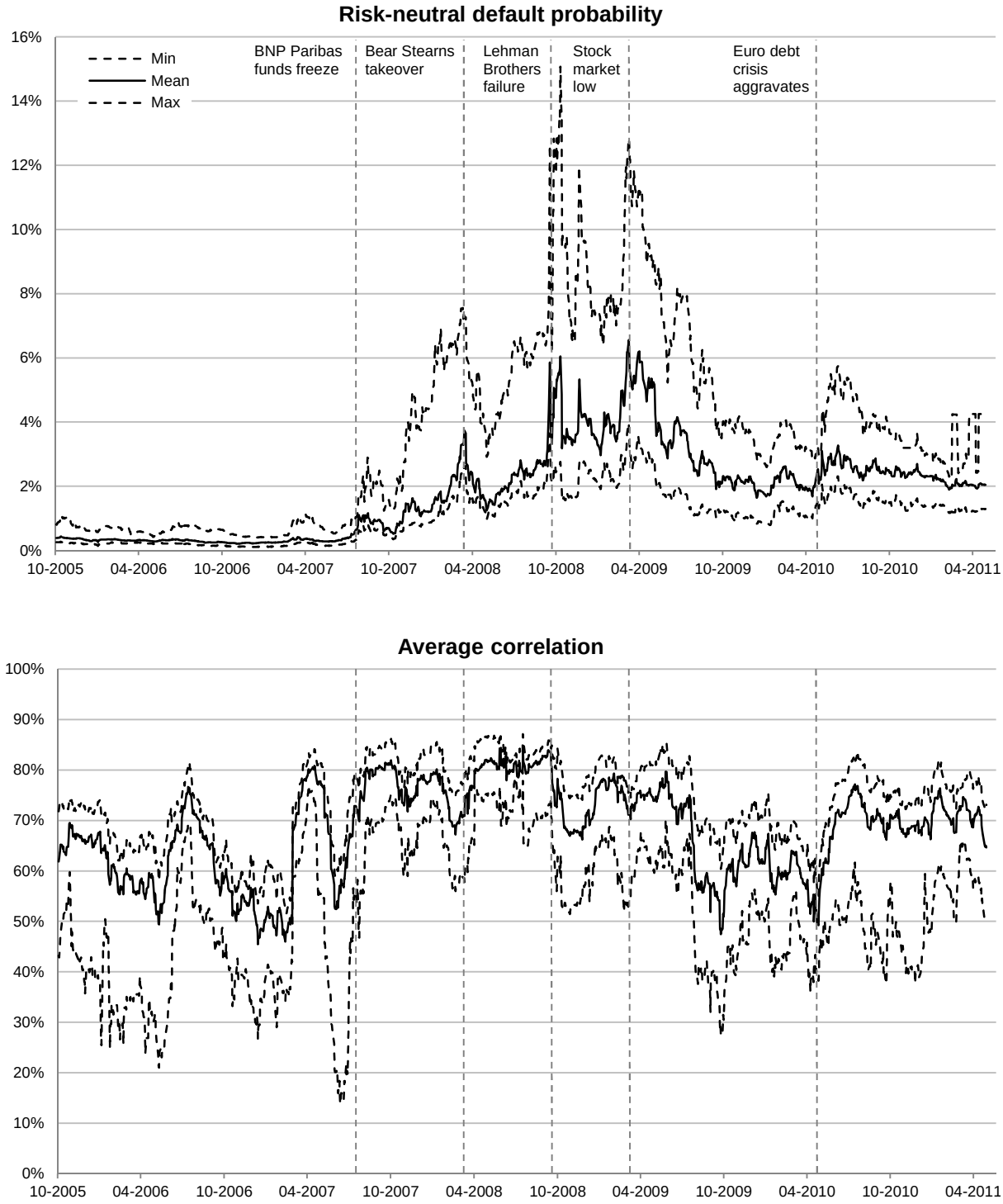
LIST OF FIGURES

Figure 1: Input variables for the ESS-indicator (Global)



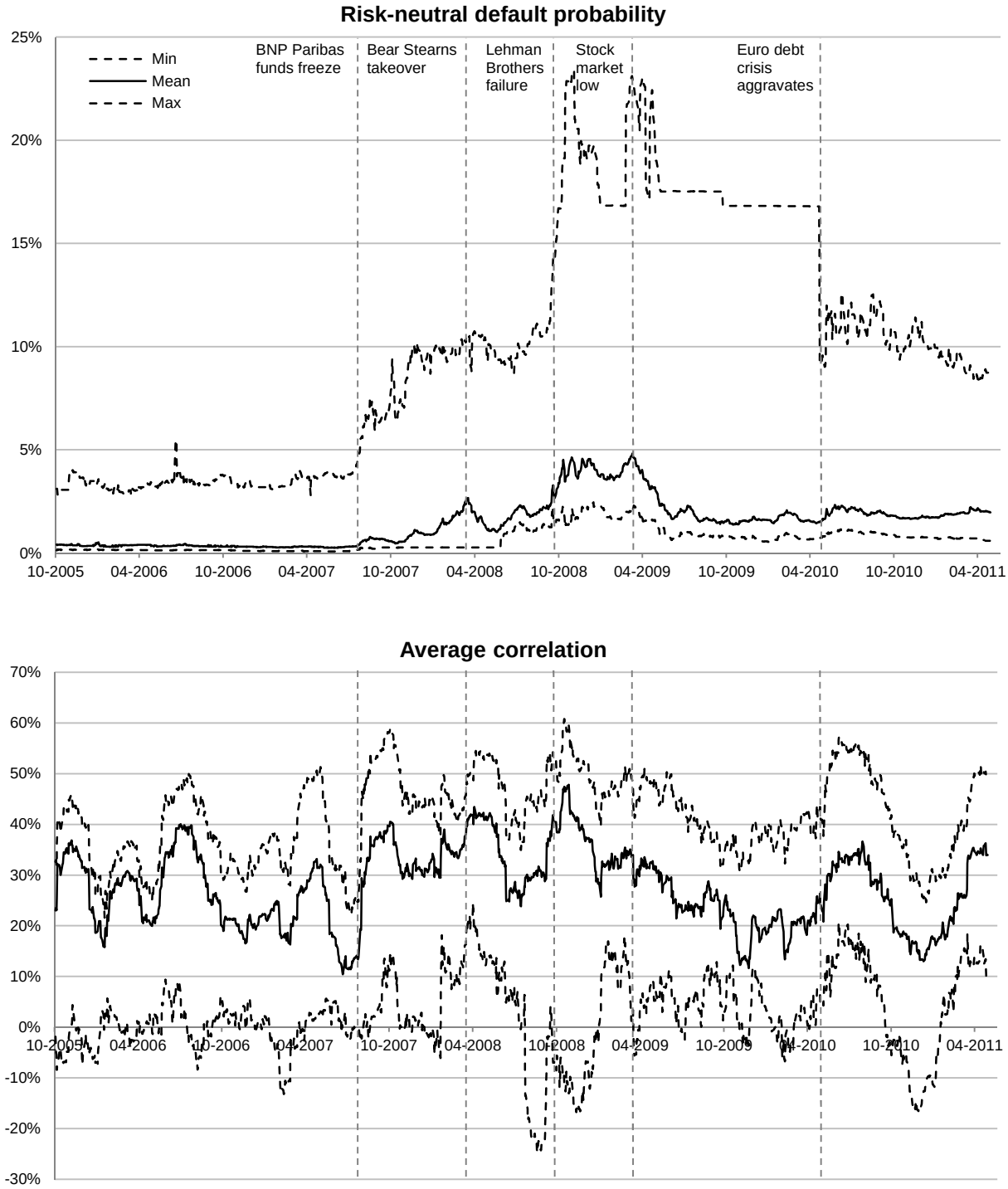
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 2: Input variables for the ESS-indicator (America)



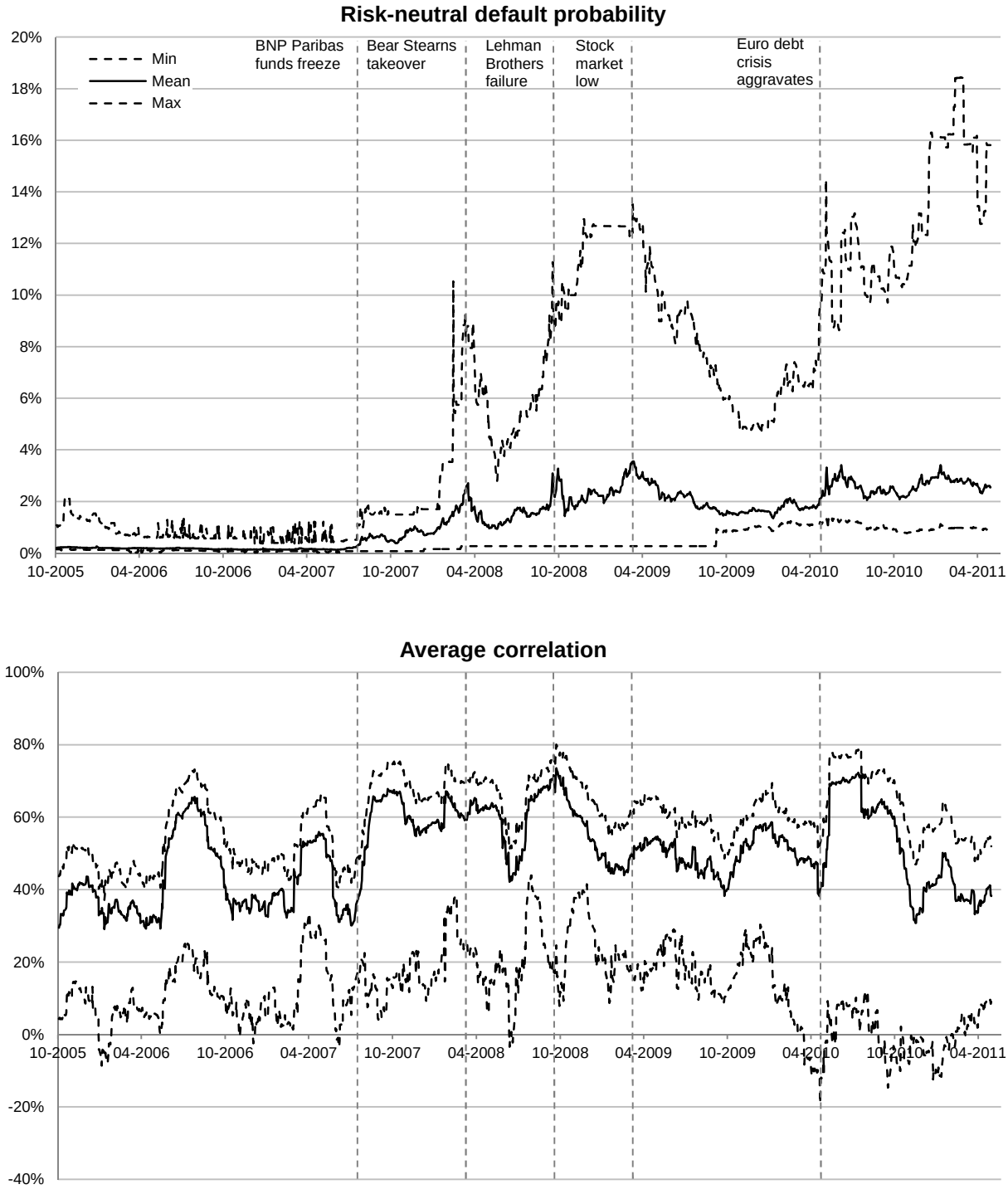
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 3: Input variables for the ESS-indicator (Asia-Pacific)



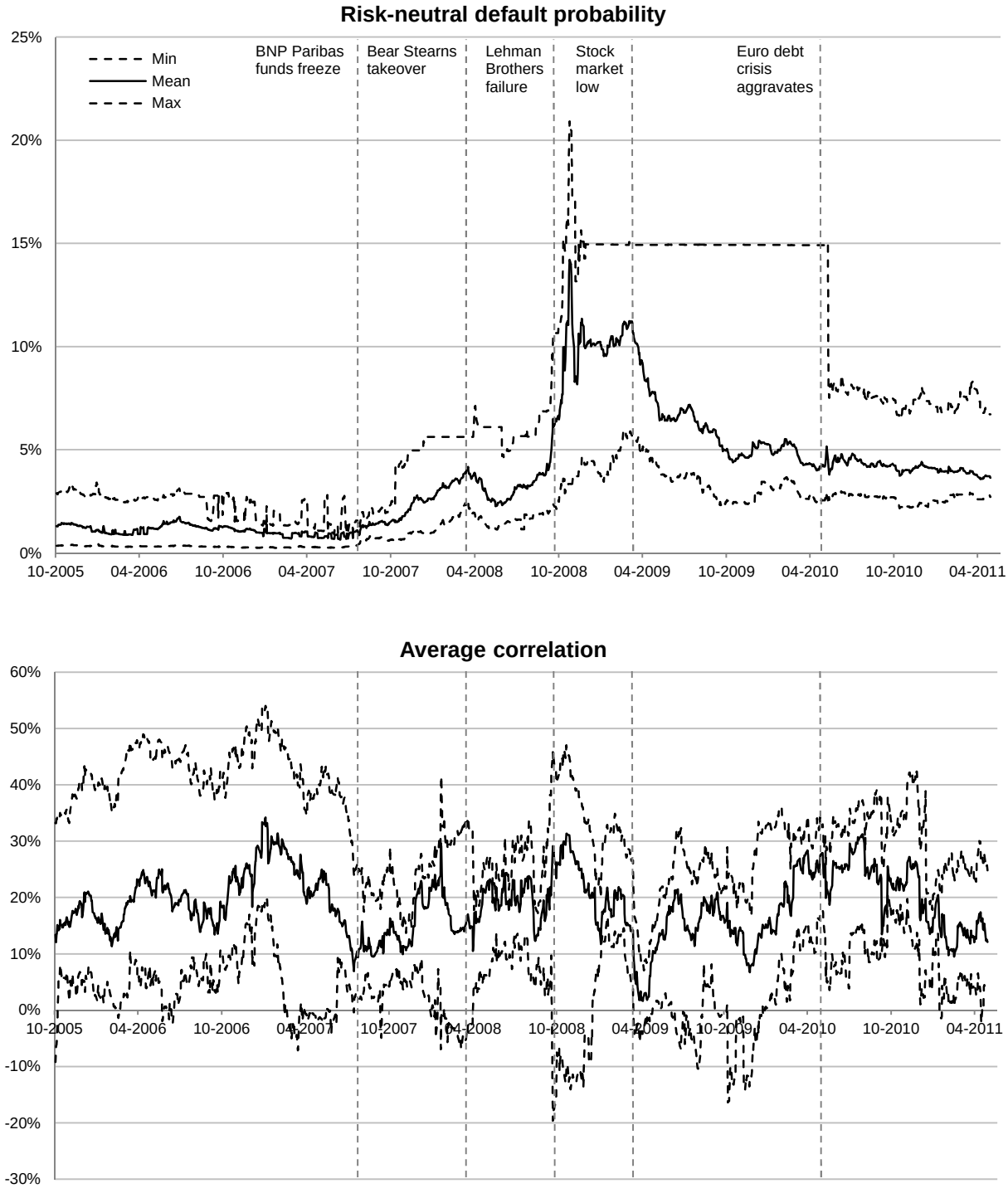
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 4: Input variables for the ESS-indicator (Europe)



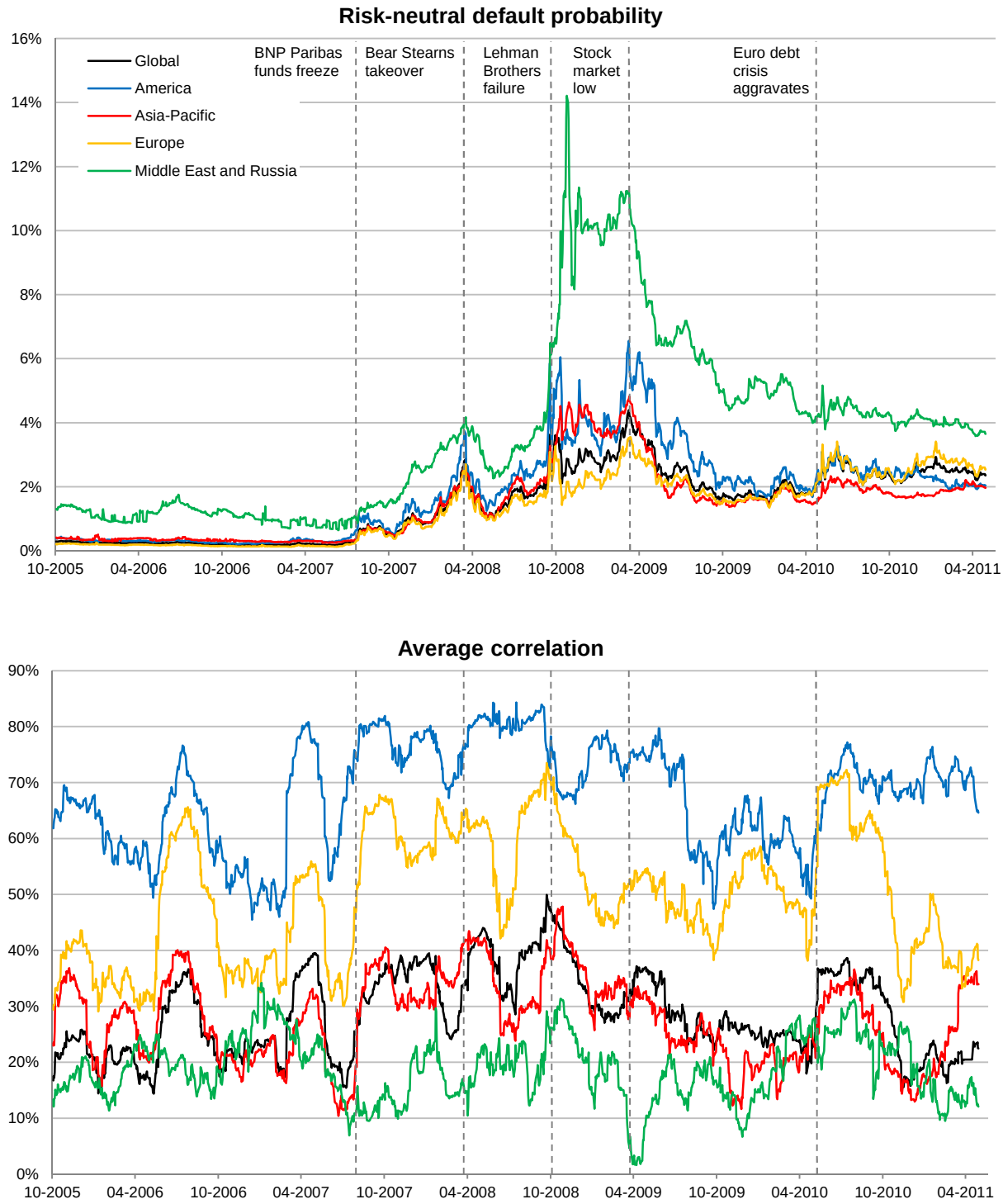
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 5: Input variables for the ESS-indicator (Middle East and Russia)



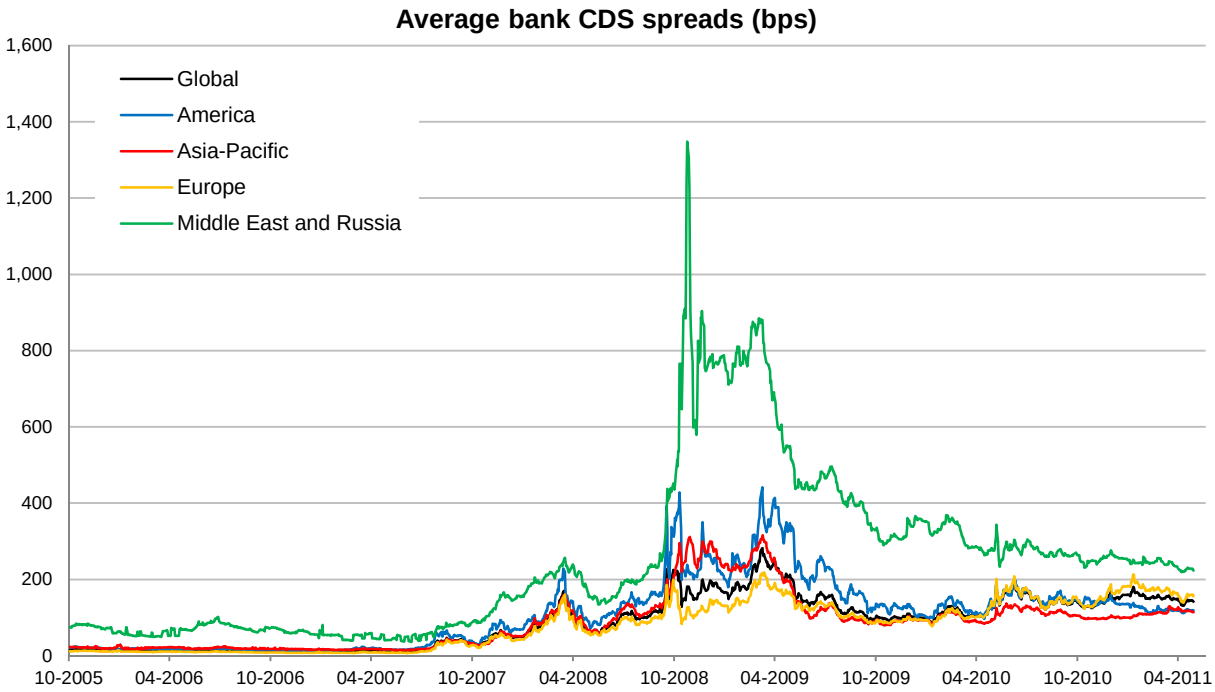
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 6: Input variables for the ESS-indicator (Comparative analysis)



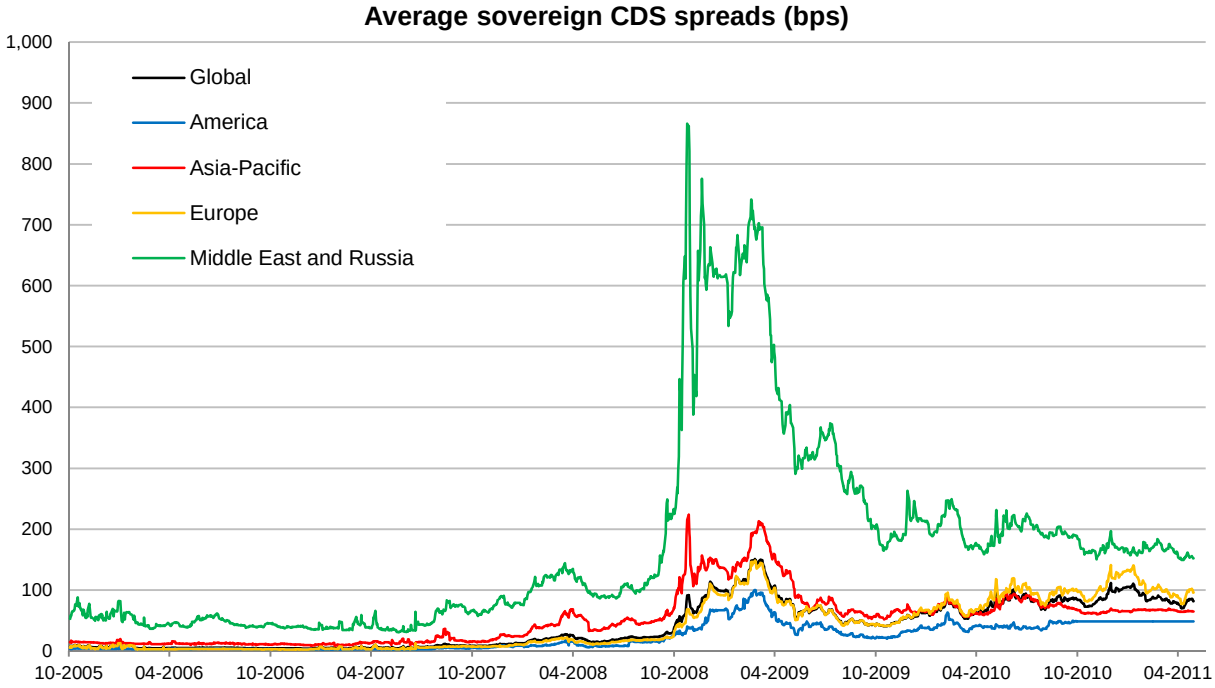
Notes: The upper panel shows the average risk-neutral default probabilities during the observation period (weighted by total liabilities). The lower panel shows the average correlations of the sample banks (computed from the correlations of one bank with all other banks, weighted by total liabilities). The dashed lines represent selected financial crisis events.

Figure 7: Bank CDS spreads



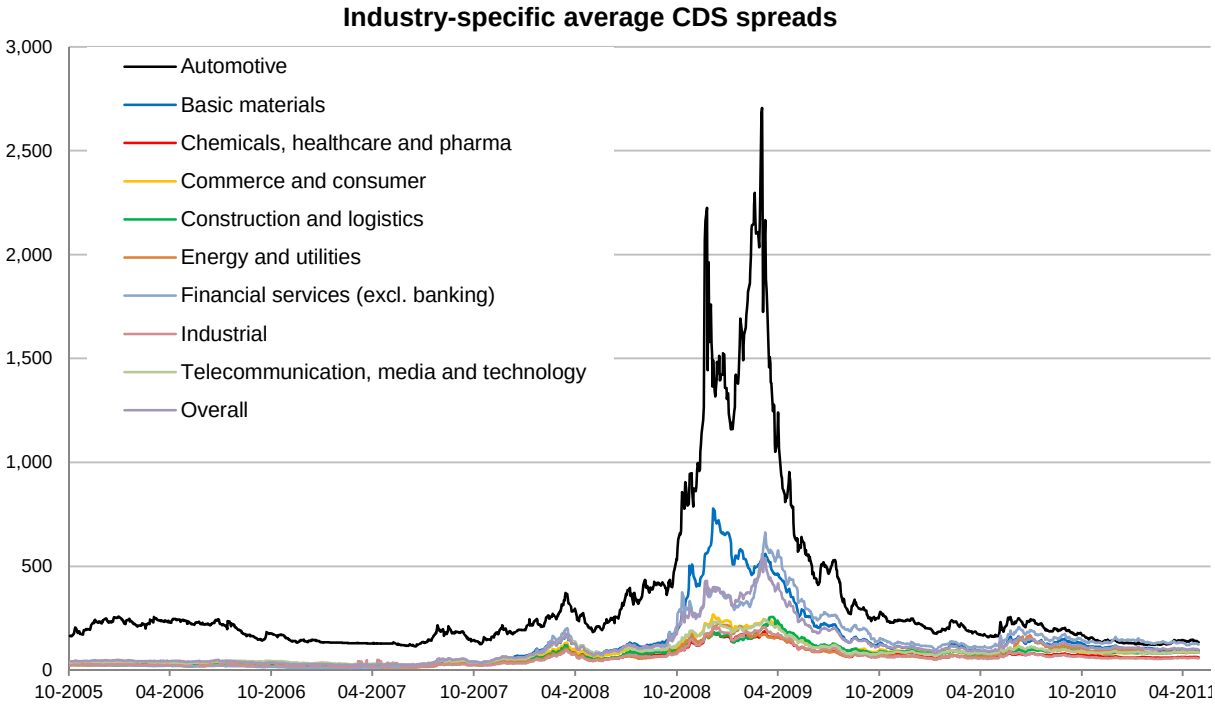
Notes: The panel shows the liability-weighted bank CDS spreads per region.

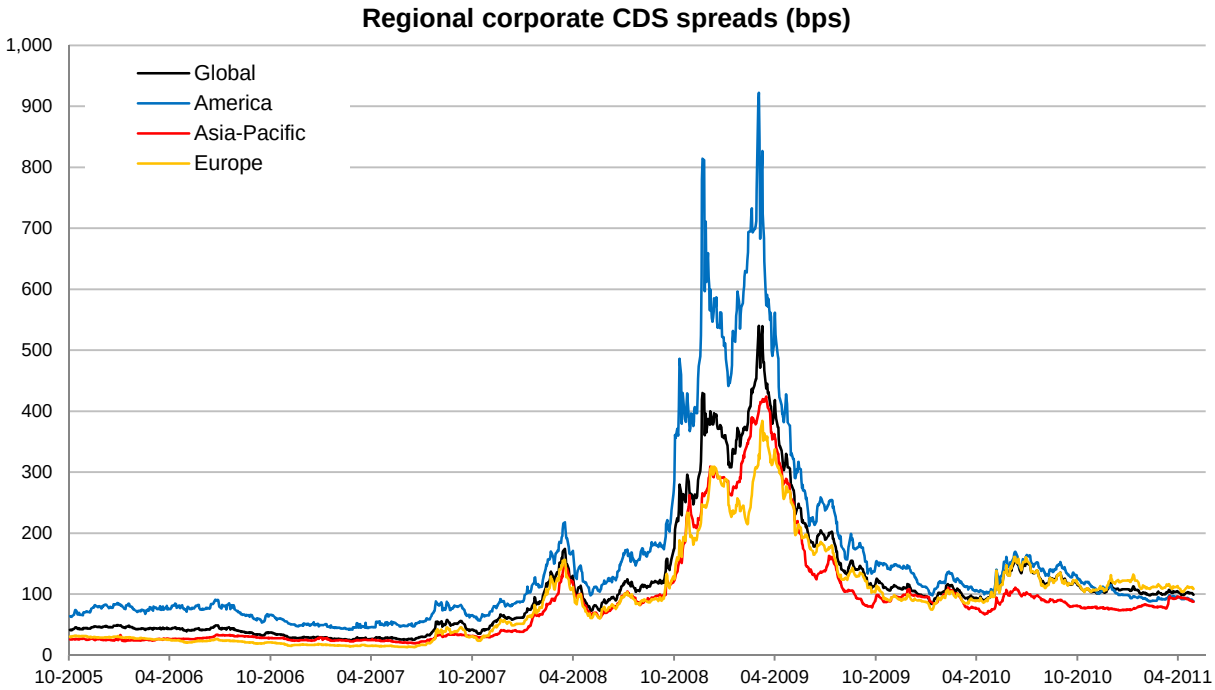
Figure 8: Sovereign CDS spreads



Notes: The panel shows the sovereign CDS spreads per region. The country sovereign CDS spreads are weighted using the total liabilities of the sample banks per country (in order to ensure comparability with the bank CDS).

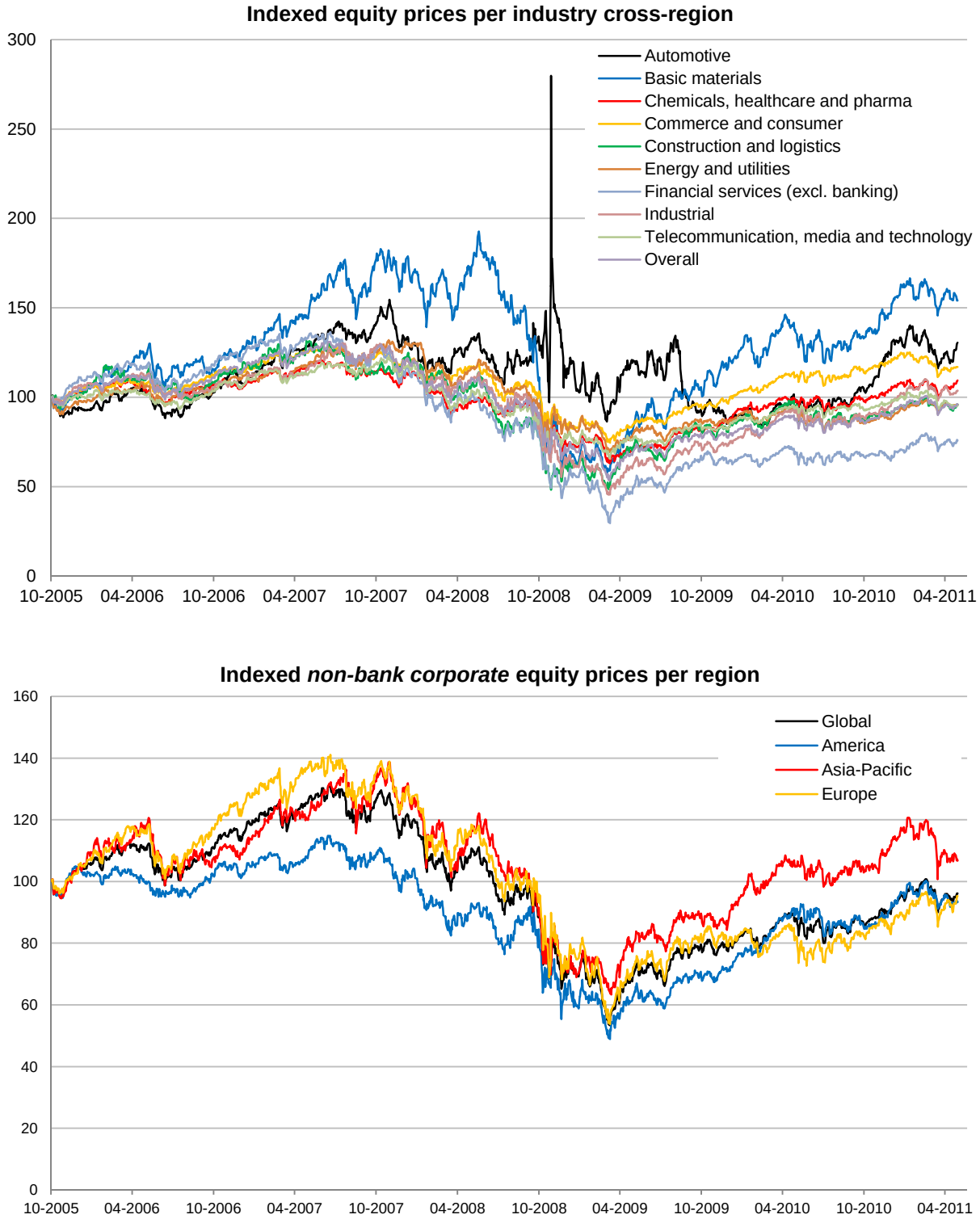
Figure 9: CDS spreads of non-bank corporate firms





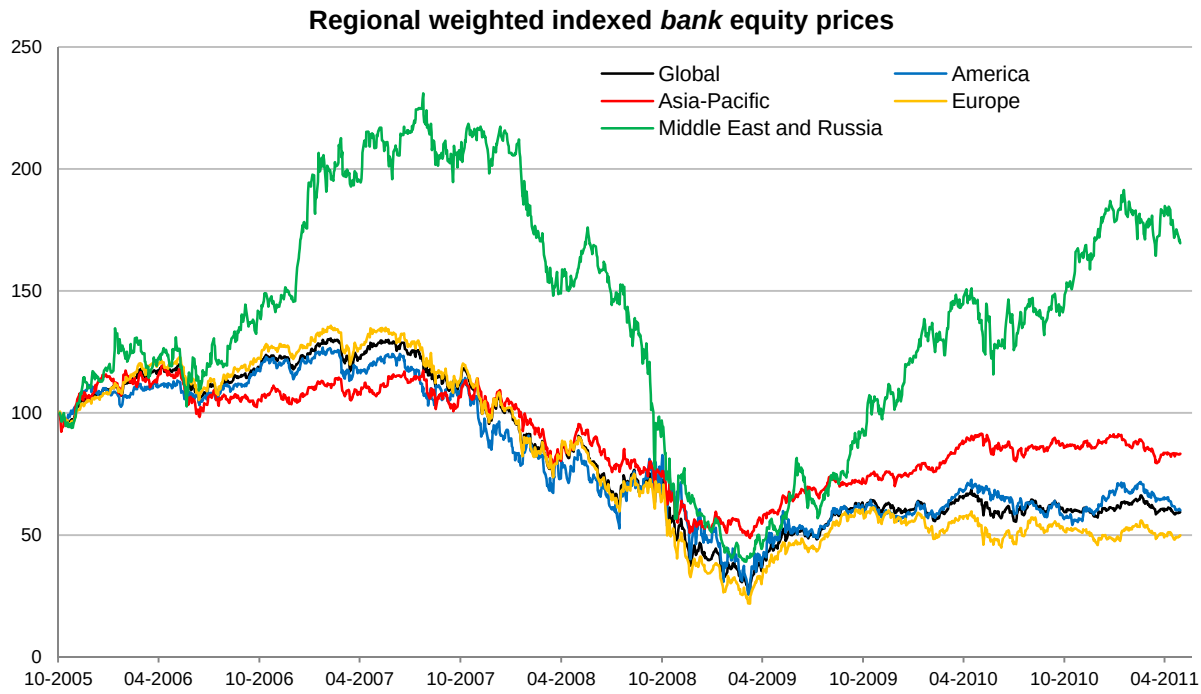
Notes: The upper panel shows the liability-weighted average non-bank corporate CDS spreads of the sample entities across the sample regions. The lower panel shows the liability-weighted average non-bank corporate CDS spreads of the sample entities across the sample industries.

Figure 10: Indexed equity prices for non-bank corporate sample firms



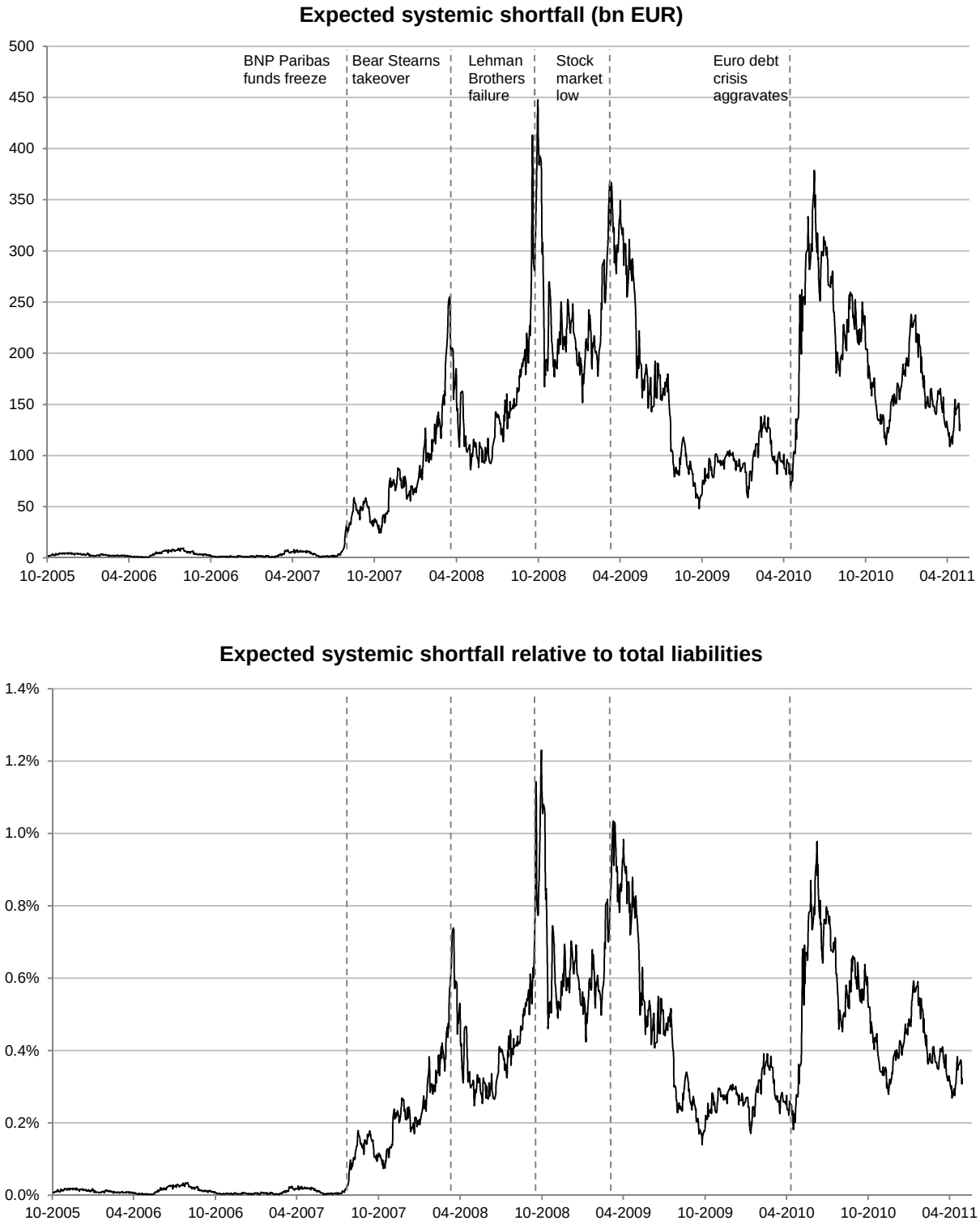
Notes: The upper panel shows the liability-weighted average non-bank corporate indexed equity prices per industry across all sample regions. The extreme hike in the automotive industry cluster on October 28th, 2008 is due to the speculation-induced share price increase of the Volkswagen stock (attempted takeover by Porsche Group). The lower panel shows the same data across all industries for each sample region. The stock prices on October 3rd, 2005 are indexed to 100 points.

Figure 11: Regional weighted indexed bank equity prices



Notes: The panel shows the liability-weighted indexed bank equity prices for the sample regions. The stock prices on October 3rd, 2005 are indexed to 100 points.

Figure 12: Absolute and relative expected systemic shortfall (Global)

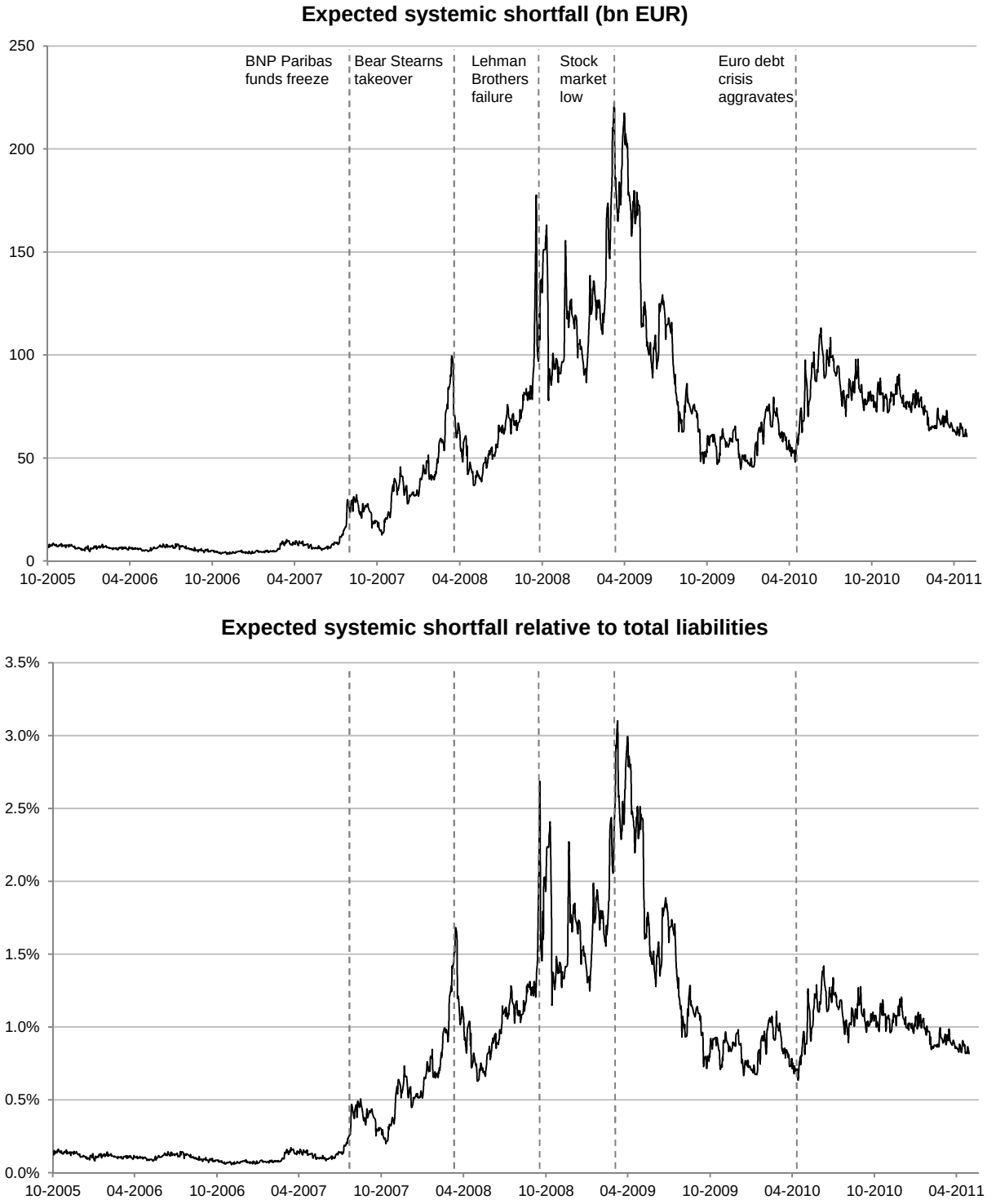


Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 13: Probability of systemic default and expected tail loss (Global)

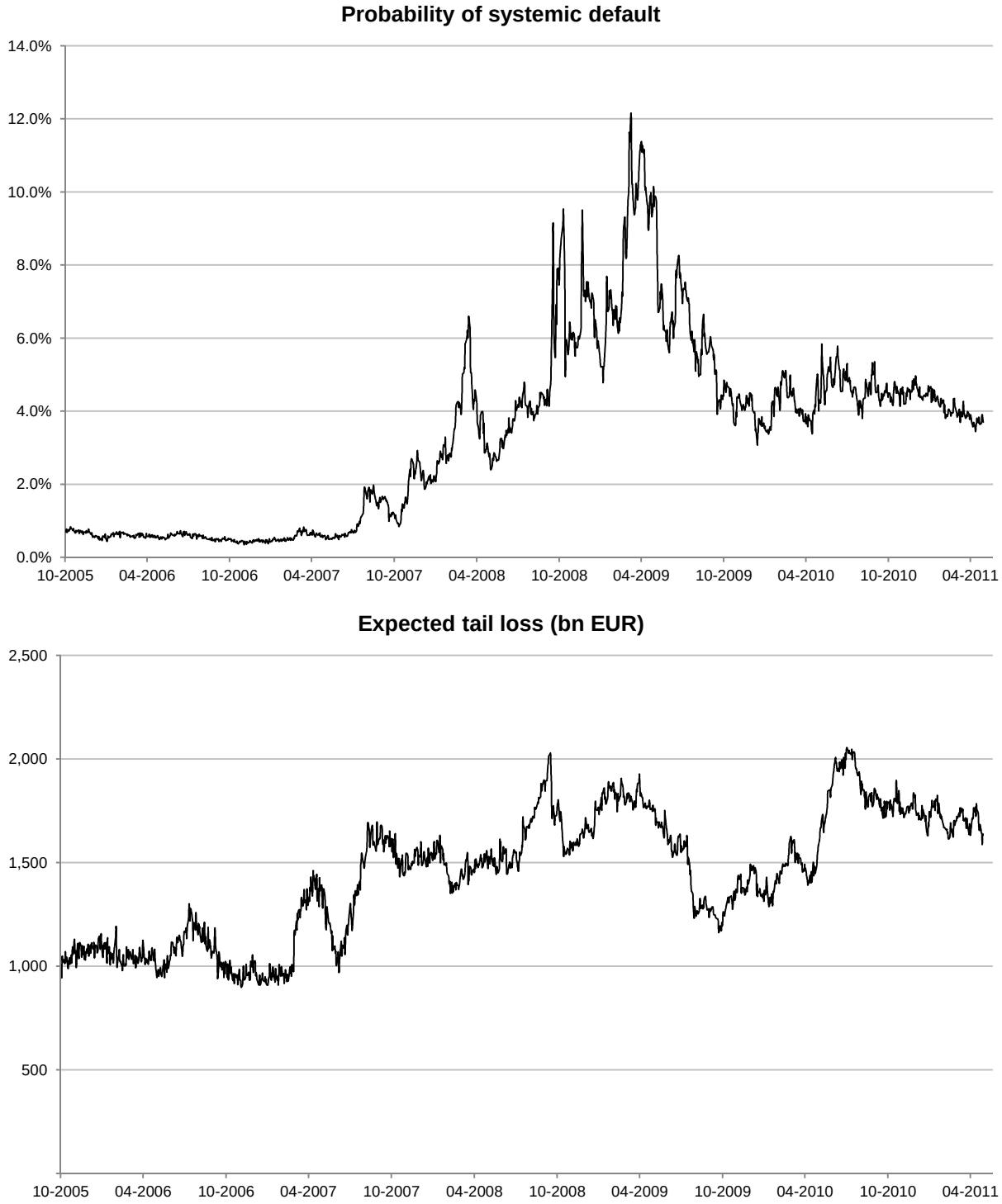
Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 14: Absolute and relative expected systemic shortfall (America)



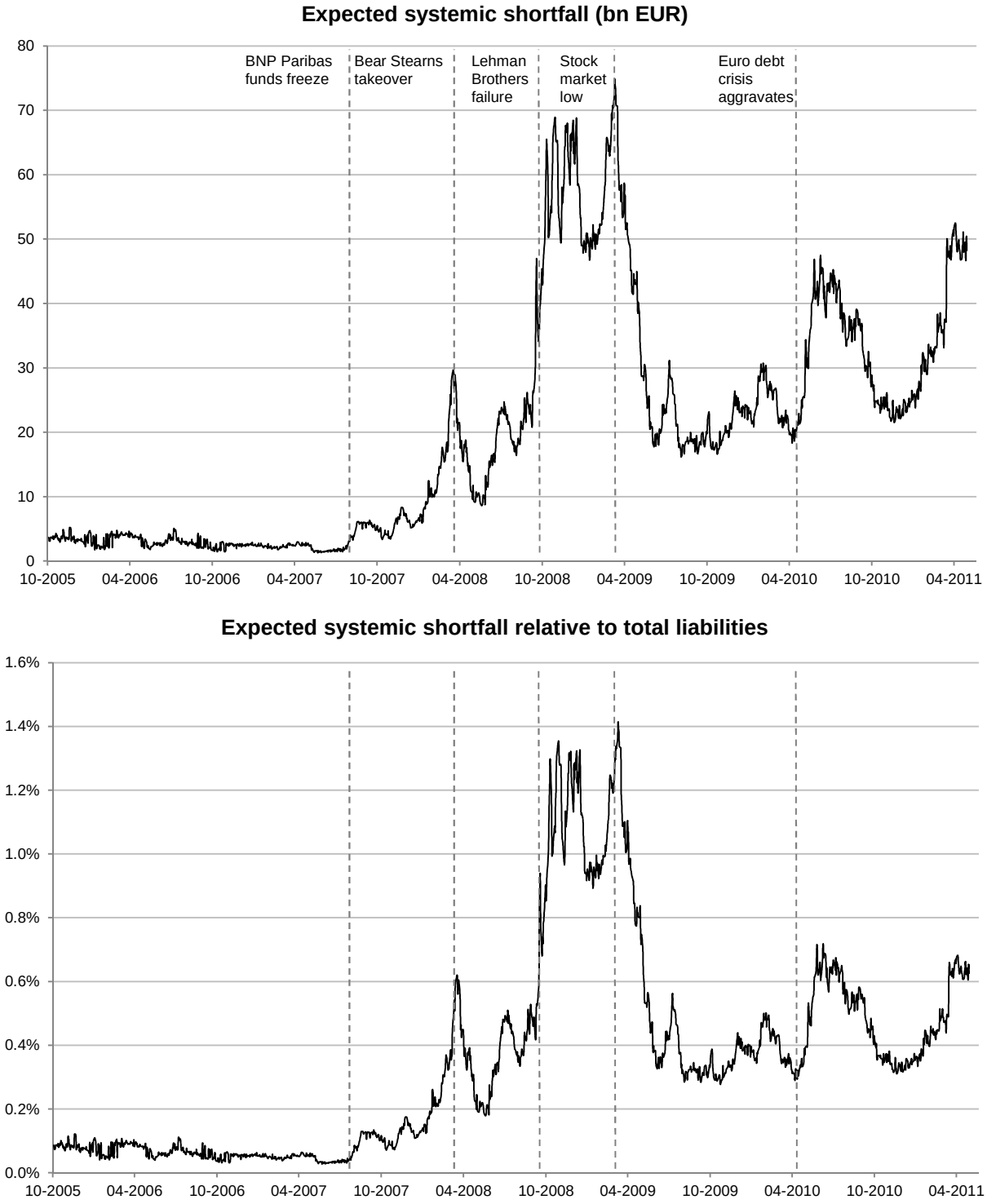
Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 15: Probability of systemic default and expected tail loss (America)



Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 16: Absolute and relative expected systemic shortfall (Asia-Pacific)

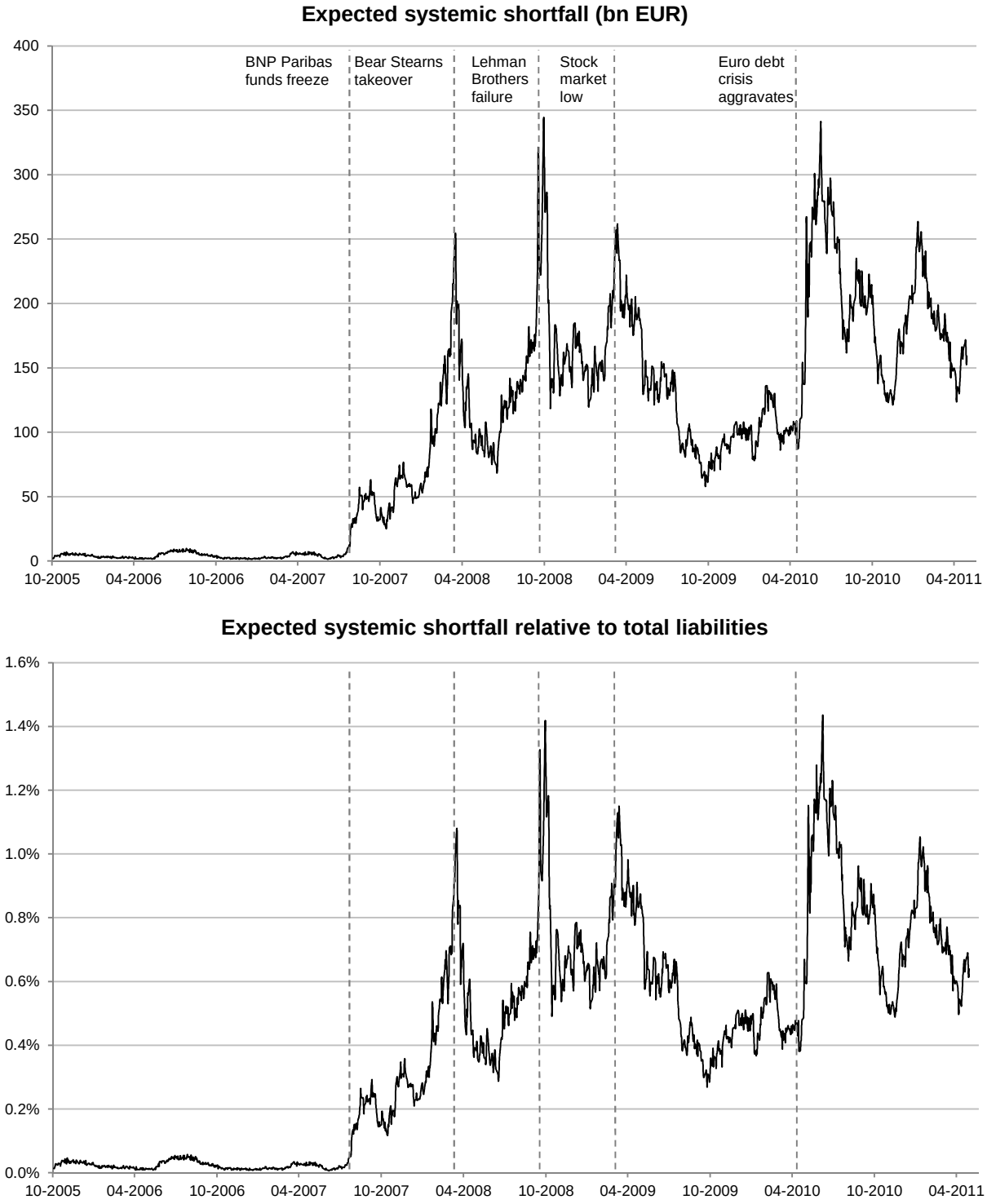


Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 17: Probability of systemic default and expected tail loss (Asia-Pacific)

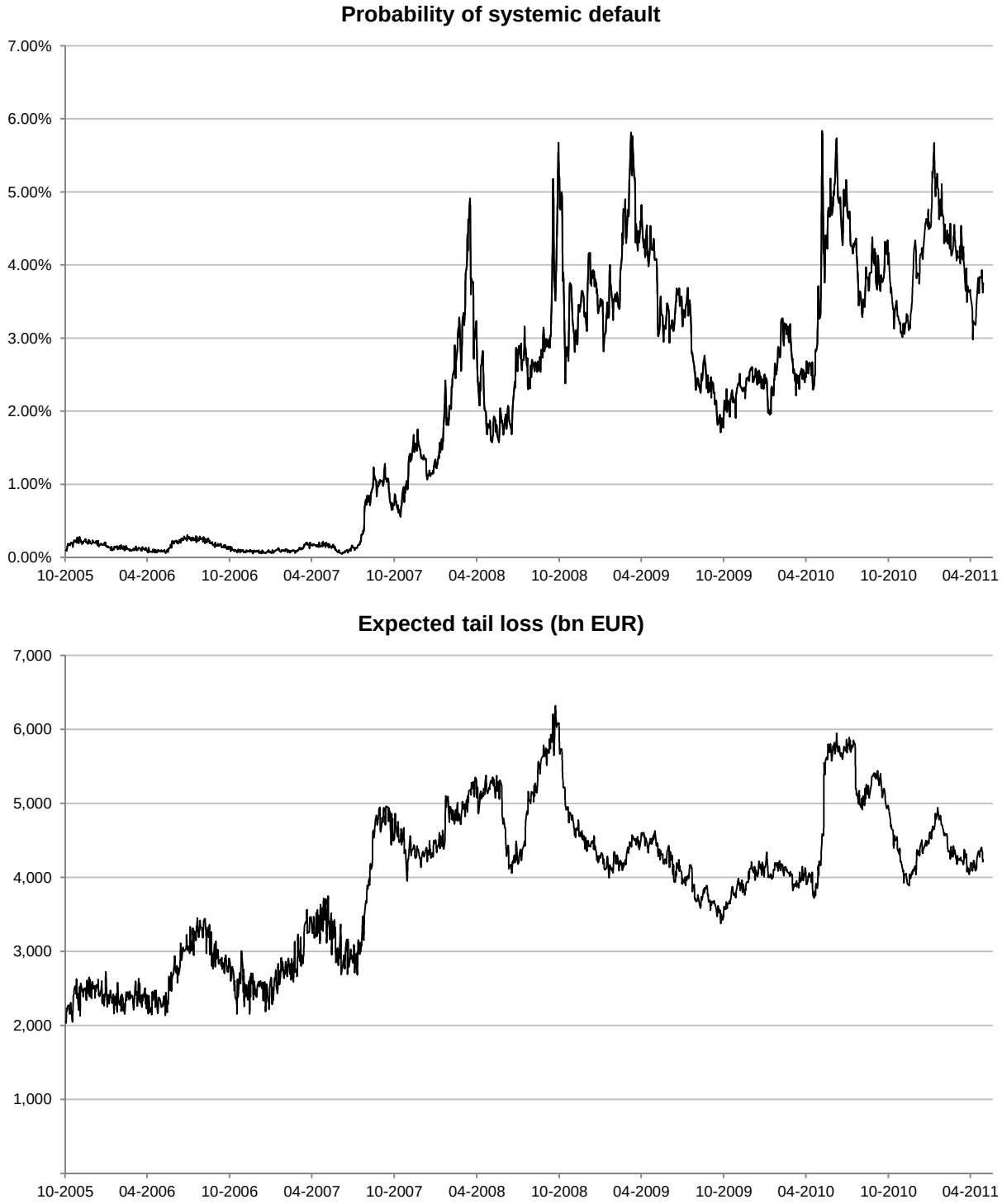
Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 18: Absolute and relative expected systemic shortfall (Europe)



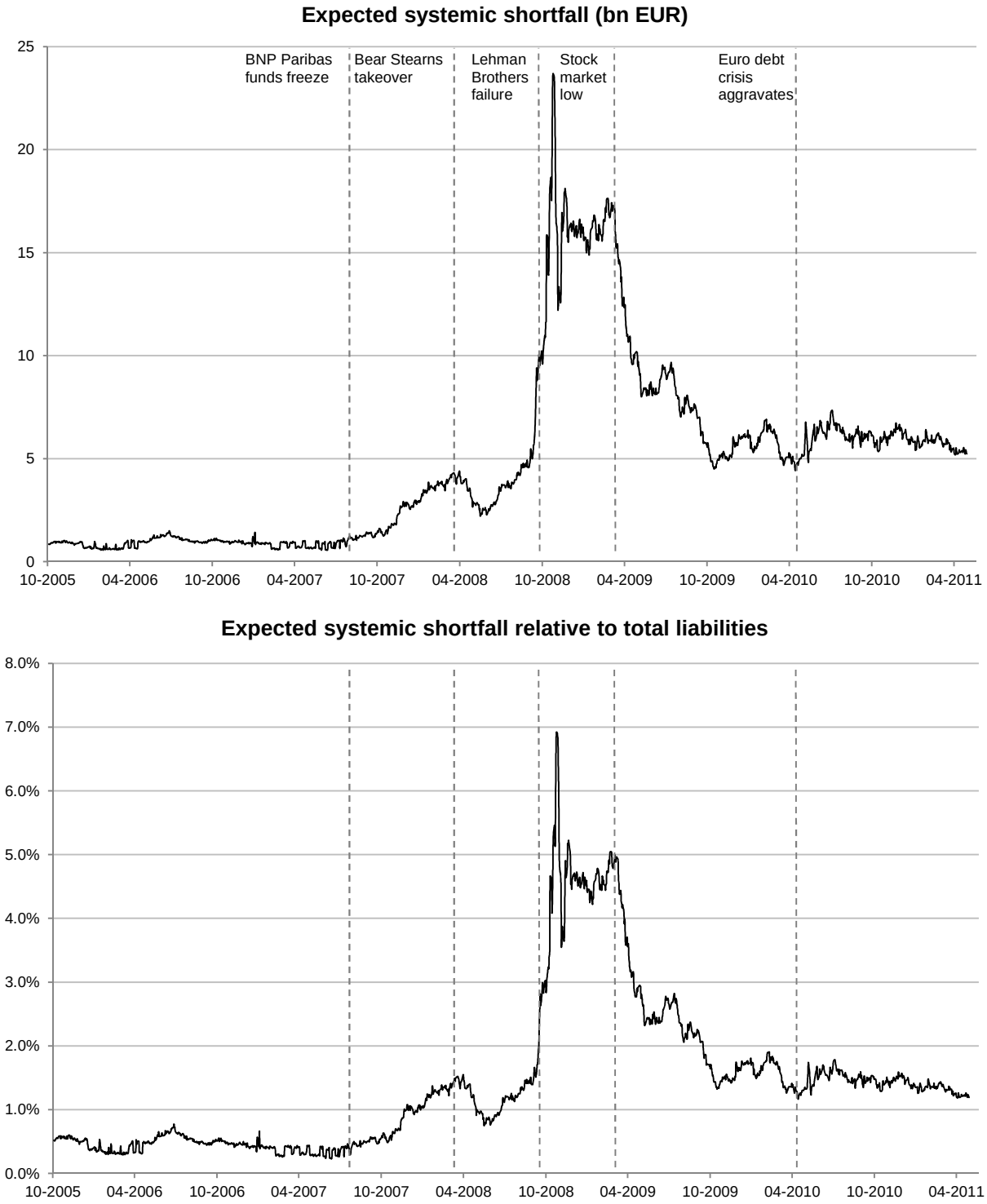
Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 19: Probability of systemic default and expected tail loss (Europe)



Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 20: Absolute and relative expected systemic shortfall (Middle East and Russia)

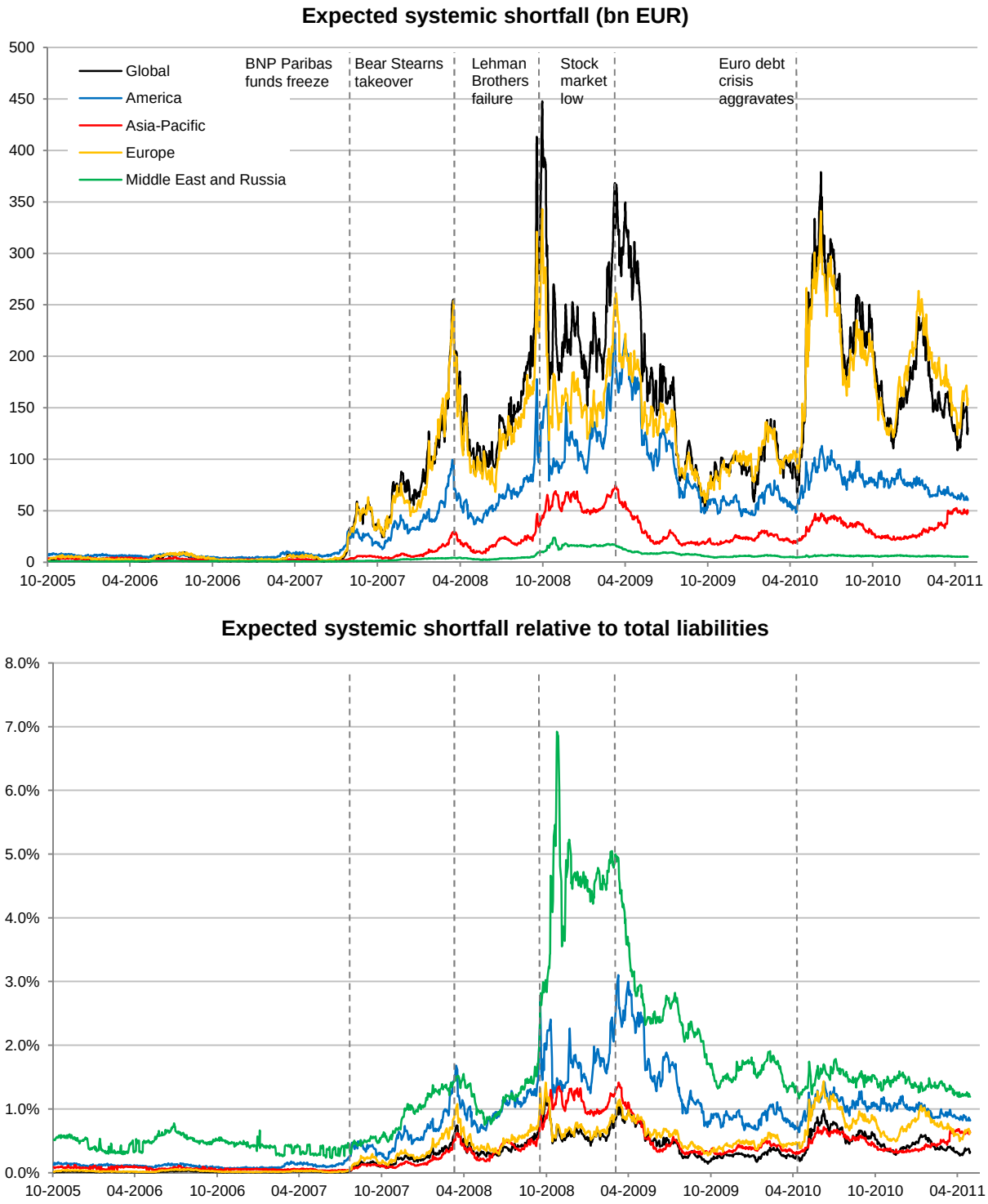


Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 21: Probability of systemic default and expected tail loss (Middle East and Russia)

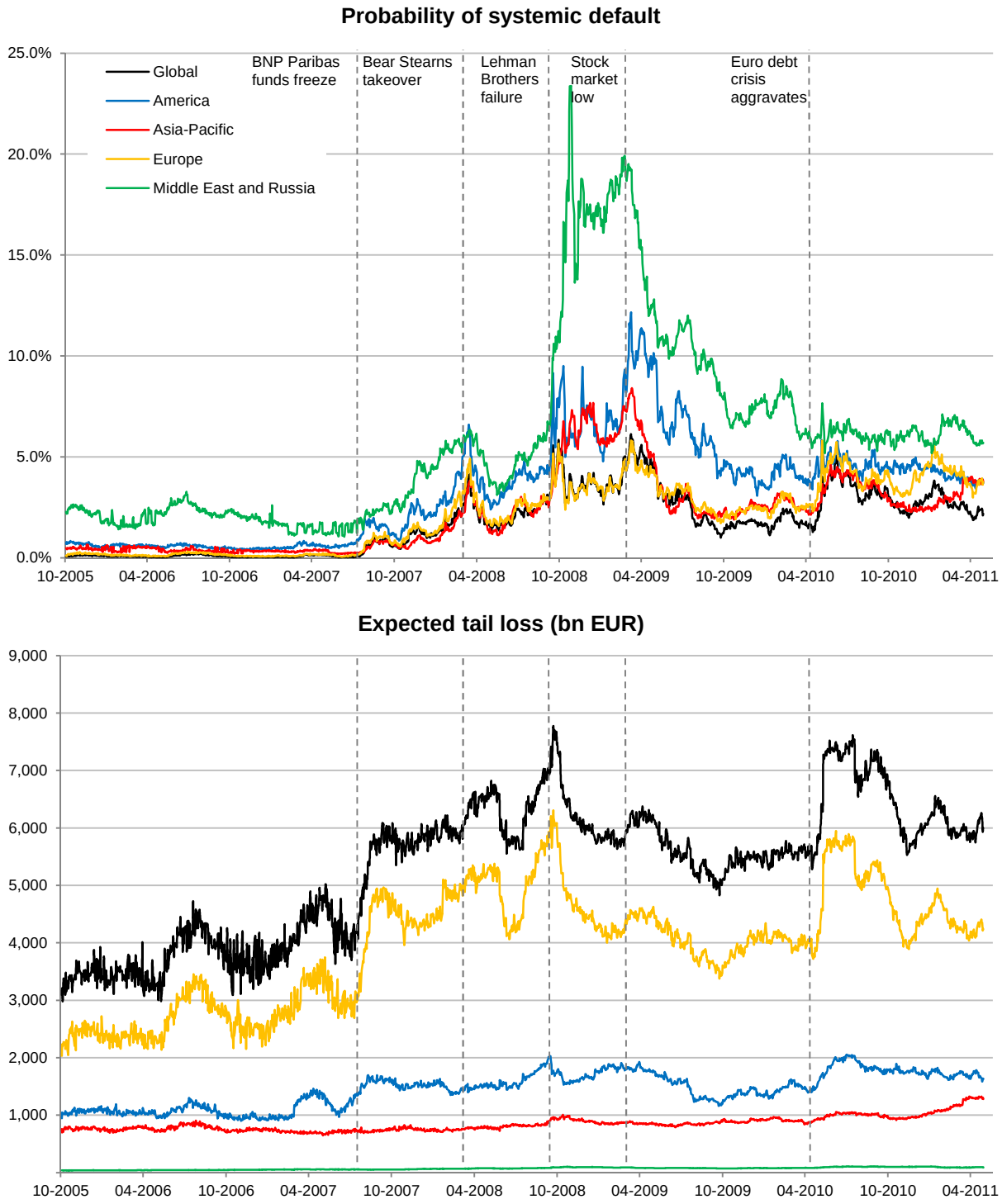
Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 22: Absolute and relative expected systemic shortfall (Comparative analysis)



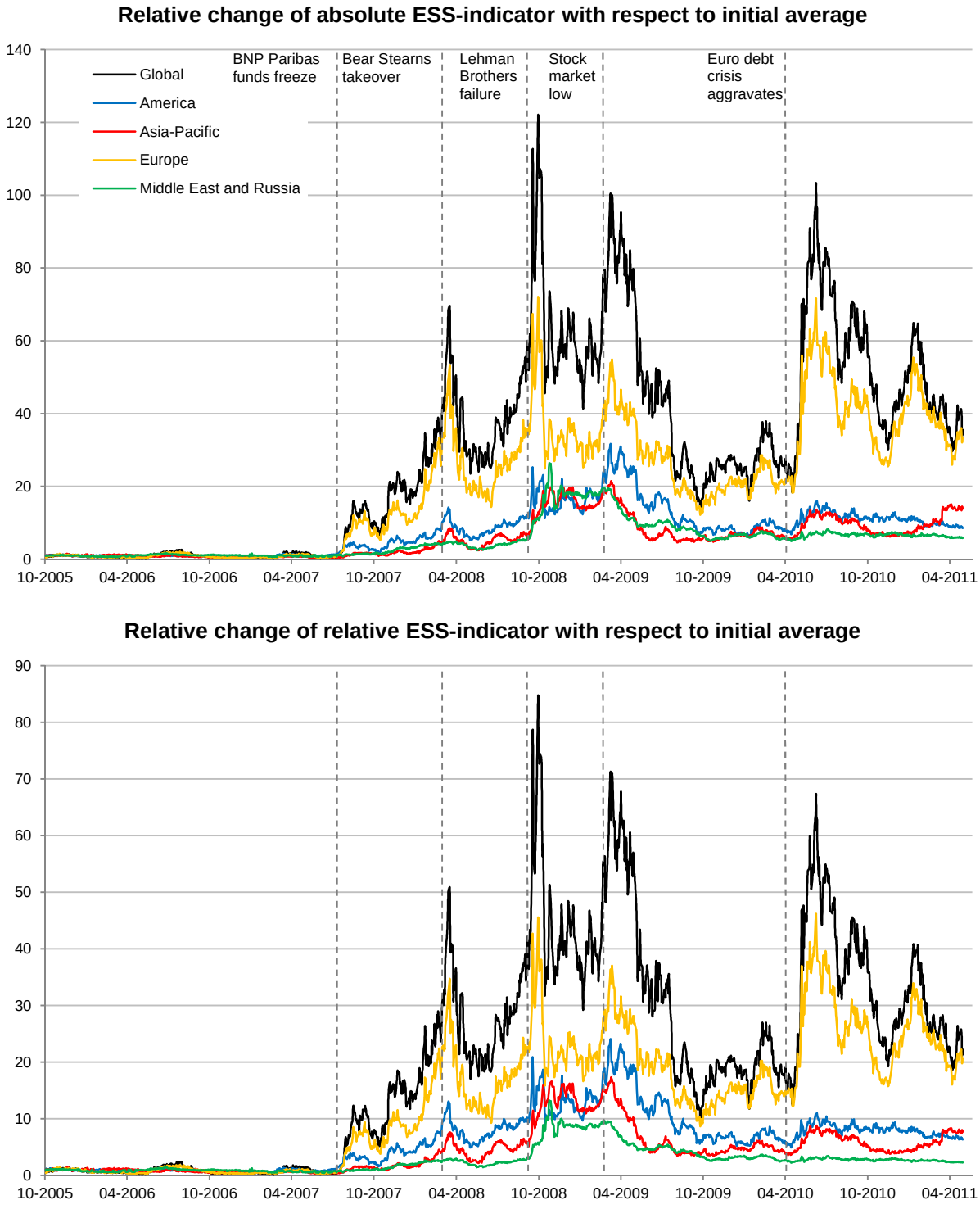
Notes: The upper panel shows the absolute ESS-indicator and the lower panel shows the relative ESS-indicator in the observation period. The dashed lines represent selected financial crisis events.

Figure 23: Probability of systemic default and expected tail loss (Comparative analysis)



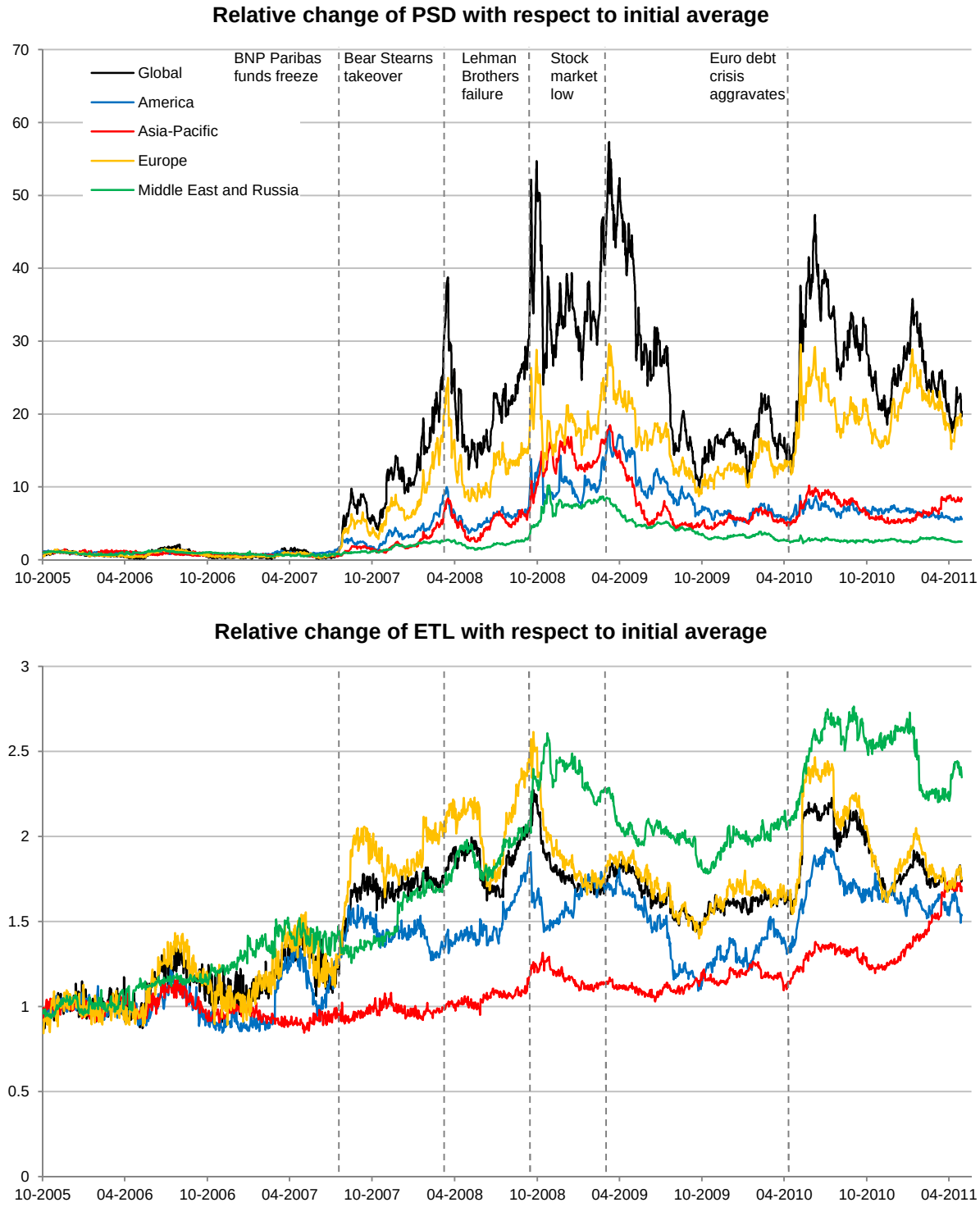
Notes: The upper panel shows the probability of the systemic default event and the lower panel shows the expected loss in case of a systemic default event during the observation period. The product of these two factors yields the expected systemic shortfall indicator.

Figure 24: Relative change of absolute and relative ESS-indicator with respect to initial average (Comparative analysis)



Notes: The upper (lower) panel shows the relative change of the absolute ESS-indicator (relative ESS-indicator) with respect to its three-month average at the beginning of the observation period over time.

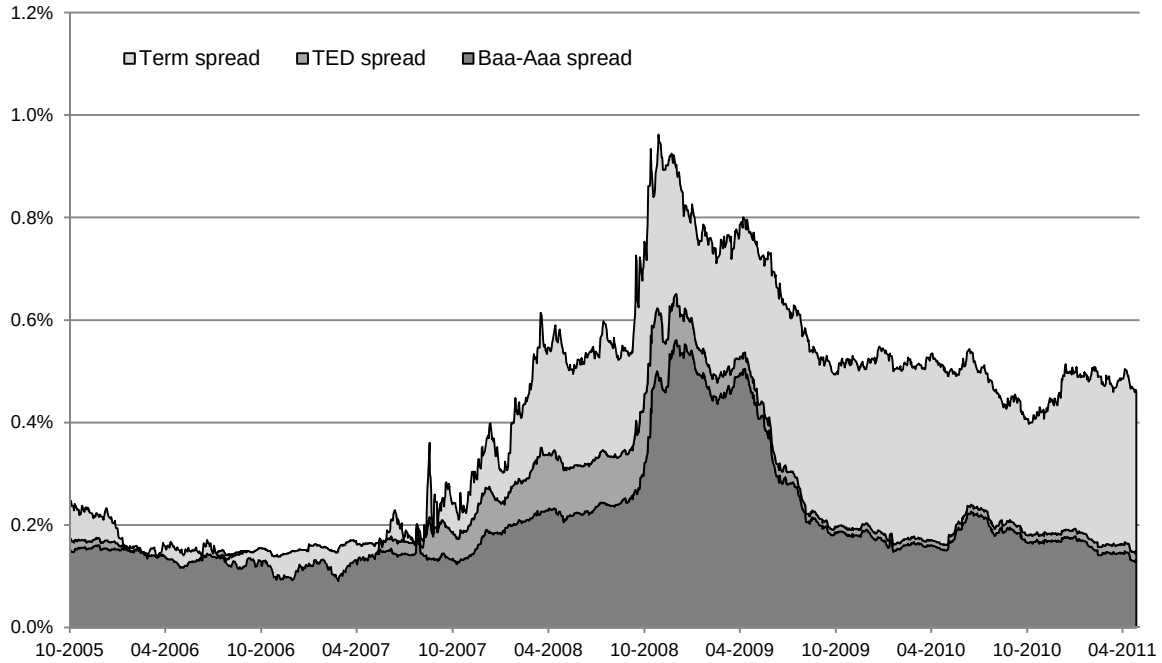
Figure 25: Relative change of probability of systemic default and expected tail loss with respect to initial average (Comparative analysis)



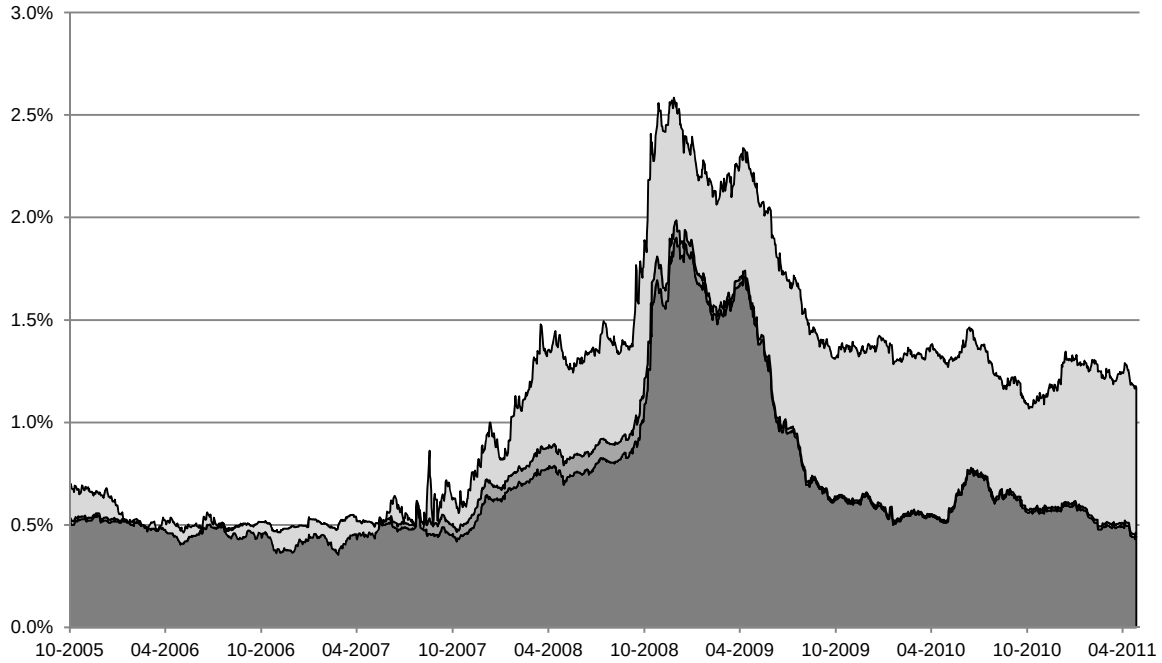
Notes: The upper (lower) panel shows the relative change of the probability of systemic default (expected tail loss) with respect to its three-month average at the beginning of the observation period over time.

Figure 26: *Risk premium determinants of the relative ESS-indicator*

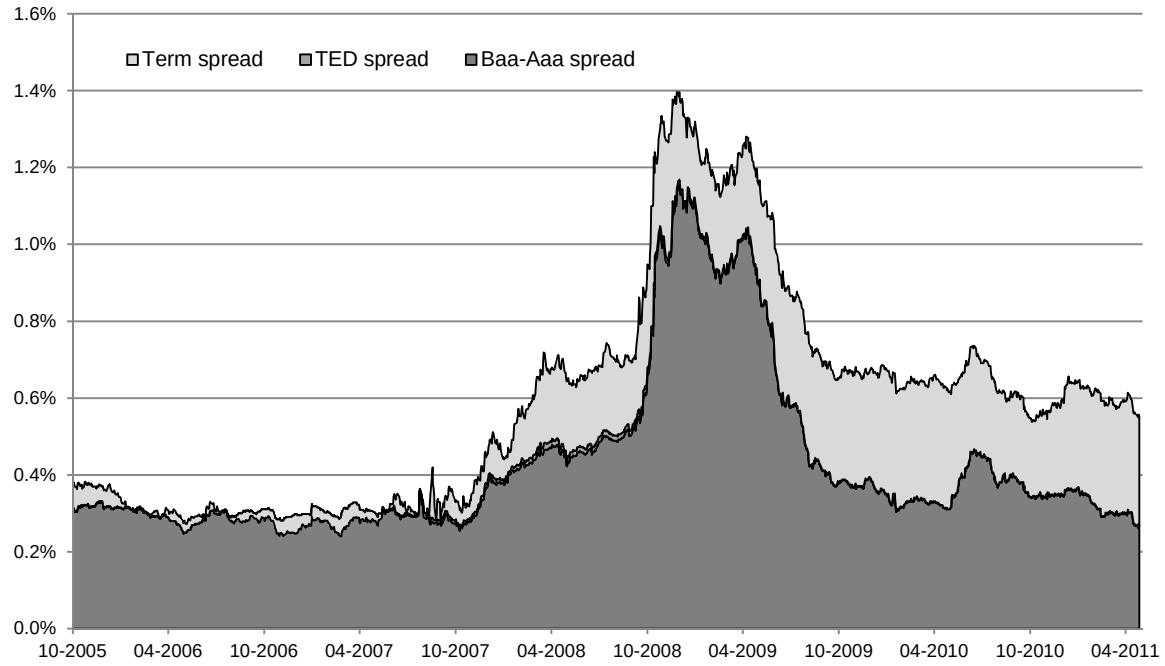
Global



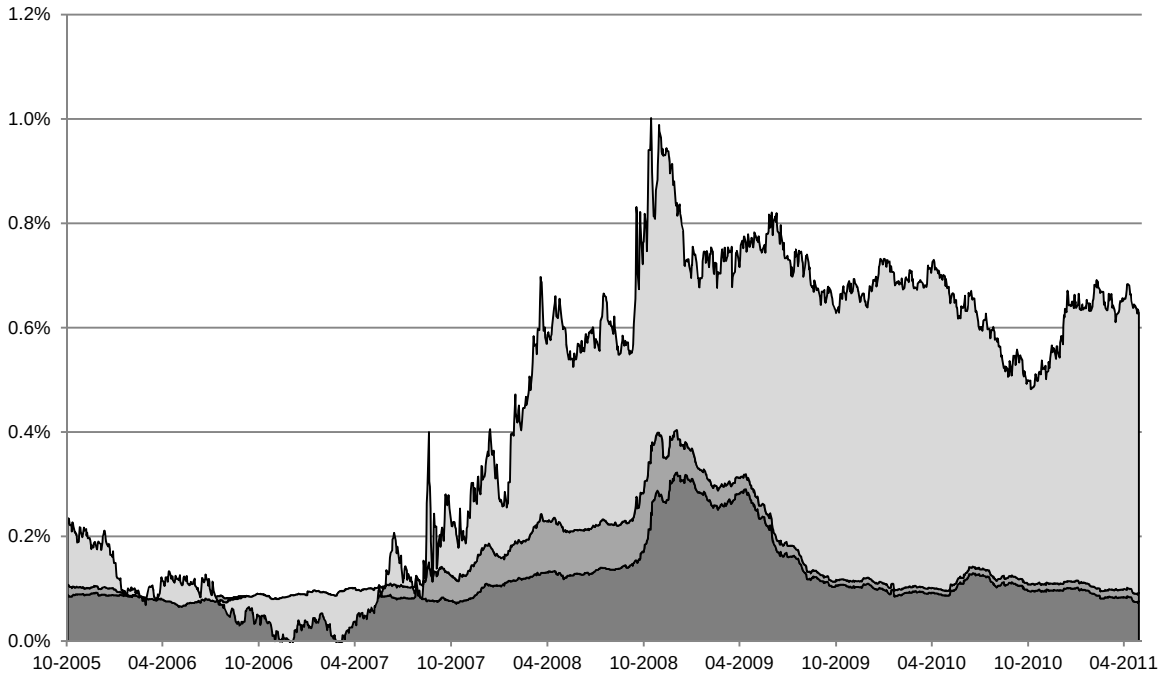
America



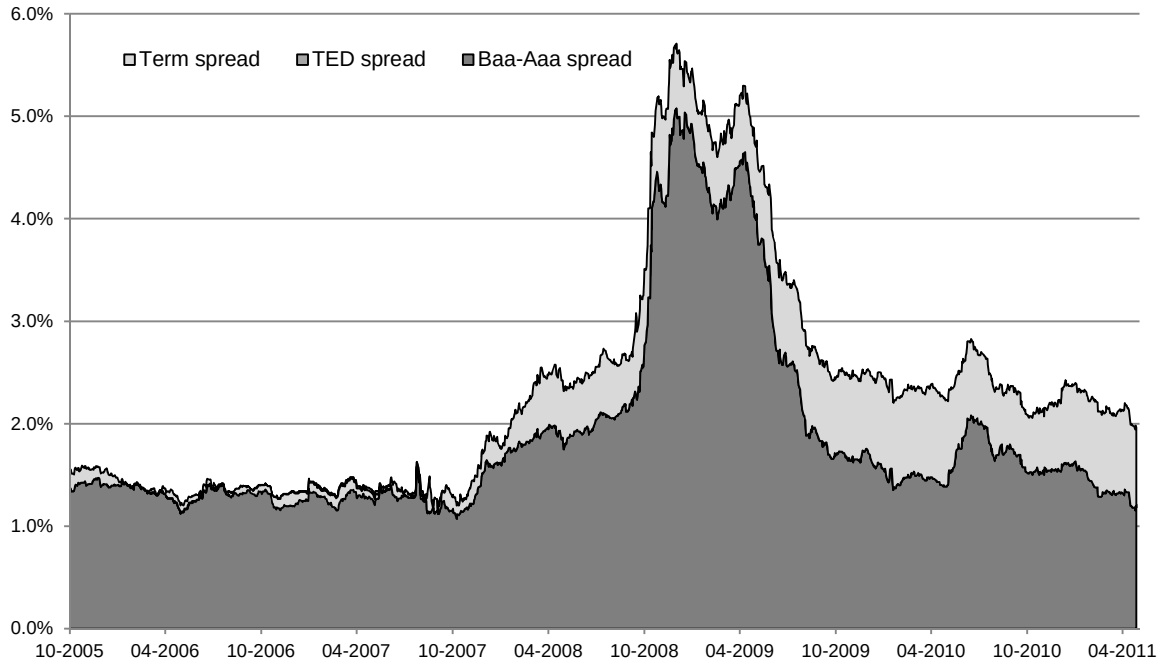
Asia-Pacific



Europe

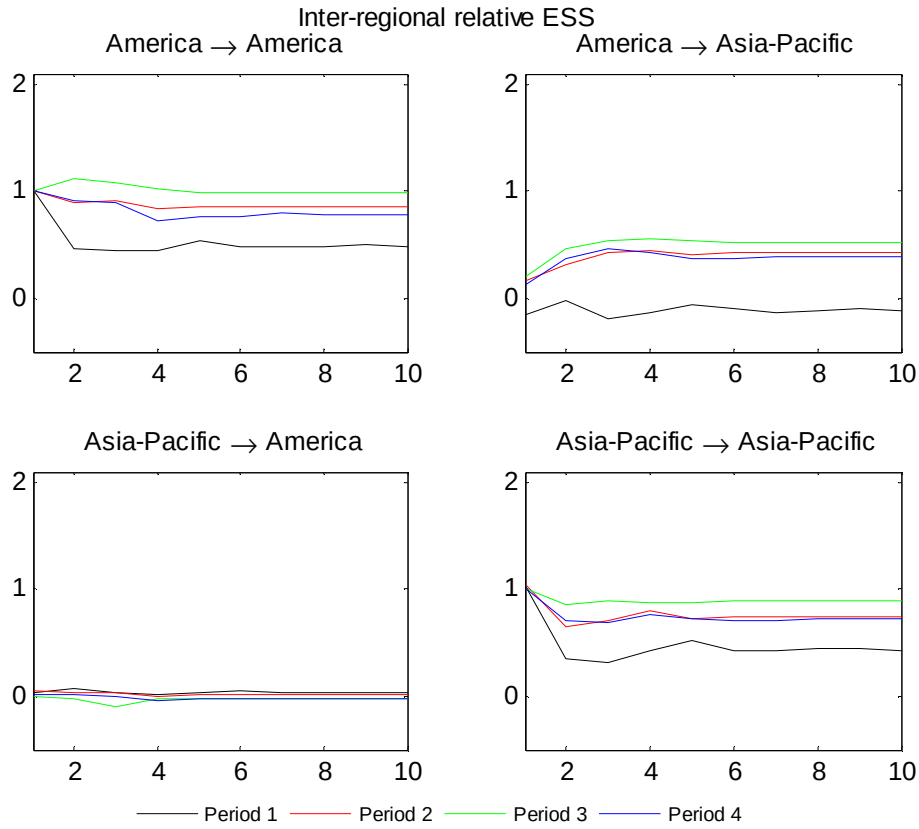


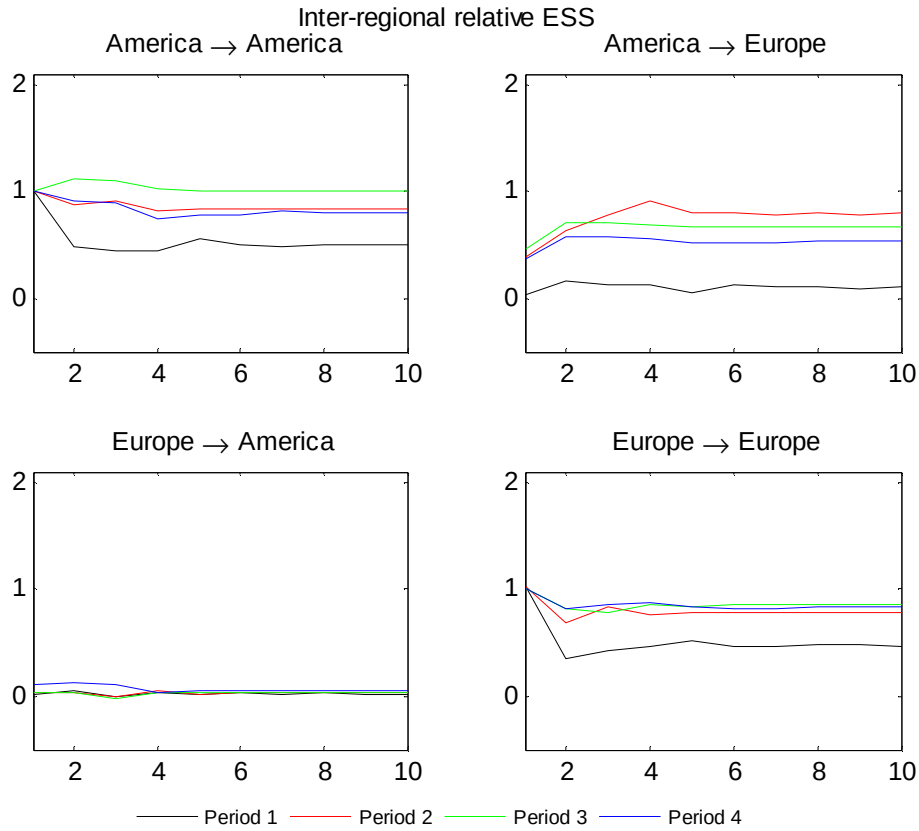
Middle East and Russia

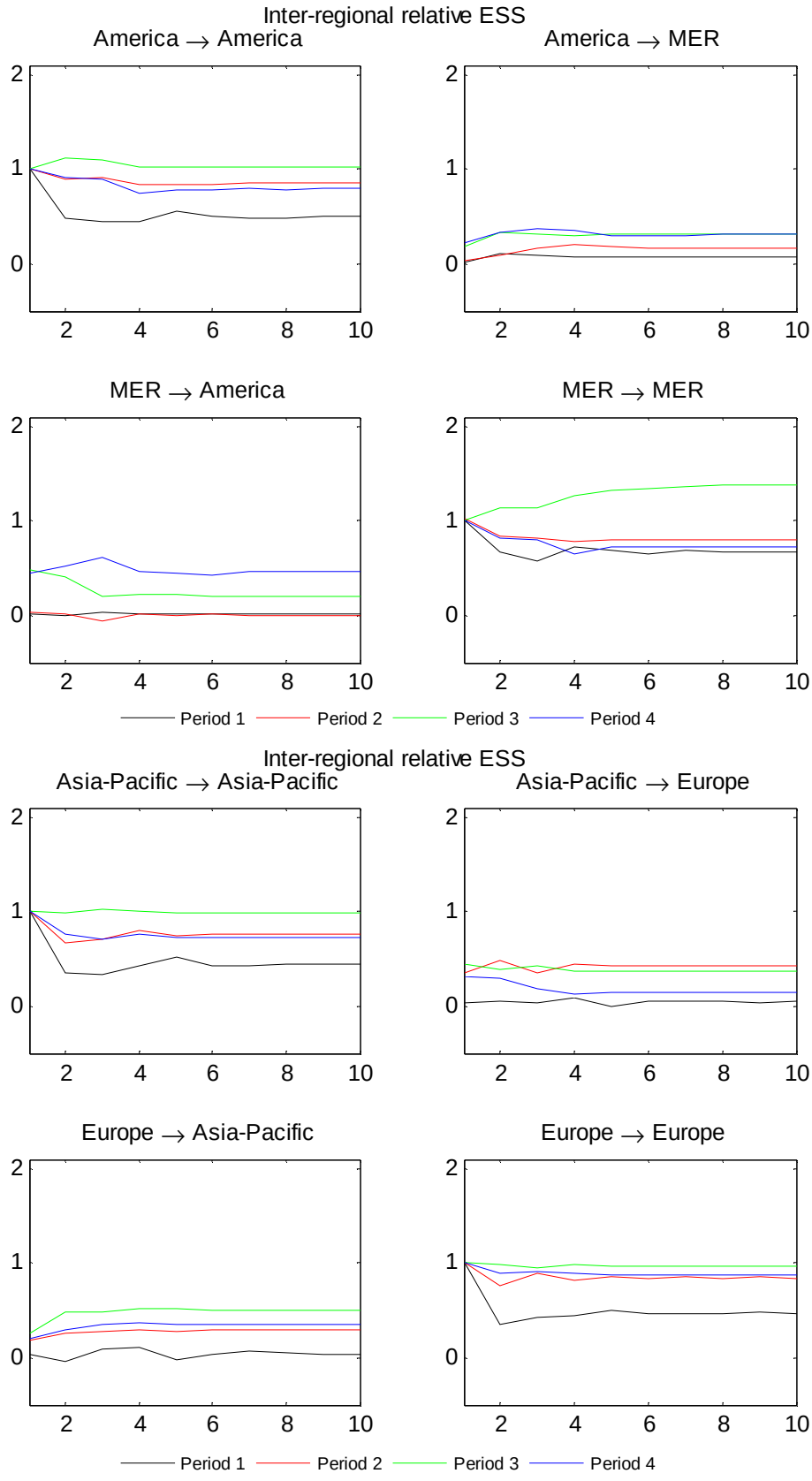


Notes: The graph shows the contribution of the risk premium proxy spreads to the relative expected systemic shortfall indicator. The graph is obtained by inserting the daily values of the respective spreads into the estimated respective regression equation from Regression 4 in Table 14 during the observation period.

Figure 27: Generalized impulse responses for inter-regional relative ESS analysis

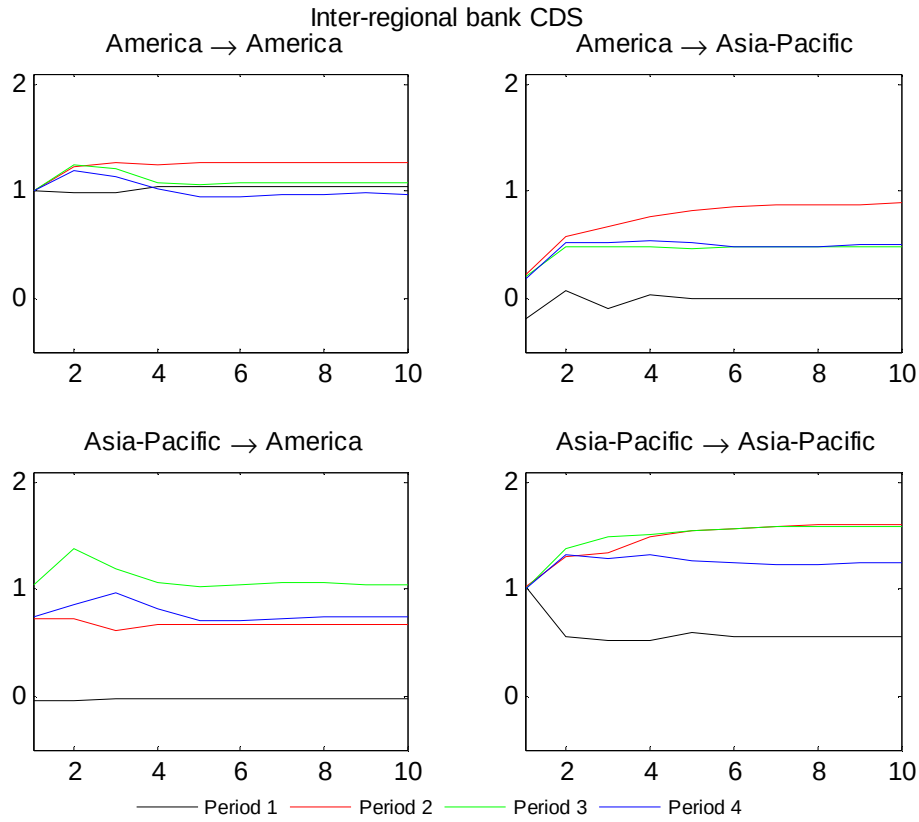


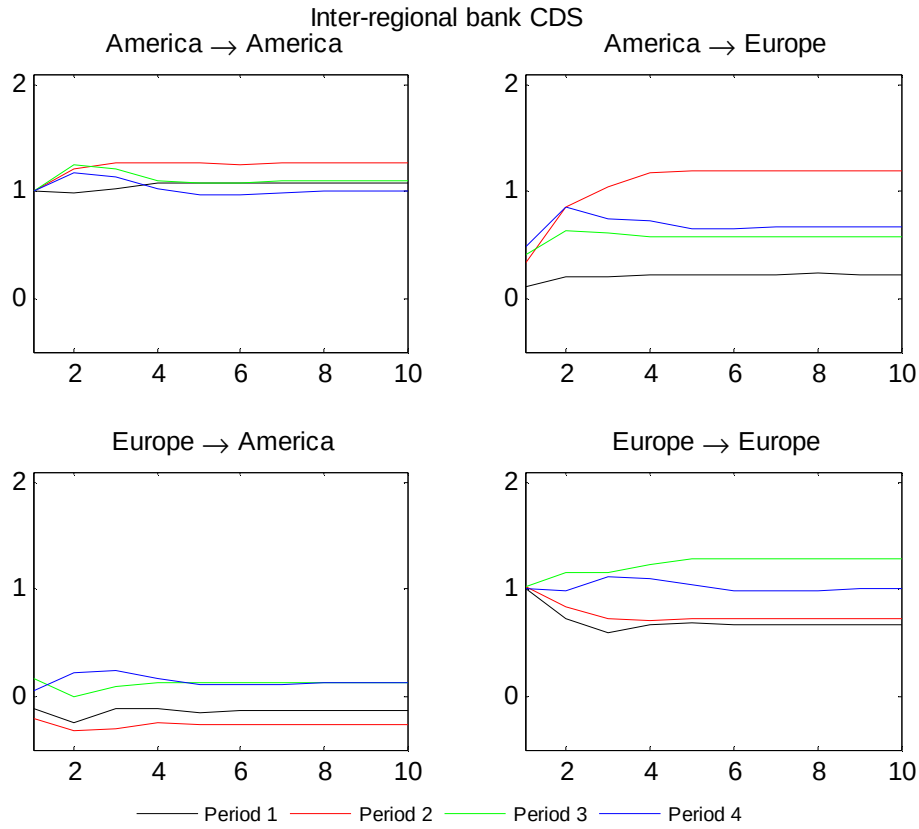


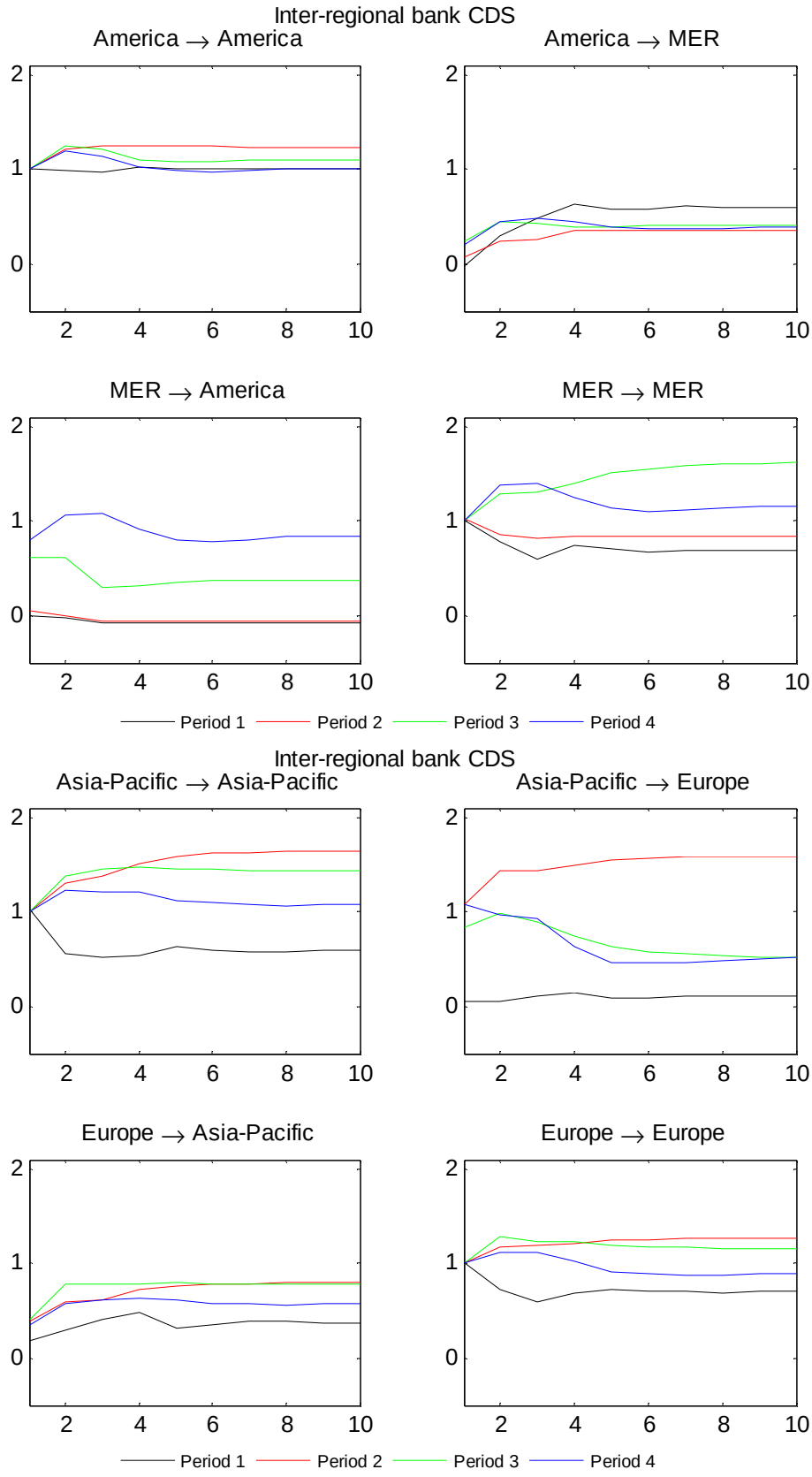


Notes: The figures show the generalized impulse response functions for the denominated variables during the four sub-periods. The values on the x-axis denote the days after the impulse to the estimated VAR model.

Figure 28: Generalized impulse responses for inter-regional bank CDS spreads analysis

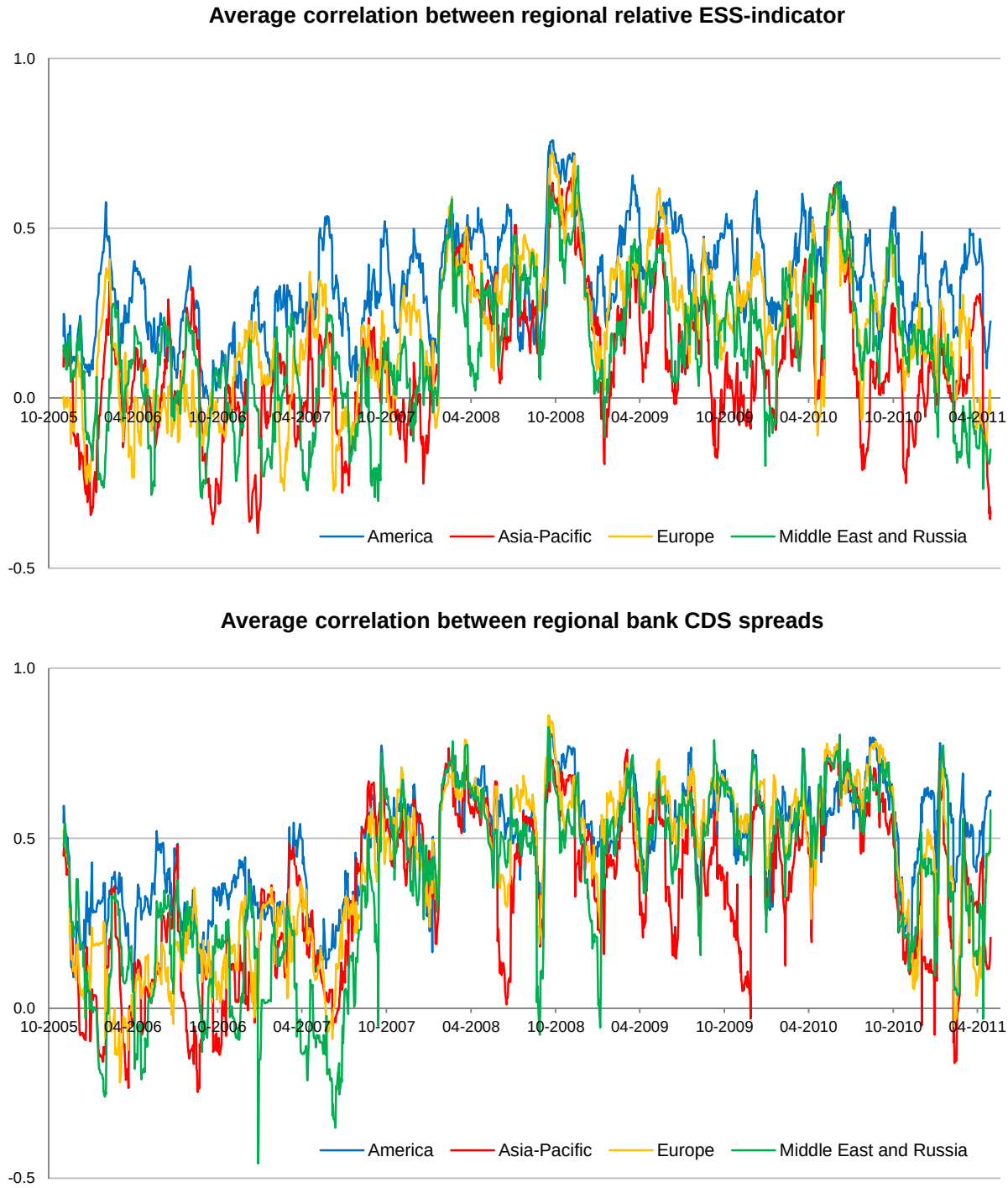






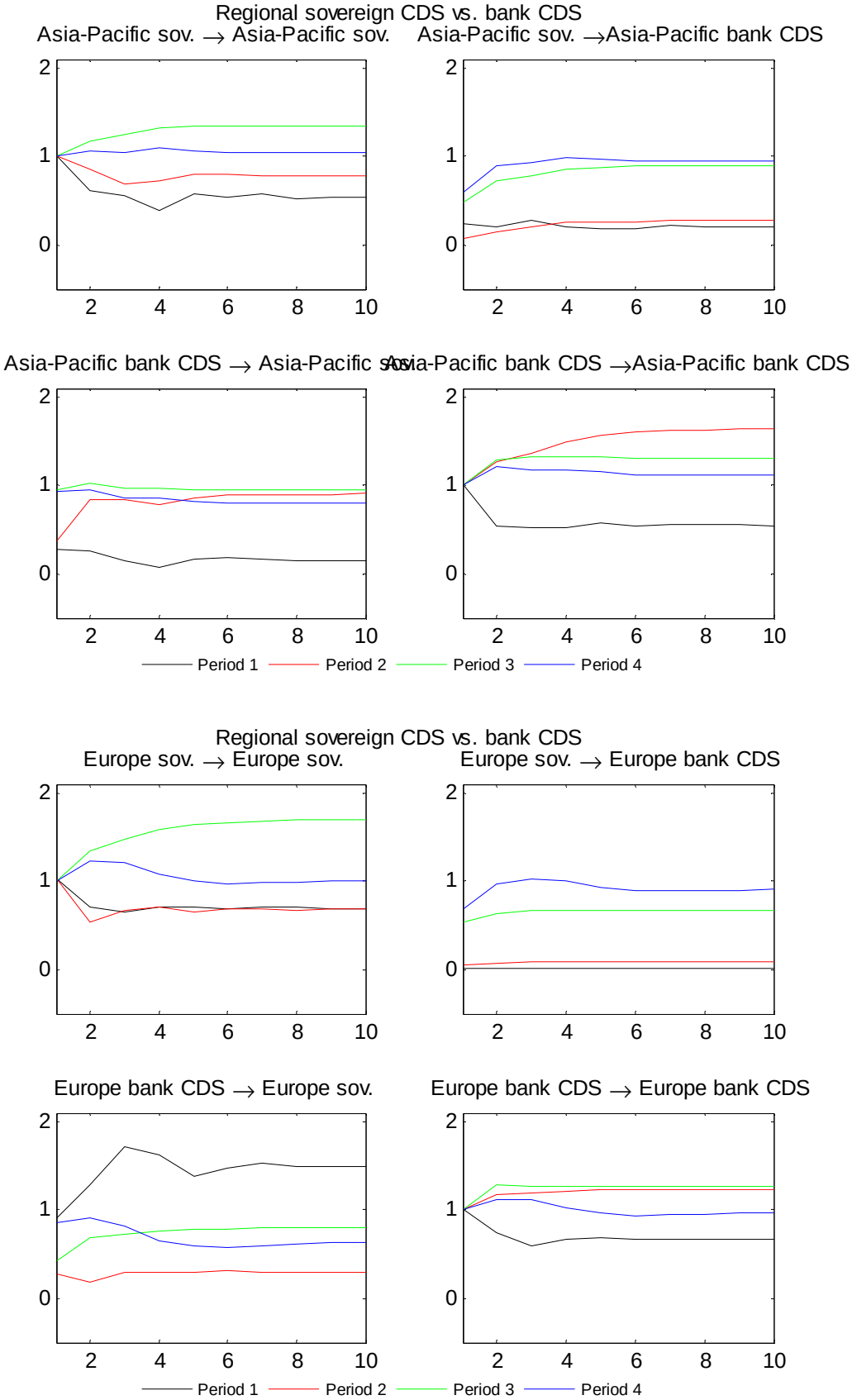
Notes: The figures show the generalized impulse response functions for the denominated variables during the four sub-periods. The values on the x-axis denote the days after the impulse to the estimated VAR model.

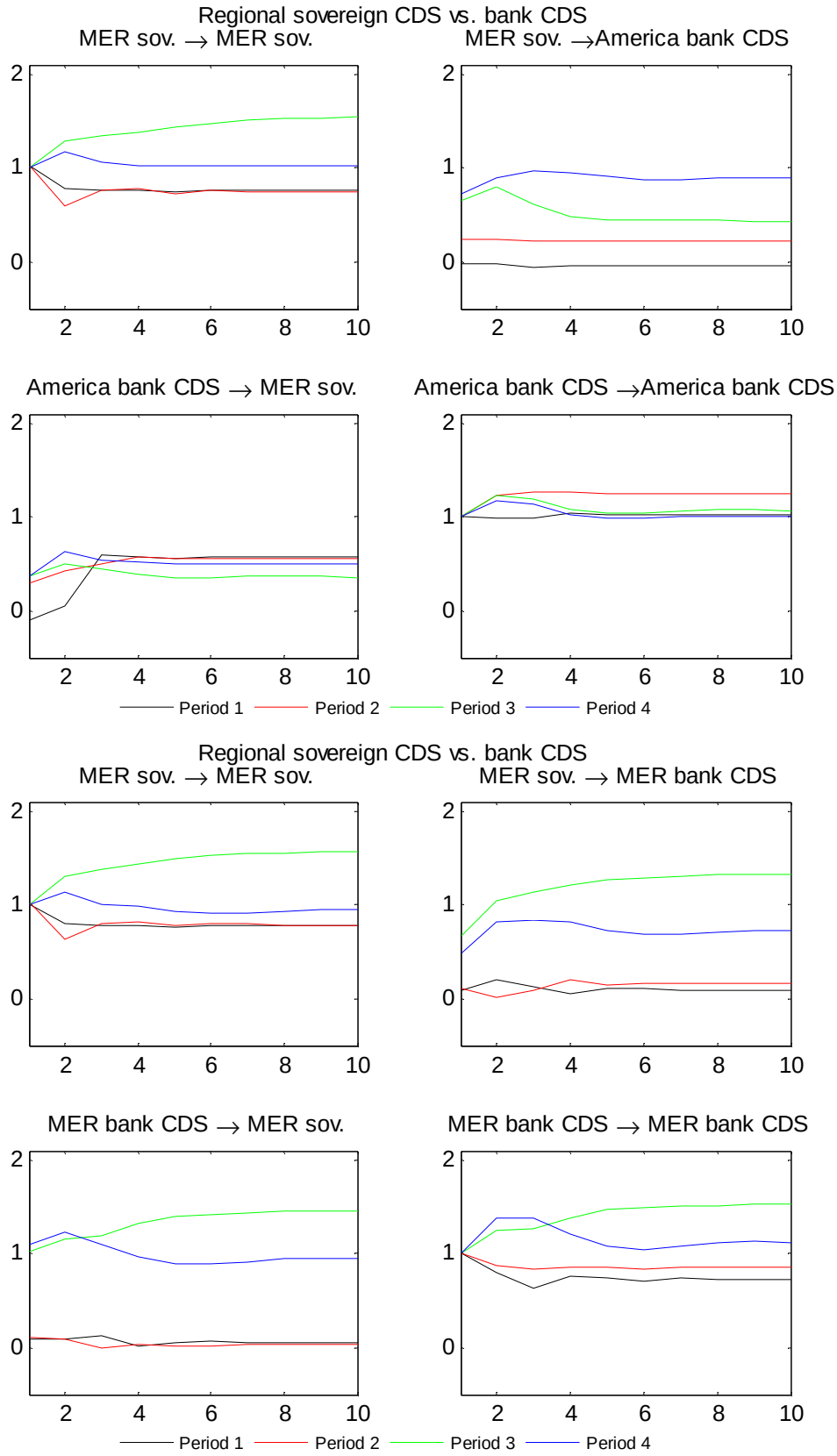
Figure 29: Correlation of regional relative ESS-indicator and regional bank CDS spreads



Notes: The upper panel shows the (average) correlations between the regional relative ESS-indicator in the shown regions (lines) and the regional ESS-indicator in all other regions (cross-regional average of bivariate estimation using the past month's returns. The lower panel shows the (average) correlations between the regional bank CDS spreads in the shown regions (lines) and the regional bank CDS spreads in all other regions (cross-regional average of bivariate estimation using the past month's returns).

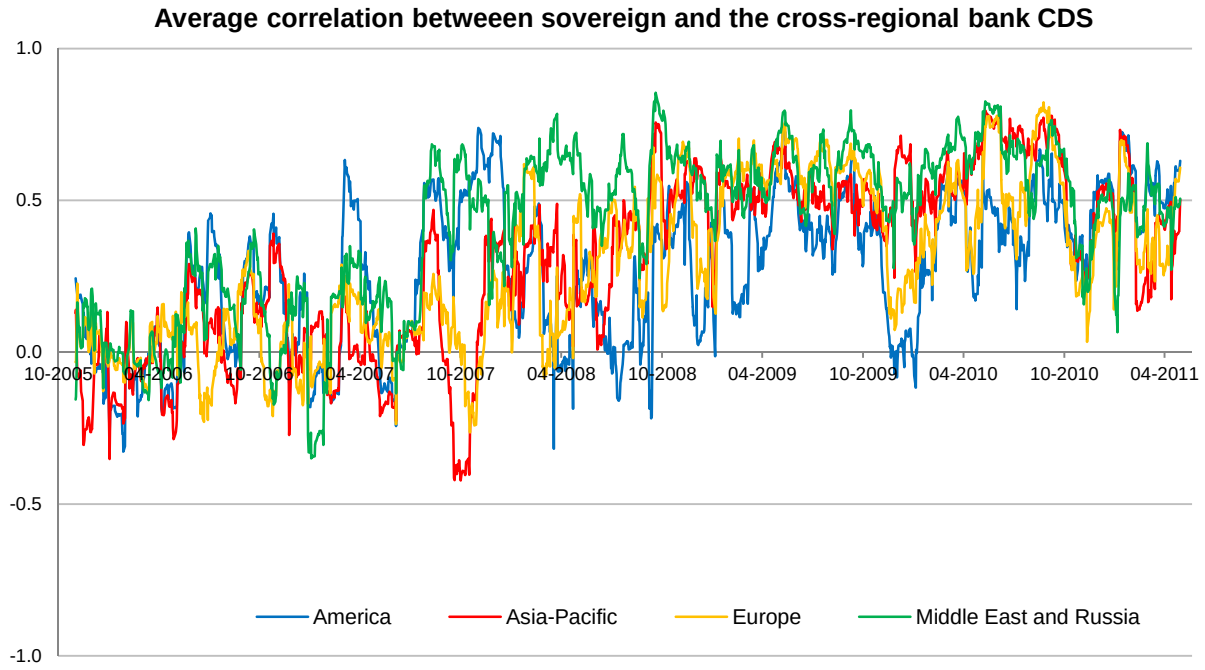
Figure 30: Generalized impulse responses for regional sovereign vs. bank CDS spreads





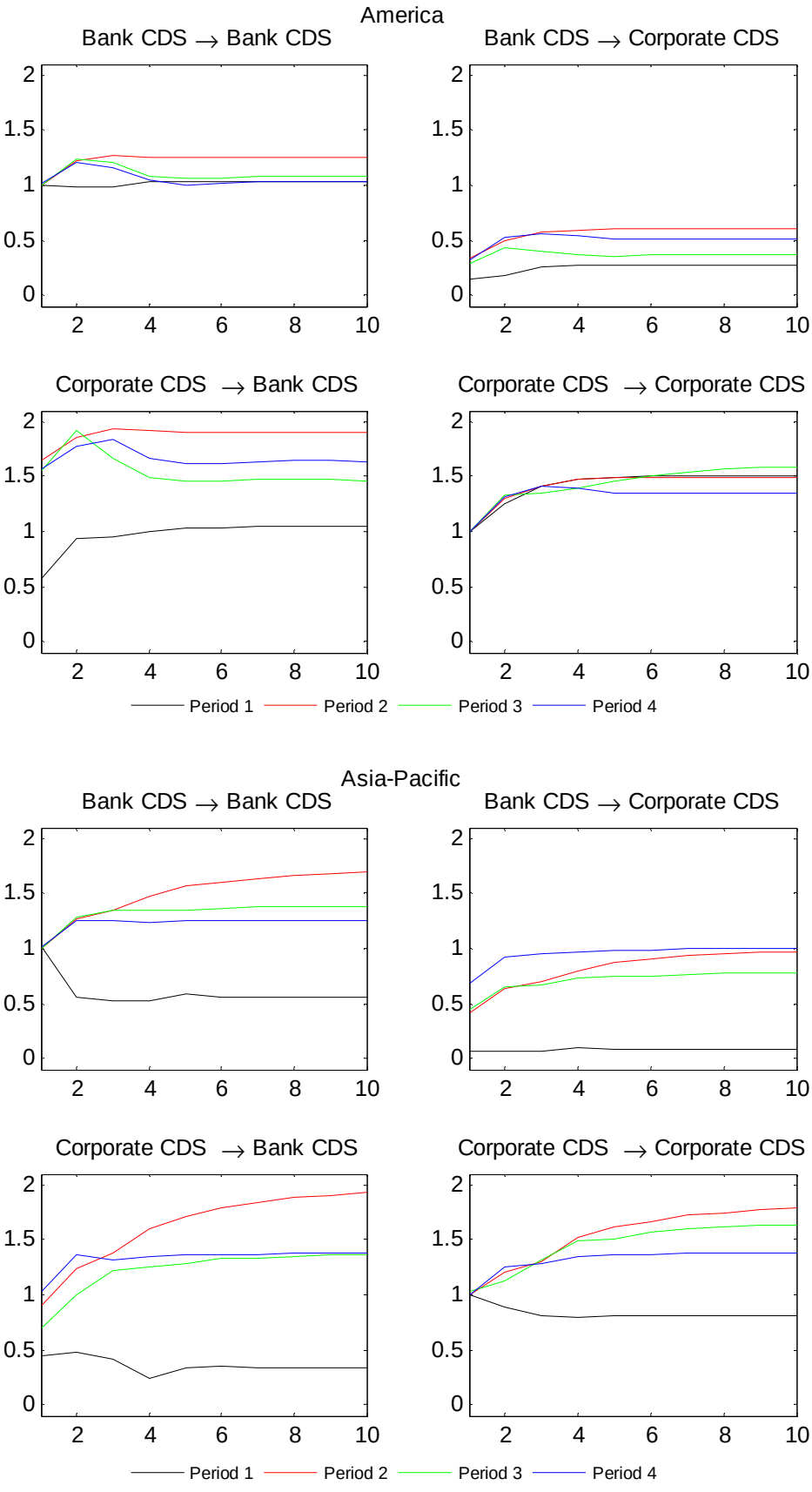
Notes: The figures show the generalized impulse response functions for the denominated variables during the four sub-periods. The values on the x-axis denote the days after the impulse to the estimated VAR model.

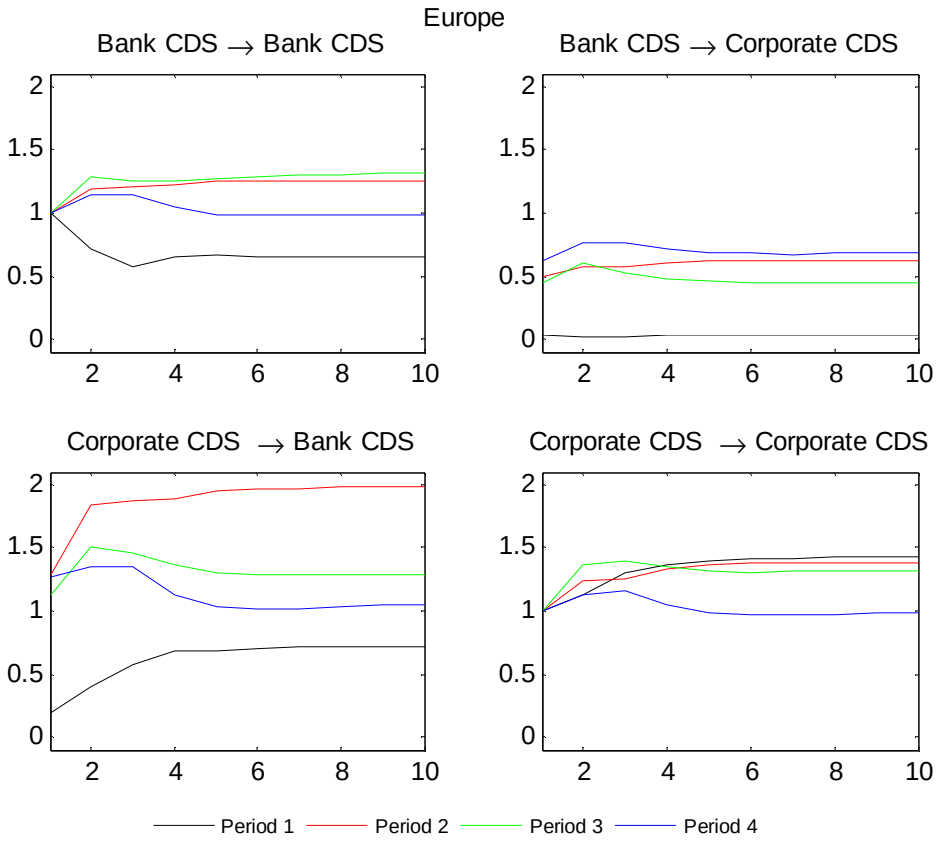
Figure 31: Correlation of regional sovereign and bank CDS spreads



Notes: The figure shows the (average) correlations between the regional sovereign CDS spreads and the bank CDS spreads of all other regions (cross-regional average of bivariate correlations).

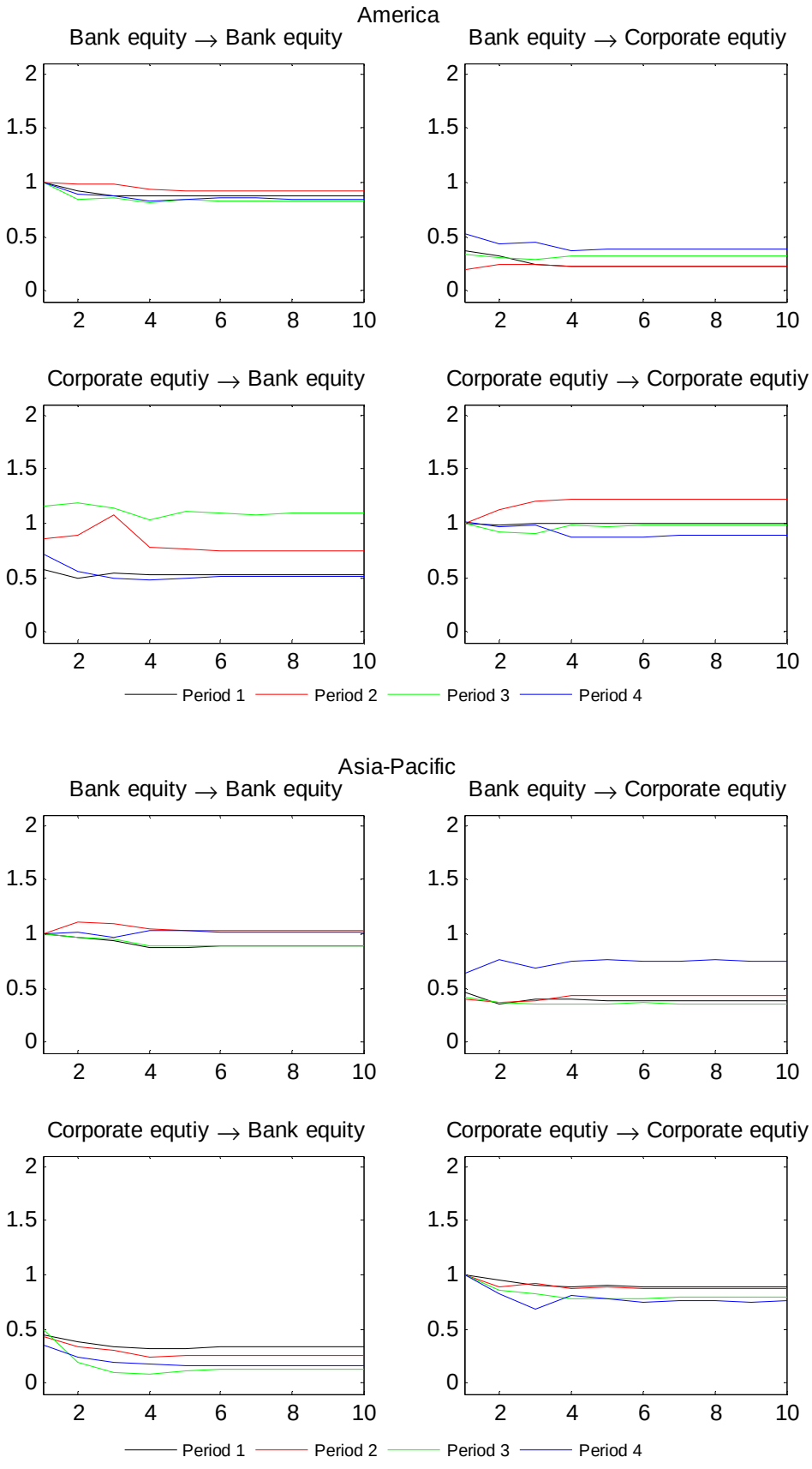
Figure 32: Generalized impulse responses for regional bank vs. corporate CDS spreads

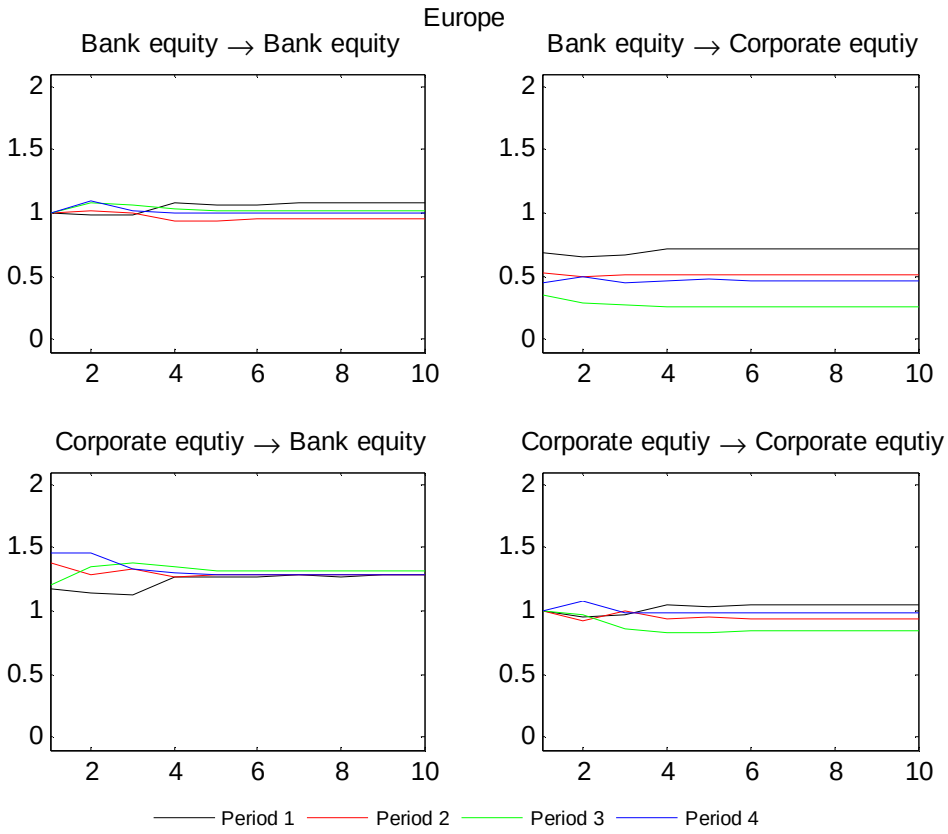




Notes: The figures show the generalized impulse response functions for the denominated variables during the four sub-periods. The values on the x-axis denote the days after the impulse to the estimated VAR model.

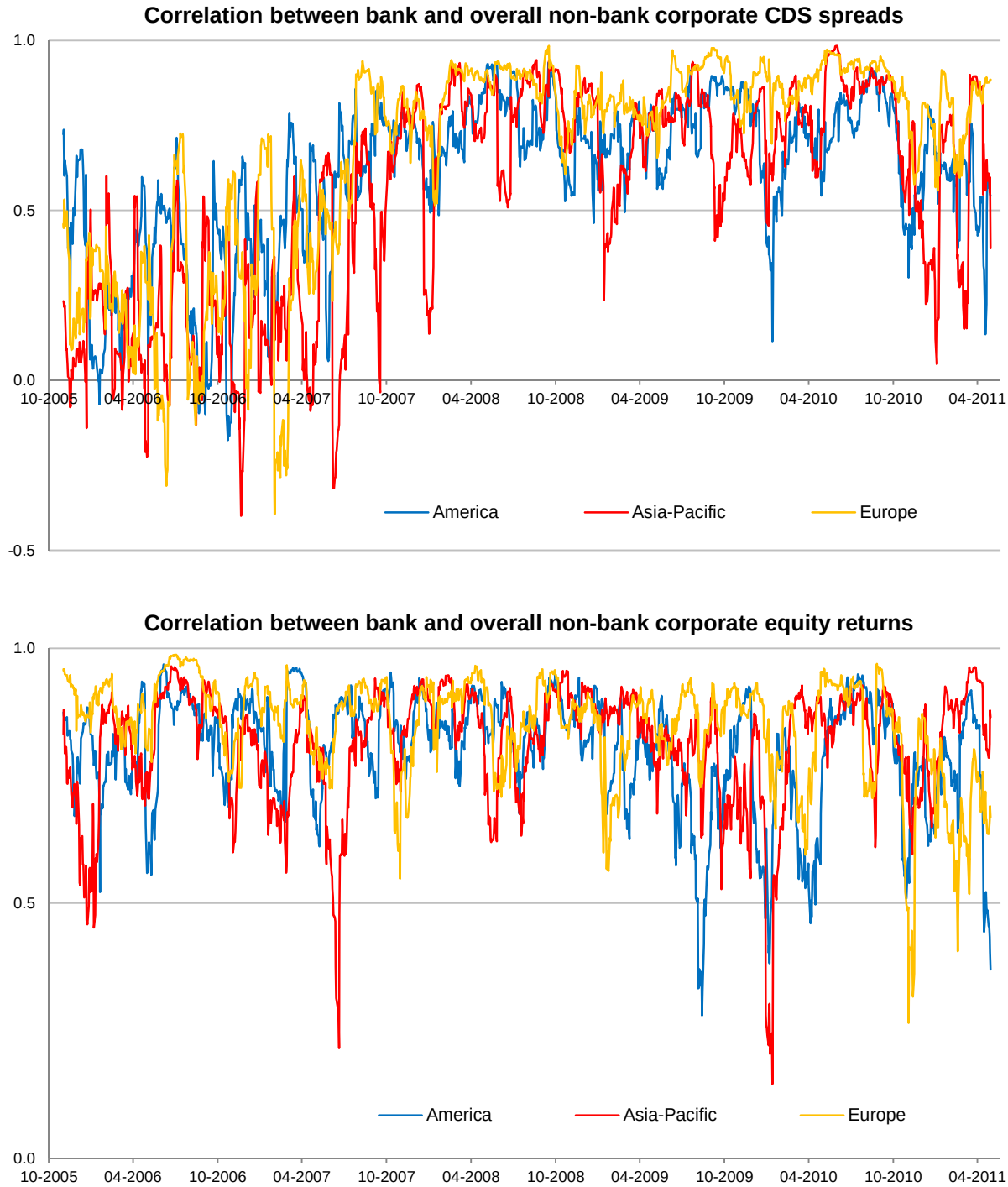
Figure 33: Generalized impulse responses for regional bank vs. corporate equity returns





Notes: The figures show the generalized impulse response functions for the denominated variables during the four sub-periods. The values on the x-axis denote the days after the impulse to the estimated VAR model.

Figure 34: Correlation between bank and corporate CDS spreads and equity returns



Notes: The upper panel shows the correlation between the regional bank CDS spreads and the overall (i.e., cross-industry) corporate CDS spreads in the respective region. The lower panel shows the correlation between the regional bank equity returns and the overall (i.e., cross-industry) corporate equity returns in the respective region.

LIST OF TABLES

Table 1: Liabilities and CDS spreads by region and country

By region

Region	Liabilities[1] Total	Liabilities[1] Mean[3]	Average daily CDS spread[2] *Period 1*	*Period 2*	*Period 3*	*Period 4*
America	6,919.7	576.6	15.9	69.7	213.5	133.7
Asia-Pacific	5,222.6	217.6	19.2	57.3	168.6	108.3
Europe	23,287.7	612.8	9.6	47.1	124.4	145.1
Middle East and Russia	353.6	39.3	69.2	127.1	526.2	279.0
Global	35,783.5	431.1	12.8	53.8	152.1	138.8

By country

Region	Country	Liability[1]	Average daily CDS spread[2] *Period 1*	*Period 2*	*Period 3*	*Period 4*
America	US	6,919.7	15.9	69.7	213.5	133.7
Asia-Pacific	Australia	1,204.7	8.7	47.3	125.3	110.3
Asia-Pacific	China	679.5	21.9	67.5	206.3	130.4
Asia-Pacific	Hong Kong	291.7	11.0	49.5	146.5	89.1
Asia-Pacific	India	247.0	65.7	148.4	314.8	183.4
Asia-Pacific	Japan	1,844.3	16.7	34.9	116.9	88.3
Asia-Pacific	Kazakhstan	22.4	192.8	449.0	1,509.9	762.5
Asia-Pacific	Korea	604.2	28.0	92.4	306.6	126.0
Asia-Pacific	Malaysia	48.1	20.2	49.2	138.6	75.9
Asia-Pacific	Singapore	280.7	9.6	44.8	98.6	47.2
Europe	Austria	189.5	21.5	52.4	208.2	148.3
Europe	Belgium	979.3	9.0	66.6	250.7	229.2
Europe	Denmark	462.8	6.0	22.1	122.4	87.9
Europe	France	4,700.4	7.2	41.1	83.4	114.0
Europe	Germany	2,810.2	13.0	51.8	113.8	112.0
Europe	Greece	139.9	21.2	20.7	71.8	777.7
Europe	Ireland	362.0	7.7	69.9	285.9	568.9
Europe	Italy	1,862.7	13.7	43.9	104.6	148.4
Europe	Netherlands	118.7	10.8	44.5	294.5	212.8
Europe	Portugal	199.4	13.0	50.7	110.2	462.7
Europe	Spain	1,740.4	10.9	46.0	119.1	203.0
Europe	Sweden	1,017.1	16.2	26.4	122.4	79.2
Europe	Switzerland	2,080.3	8.6	55.3	144.9	101.2
Europe	UK	6,625.1	7.6	49.3	127.6	133.1
Middle East	Bahrain	18.6	35.3	114.1	457.3	354.3
Middle East	Qatar	10.1	17.5	56.8	221.1	182.9
Middle East	UAE	87.2	22.5	72.3	345.7	315.1
Russia	Russia	237.6	91.1	151.2	610.9	263.9
Mean		1,278.0	12.8	53.8	152.1	138.8
Total		35,783.5				

Notes: 1. Total liabilities as of 31.12.2008 in billion EUR. 2. Mean of daily CDS spread in basis points. 3. Mean computed per bank in region. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the CDS spreads is obtained by weighting the period CDS spreads with the liabilities as of 31.12.2008.

Table 2: Liabilities and CDS spreads by bank

					Average daily CDS spread[2]			
No.	Bank name	Region	Country	Liability[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
1	American Express	America	US	79.7	16.7	85.4	291.5	88.6
2	Bank of America	America	US	1,180.4	11.5	54.6	172.4	150.1
3	Bank of New York Mellon	America	US	150.7	14.5	80.3	221.0	133.9
4	Capital One Financial	America	US	100.2	34.4	205.7	267.1	116.5
5	Citigroup	America	US	1,292.6	11.0	72.0	298.0	161.8
6	Goldman Sachs	America	US	638.5	22.9	79.2	207.5	135.9
7	JPMorgan Chase & Co.	America	US	1,444.6	17.9	57.0	111.4	83.4
8	MetLife	America	US	331.1	20.2	64.3	451.4	208.3
9	Morgan Stanley	America	US	479.1	23.0	103.5	302.9	169.2
10	PNC Financial Services	America	US	189.5	22.8	119.0	257.5	137.9
11	US Bancorp	America	US	172.4	20.4	74.9	288.6	159.4
12	Wells Fargo	America	US	860.9	10.2	53.9	137.6	103.5
13	ANZ Banking Group	Asia-Pacific	Australia	249.4	8.0	43.2	109.9	103.0
14	Commonwealth Bank	Asia-Pacific	Australia	281.0	8.1	42.7	105.4	103.0
15	Macquarie Bank	Asia-Pacific	Australia	90.1	16.7	99.3	340.4	171.7
16	National Australia Bank	Asia-Pacific	Australia	348.8	8.1	43.6	110.6	104.9
17	Westspac Banking Corp	Asia-Pacific	Australia	235.4	7.9	42.6	104.8	111.2
18	Bank of China	Asia-Pacific	China	679.5	21.9	67.5	206.3	130.4
19	Standard Chartered Bank	Asia-Pacific	Hong Kong	291.7	11.0	49.5	146.5	89.1
20	Bank of India	Asia-Pacific	India	26.5	81.1	140.2	249.1	175.6
21	ICICI Bank	Asia-Pacific	India	68.9	71.9	191.6	446.0	213.7
22	State Bank of India	Asia-Pacific	India	151.5	60.1	130.2	266.6	171.1
23	Mizuho Financial Group	Asia-Pacific	Japan	939.1	18.5	24.4	101.9	94.8
24	Resona Holdings	Asia-Pacific	Japan	234.7	22.1	68.8	266.9	82.5
25	Sumitomo Mitsui Banking	Asia-Pacific	Japan	670.5	12.5	37.8	85.4	81.2
26	Halyk Bank of Kazakhstan	Asia-Pacific	Kazakhstan	8.7	180.3	336.5	1,369.1	481.8
27	Kazkommertsbank	Asia-Pacific	Kazakhstan	13.7	200.8	520.4	1,599.3	940.7
28	Hana Bank	Asia-Pacific	Korea	84.8	27.6	93.4	309.8	126.2
29	Industrial Bank of Korea	Asia-Pacific	Korea	78.1	23.1	74.1	279.1	118.2
30	Kookmin Bank	Asia-Pacific	Korea	143.6	24.0	81.3	292.4	120.9
31	Shinhan Financial Group	Asia-Pacific	Korea	140.1	27.7	94.9	308.0	124.2
32	Woori Bank	Asia-Pacific	Korea	157.7	34.4	108.8	330.1	135.9
33	Malayan Banking Berhad	Asia-Pacific	Malaysia	48.1	20.2	49.2	138.6	75.9
34	DBS Bank	Asia-Pacific	Singapore	116.1	9.0	44.9	98.8	46.5
35	Oversea Chinese Banking	Asia-Pacific	Singapore	81.3	9.5	44.7	98.0	46.2
36	United Overseas Bank	Asia-Pacific	Singapore	83.3	10.7	44.6	98.9	49.3
37	Erste Group Bank	Europe	Austria	189.5	21.5	52.4	208.2	148.3
38	Dexia	Europe	Belgium	641.4	9.1	67.7	274.6	269.0
39	KBC Bank	Europe	Belgium	337.9	9.0	64.5	205.4	153.6
40	DANSKE Bank	Europe	Denmark	462.8	6.0	22.1	122.4	87.9
41	BNP Paribas	Europe	France	2,012.6	7.0	35.1	69.6	96.4
42	Crédit Agricole	Europe	France	1,601.7	7.1	46.7	91.8	130.8
43	Societé Generale	Europe	France	1,086.2	7.6	43.9	96.9	121.7
44	Commerzbank	Europe	Germany	599.3	12.9	52.3	90.3	115.1
45	Deutsche Bank	Europe	Germany	2,162.0	12.7	49.1	107.9	105.2
46	IKB - Deutsche Industriebank	Europe	Germany	48.9	22.6	164.5	664.7	374.7
47	Alpha Bank	Europe	Greece	61.9	21.4	27.4	92.4	756.3
48	EFG Eurobank	Europe	Greece	78.0	21.1	15.4	55.6	794.6
49	Allied Irish Banks	Europe	Ireland	171.2	7.7	67.1	278.5	725.9

No.	Bank name	Region	Country	Liability[1]	Average daily CDS spread[2] *Period 1*	*Period 2*	*Period 3*	*Period 4*
50	Bank of Ireland	Europe	Ireland	190.8	7.7	72.3	292.5	427.9
51	Banca Monte d.P. die Siena	Europe	Italy	195.1	12.6	46.5	89.5	185.4
52	Banco Popolare	Europe	Italy	109.3	37.8	68.2	151.9	202.2
53	Intesa Sanpaolo	Europe	Italy	581.3	11.0	36.3	82.5	126.2
54	Unicredit Group	Europe	Italy	976.9	12.8	45.1	115.5	148.1
55	SNS REAAL Bank	Europe	Netherlands	118.7	10.8	44.5	294.5	212.8
56	Banco BPI	Europe	Portugal	40.8	17.5	40.5	99.5	454.2
57	Banco Comercial Portuges	Europe	Portugal	87.6	11.5	50.2	104.4	463.1
58	Espirito Santo Financial Group	Europe	Portugal	71.0	12.4	57.3	123.5	467.1
59	Banco de Sabadell	Europe	Spain	75.1	24.6	83.4	239.1	304.7
60	Banco Pastor	Europe	Spain	25.5	21.1	27.3	372.8	428.2
61	Banco Popular	Europe	Spain	102.8	11.3	31.4	218.0	307.2
62	Bankinter	Europe	Spain	51.3	14.1	14.5	199.0	285.1
63	Grupo BBVA	Europe	Spain	510.7	9.5	46.1	98.4	204.7
64	Grupo Santander	Europe	Spain	975.0	10.2	46.7	99.4	173.0
65	Nordea	Europe	Sweden	450.1	10.7	29.3	95.4	74.7
66	Skand Enskilda Banken	Europe	Sweden	220.5	19.9	29.7	149.3	93.7
67	Svenska Handelsbanken	Europe	Sweden	189.5	13.7	20.4	90.2	58.1
68	Swedbank	Europe	Sweden	156.9	29.5	21.0	201.0	97.1
69	Crédit Suisse	Europe	Switzerland	751.9	13.1	55.1	119.4	96.1
70	UBS	Europe	Switzerland	1,328.4	6.0	55.4	159.3	104.1
71	Barclay's	Europe	UK	2,075.4	8.0	52.9	136.6	115.6
72	HSBC	Europe	UK	1,716.2	8.0	40.7	87.4	77.0
73	Lloyds Banking Group	Europe	UK	440.1	6.0	37.8	134.5	175.2
74	Royal Bank of Scotland	Europe	UK	2,393.4	7.2	54.3	147.2	180.7
75	Arab Banking Corp	Middle East	Bahrain	18.6	35.3	114.1	457.3	354.3
76	Commercial Bank of Qatar	Middle East	Qatar	10.1	17.5	56.8	221.1	182.9
77	Abu Dhabi Commercial Bank	Middle East	UAE	26.7	24.7	79.3	274.6	290.9
78	Dubai Islamic Bank	Middle East	UAE	14.9	25.7	83.4	507.8	450.6
79	Mashreqbank	Middle East	UAE	16.2	25.2	81.8	531.9	503.6
80	National Bank of Abu Dhabi	Middle East	UAE	29.4	17.5	55.2	226.0	165.1
81	Bank of Moscow	Russia	Russia	15.8	138.2	225.8	1,199.2	624.1
82	Sberbank	Russia	Russia	141.0	80.6	125.7	463.9	187.5
83	WTB/VTB (Wneschtorgbank)	Russia	Russia	80.7	100.4	181.1	752.2	326.8
	Mean			431.1	12.8	53.8	152.1	138.8
	Total			35,783.5				

Notes: 1. Total liabilities as of 31.12.2008 in billion EUR. 2. Mean of daily CDS spread in basis points. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the CDS spreads is obtained by weighting the period CDS spreads with the liabilities as of 31.12.2008.

Table 3: Equity and average equity return correlation by country (Global)

			Average equity return correlation[2]			
Region	Country	Equity[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
America	US	464.5	19.2%	26.4%	27.1%	24.4%
Asia-Pacific	Australia	60.3	17.5%	23.9%	28.5%	22.0%
Asia-Pacific	China	48.9	9.4%	10.3%	1.5%	4.6%
Asia-Pacific	Hong Kong	15.7	25.6%	39.9%	36.1%	28.5%
Asia-Pacific	India	18.3	13.3%	21.5%	24.7%	16.2%
Asia-Pacific	Japan	55.2	15.6%	12.9%	13.1%	3.2%
Asia-Pacific	Kazakhstan	3.0	6.3%	8.3%	7.6%	5.6%
Asia-Pacific	Korea	34.9	15.8%	22.8%	22.4%	16.9%
Asia-Pacific	Malaysia	3.7	10.4%	19.0%	20.1%	10.7%
Asia-Pacific	Singapore	23.5	19.2%	28.2%	28.5%	18.5%
Europe	Austria	8.1	19.0%	34.0%	36.4%	28.5%
Europe	Belgium	19.8	25.0%	37.2%	32.5%	31.3%
Europe	Denmark	13.2	20.5%	35.8%	36.2%	22.3%
Europe	France	132.5	28.8%	39.8%	39.4%	34.1%
Europe	Germany	51.7	29.0%	39.1%	37.7%	32.5%
Europe	Greece	6.6	15.2%	25.5%	30.0%	18.8%
Europe	Ireland	15.7	18.5%	36.1%	27.4%	21.1%
Europe	Italy	128.6	23.5%	35.6%	38.9%	31.6%
Europe	Netherlands	4.8	21.4%	30.3%	35.9%	29.9%
Europe	Portugal	11.4	10.5%	26.1%	30.5%	27.0%
Europe	Spain	97.9	26.5%	34.0%	37.1%	30.1%
Europe	Sweden	39.8	24.6%	35.3%	36.5%	29.0%
Europe	Switzerland	44.0	27.2%	38.7%	38.0%	32.3%
Europe	UK	169.5	27.4%	38.8%	36.0%	30.3%
Middle East	Bahrain	1.3	7.0%	6.2%	-5.3%	3.5%
Middle East	Qatar	2.0	6.6%	7.7%	12.3%	12.0%
Middle East	UAE	8.7	3.3%	8.0%	10.7%	4.3%
Russia	Russia	28.7	17.2%	25.2%	29.7%	23.9%
Mean		54.0	23.5%	32.7%	32.3%	27.0%
Total		1,512.3				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 4: Equity and average equity return correlation by bank (Global)

No.	Bank name	Region	Country	Equity[1]	Average equity return correlation[2] *Period 1*	*Period 2*	*Period 3*	*Period 4*
1	American Express	America	US	8.5	18.9%	24.1%	26.5%	21.1%
2	Bank of America	America	US	99.1	19.1%	27.0%	30.7%	27.4%
3	Bank of New York Mellon	America	US	20.2	18.6%	25.3%	23.0%	22.7%
4	Capital One Financial	America	US	16.6	18.1%	23.5%	26.7%	22.4%
5	Citigroup	America	US	51.1	20.4%	29.4%	27.7%	22.9%
6	Goldman Sachs	America	US	36.5	20.1%	28.0%	28.1%	17.9%
7	JPMorgan Chase & Co.	America	US	97.1	20.6%	24.6%	25.8%	26.4%
8	MetLife	America	US	24.6	15.6%	25.5%	27.1%	26.6%
9	Morgan Stanley	America	US	25.0	22.7%	27.8%	28.4%	24.7%
10	PNC Financial Services	America	US	18.3	15.4%	23.9%	20.8%	21.8%
11	US Bancorp	America	US	18.9	16.8%	25.2%	22.2%	23.7%
12	Wells Fargo	America	US	48.7	15.7%	23.6%	25.1%	24.9%
13	ANZ Banking Group	Asia-Pacific	Australia	14.4	14.4%	21.2%	27.3%	20.7%
14	Commonwealth Bank	Asia-Pacific	Australia	15.0	18.3%	26.6%	30.7%	22.7%
15	Macquarie Bank	Asia-Pacific	Australia	5.1	16.3%	25.0%	25.4%	19.0%
16	National Australia Bank	Asia-Pacific	Australia	15.8	18.9%	22.6%	28.1%	22.7%
17	Westspac Banking Corp	Asia-Pacific	Australia	10.0	18.2%	24.9%	29.1%	22.4%
18	Bank of China	Asia-Pacific	China	48.9	9.4%	10.3%	1.5%	4.6%
19	Standard Chartered Bank	Asia-Pacific	Hong Kong	15.7	25.6%	39.9%	36.1%	28.5%
20	Bank of India	Asia-Pacific	India	1.7	13.4%	16.1%	20.7%	9.4%
21	ICICI Bank	Asia-Pacific	India	7.0	13.7%	23.1%	27.8%	17.1%
22	State Bank of India	Asia-Pacific	India	9.6	13.2%	21.7%	24.0%	16.9%
23	Mizuho Financial Group	Asia-Pacific	Japan	18.5	16.6%	13.2%	13.9%	2.6%
24	Resona Holdings	Asia-Pacific	Japan	16.3	16.4%	12.5%	6.5%	1.4%
25	Sumitomo Mitsui Banking	Asia-Pacific	Japan	20.4	13.9%	12.8%	14.4%	4.8%
26	Halyk Bank of Kazakhstan	Asia-Pacific	Kazakhstan	1.1	6.9%	8.4%	13.2%	5.7%
27	Kazkommertsbank	Asia-Pacific	Kazakhstan	1.9	5.8%	8.3%	4.1%	5.6%
28	Hana Bank	Asia-Pacific	Korea	5.1	15.2%	22.9%	21.2%	13.1%
29	Industrial Bank of Korea	Asia-Pacific	Korea	4.0	14.6%	22.2%	23.7%	16.4%
30	Kookmin Bank	Asia-Pacific	Korea	9.0	16.6%	24.1%	22.0%	18.9%
31	Shinhan Financial Group	Asia-Pacific	Korea	9.8	15.4%	24.1%	22.9%	16.4%
32	Woori Bank	Asia-Pacific	Korea	7.0	16.5%	20.6%	22.3%	17.7%
33	Malayan Banking Berhad	Asia-Pacific	Malaysia	3.7	10.4%	19.0%	20.1%	10.7%
34	DBS Bank	Asia-Pacific	Singapore	9.9	20.4%	29.0%	28.3%	18.4%
35	Oversea Chinese Banking	Asia-Pacific	Singapore	7.0	19.0%	28.6%	29.2%	17.0%
36	United Overseas Bank	Asia-Pacific	Singapore	6.7	17.6%	26.7%	28.1%	20.2%
37	Erste Group Bank	Europe	Austria	8.1	19.0%	34.0%	36.4%	28.5%
38	Dexia	Europe	Belgium	14.2	25.2%	36.1%	30.2%	30.3%
39	KBC Bank	Europe	Belgium	5.6	24.5%	39.3%	36.8%	33.3%
40	DANSKE Bank	Europe	Denmark	13.2	20.5%	35.8%	36.2%	22.3%
41	BNP Paribas	Europe	France	53.2	29.8%	40.9%	39.3%	34.4%
42	Crédit Agricole	Europe	France	41.7	26.6%	39.3%	39.8%	33.5%
43	Societé Generale	Europe	France	37.5	30.1%	38.4%	38.9%	34.3%
44	Commerzbank	Europe	Germany	19.2	25.3%	37.8%	34.3%	29.7%
45	Deutsche Bank	Europe	Germany	30.7	30.2%	39.9%	39.1%	34.0%
46	IKB - Deutsche Industriebank	Europe	Germany	1.8	22.8%	21.5%	17.7%	0.9%
47	Alpha Bank	Europe	Greece	3.0	15.8%	26.6%	29.2%	18.2%
48	EFG Eurobank	Europe	Greece	3.6	14.7%	24.6%	30.6%	19.2%
49	Allied Irish Banks	Europe	Ireland	9.3	23.1%	37.8%	28.0%	21.4%

					Average equity return correlation[2]			
No.	Bank name	Region	Country	Equity[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
50	Bank of Ireland	Europe	Ireland	6.4	14.5%	34.6%	26.9%	20.8%
51	Banca Monte d.P. die Siena	Europe	Italy	14.8	21.4%	33.4%	35.8%	29.5%
52	Banco Popolare	Europe	Italy	9.8	17.2%	30.7%	33.4%	29.7%
53	Intesa Sanpaolo	Europe	Italy	49.0	19.1%	34.3%	39.6%	31.6%
54	Unicredit Group	Europe	Italy	55.0	27.3%	37.4%	39.7%	32.1%
55	SNS REAAL Bank	Europe	Netherlands	4.8	21.4%	30.3%	35.9%	29.9%
56	Banco BPI	Europe	Portugal	1.5	8.0%	19.8%	33.2%	26.2%
57	Banco Comercial Portuges	Europe	Portugal	6.0	12.9%	24.9%	30.9%	27.4%
58	Espirito Santo Financial Group	Europe	Portugal	3.9	8.9%	31.1%	28.3%	27.0%
59	Banco de Sabadell	Europe	Spain	4.4	23.3%	36.1%	39.4%	26.7%
60	Banco Pastor	Europe	Spain	1.5	16.1%	30.9%	24.7%	16.7%
61	Banco Popular	Europe	Spain	6.8	23.8%	37.6%	41.2%	28.3%
62	Bankinter	Europe	Spain	2.0	22.8%	36.2%	29.2%	29.2%
63	Grupo BBVA	Europe	Spain	25.7	23.4%	21.9%	27.8%	27.6%
64	Grupo Santander	Europe	Spain	57.6	29.1%	39.8%	42.2%	32.2%
65	Nordea	Europe	Sweden	17.5	25.1%	35.9%	36.9%	29.0%
66	Skand Enskilda Banken	Europe	Sweden	7.6	24.8%	37.0%	37.4%	30.0%
67	Svenska Handelsbanken	Europe	Sweden	6.8	24.2%	31.7%	35.6%	29.0%
68	Swedbank	Europe	Sweden	7.8	23.3%	35.4%	35.1%	27.6%
69	Crédit Suisse	Europe	Switzerland	21.8	26.7%	39.5%	37.2%	33.1%
70	UBS	Europe	Switzerland	22.2	27.5%	38.3%	38.4%	31.8%
71	Barclay's	Europe	UK	34.1	26.9%	39.8%	36.8%	34.3%
72	HSBC	Europe	UK	64.8	31.0%	38.3%	40.3%	30.1%
73	Lloyds Banking Group	Europe	UK	9.7	26.4%	39.3%	31.9%	26.9%
74	Royal Bank of Scotland	Europe	UK	60.9	25.3%	38.1%	33.0%	27.5%
75	Arab Banking Corp	Middle East	Bahrain	1.3	7.0%	6.2%	-5.3%	3.5%
76	Commercial Bank of Qatar	Middle East	Qatar	2.0	6.6%	7.7%	12.3%	12.0%
77	Abu Dhabi Commercial Bank	Middle East	UAE	2.2	4.5%	9.5%	11.5%	7.2%
78	Dubai Islamic Bank	Middle East	UAE	1.7	0.4%	10.7%	15.0%	8.0%
79	Mashreqbank	Middle East	UAE	2.0	6.0%	6.7%	-4.9%	-5.5%
80	National Bank of Abu Dhabi	Middle East	UAE	2.8	2.2%	6.1%	16.5%	5.1%
81	Bank of Moscow	Russia	Russia	1.6	10.3%	20.6%	21.2%	11.7%
82	Sberbank	Russia	Russia	17.6	20.2%	28.4%	30.5%	25.5%
83	WTB/VTB (Wneschtorgbank)	Russia	Russia	9.5	13.3%	20.6%	30.1%	23.5%
	Mean			18.2	23.5%	32.7%	32.3%	27.0%
	Total			1,512.3				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 5: Equity and average equity return correlation by bank (America)

No.	Bank name	Country	Equity[1]	Average equity return correlation[2]			
				Period 1	*Period 2*	*Period 3*	*Period 4*
1	American Express	US	8.5	59.3%	72.4%	68.0%	60.9%
2	Bank of America	US	99.1	62.1%	78.1%	71.2%	70.2%
3	Bank of New York Mellon	US	20.2	53.5%	72.3%	68.5%	65.4%
4	Capital One Financial	US	16.6	50.1%	66.4%	67.8%	65.2%
5	Citigroup	US	51.1	61.4%	76.0%	62.3%	60.4%
6	Goldman Sachs	US	36.5	55.0%	73.5%	68.9%	60.8%
7	JPMorgan Chase & Co.	US	97.1	64.1%	77.4%	75.8%	72.7%
8	MetLife	US	24.6	50.1%	70.4%	67.9%	63.1%
9	Morgan Stanley	US	25.0	57.5%	74.4%	66.4%	67.7%
10	PNC Financial Services	US	18.3	53.5%	74.1%	68.9%	67.8%
11	US Bancorp	US	18.9	58.7%	76.8%	71.4%	70.0%
12	Wells Fargo	US	48.7	62.6%	76.9%	74.3%	71.0%
	Mean		38.7	60.2%	75.9%	70.0%	67.3%
	Total		464.5				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 6: Equity and average equity return correlation (Asia-Pacific)

By country

			Average equity return correlation[2]			
Region	Country	Equity[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
Asia-Pacific	Australia	60.3	28.6%	35.6%	35.1%	35.5%
Asia-Pacific	China	48.9	14.8%	17.1%	13.2%	16.1%
Asia-Pacific	Hong Kong	15.7	14.6%	25.6%	24.7%	11.6%
Asia-Pacific	India	18.3	22.1%	27.3%	29.3%	22.9%
Asia-Pacific	Japan	55.2	29.3%	29.8%	27.8%	18.3%
Asia-Pacific	Kazakhstan	3.0	7.1%	8.7%	13.5%	15.2%
Asia-Pacific	Korea	34.9	29.4%	36.8%	39.6%	34.6%
Asia-Pacific	Malaysia	3.7	16.5%	27.0%	27.2%	25.3%
Asia-Pacific	Singapore	23.5	28.5%	38.1%	39.2%	33.6%
Mean		29.3	25.8%	30.2%	29.4%	24.6%
Total		263.7				

By bank

				Average equity return correlation[2]			
No.	Bank name	Country	Equity[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
1	ANZ Banking Group	Australia	14.4	20.7%	27.2%	27.0%	33.7%
2	Commonwealth Bank	Australia	15.0	31.5%	38.4%	36.9%	36.6%
3	Macquarie Bank	Australia	5.1	26.5%	40.1%	35.8%	36.1%
4	National Australia Bank	Australia	15.8	32.2%	36.9%	37.7%	36.1%
5	Westspac Banking Corp	Australia	10.0	29.1%	37.3%	37.7%	35.0%
6	Bank of China	China	48.9	14.8%	17.1%	13.2%	16.1%
7	Standard Chartered Bank	Hong Kong	15.7	14.6%	25.6%	24.7%	11.6%
8	Bank of India	India	1.7	20.9%	23.0%	25.3%	19.0%
9	ICICI Bank	India	7.0	24.3%	31.2%	33.7%	25.6%
10	State Bank of India	India	9.6	21.4%	26.2%	27.9%	22.3%
11	Mizuho Financial Group	Japan	18.5	30.4%	31.1%	28.2%	17.0%
12	Resona Holdings	Japan	16.3	29.5%	28.1%	20.0%	13.7%
13	Sumitomo Mitsui Banking	Japan	20.4	27.6%	28.5%	30.0%	21.7%
14	Halyk Bank of Kazakhstan	Kazakhstan	1.1	8.5%	9.9%	19.9%	15.3%
15	Kazkommertsbank	Kazakhstan	1.9	6.2%	8.0%	9.5%	15.2%
16	Hana Bank	Korea	5.1	29.7%	35.9%	36.7%	32.8%
17	Industrial Bank of Korea	Korea	4.0	28.0%	34.7%	39.7%	33.4%
18	Kookmin Bank	Korea	9.0	31.2%	39.0%	40.9%	36.7%
19	Shinhan Financial Group	Korea	9.8	28.2%	38.1%	41.0%	35.2%
20	Woori Bank	Korea	7.0	29.3%	35.1%	38.6%	33.9%
21	Malayan Banking Berhad	Malaysia	3.7	16.5%	27.0%	27.2%	25.3%
22	DBS Bank	Singapore	9.9	31.1%	40.3%	40.1%	34.5%
23	Oversea Chinese Banking	Singapore	7.0	27.7%	37.8%	38.9%	33.1%
24	United Overseas Bank	Singapore	6.7	25.8%	35.2%	38.1%	32.7%
	Mean		11.0	25.8%	30.2%	29.4%	24.6%
	Total		263.7				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 7: Equity and average equity return correlation by country (Europe)

			Average equity return correlation[2]			
Region	Country	Equity[1]	*Period 1*	*Period 2*	*Period 3*	*Period 4*
Europe	Austria	8.1	28.7%	49.1%	53.2%	51.9%
Europe	Belgium	19.8	40.6%	54.8%	46.5%	54.7%
Europe	Denmark	13.2	30.2%	50.5%	51.5%	39.3%
Europe	France	132.5	46.0%	59.3%	57.6%	59.6%
Europe	Germany	51.7	44.5%	56.0%	53.1%	51.2%
Europe	Greece	6.6	23.9%	36.0%	41.9%	35.6%
Europe	Ireland	15.7	32.0%	51.2%	40.1%	35.0%
Europe	Italy	128.6	38.1%	53.5%	55.1%	57.3%
Europe	Netherlands	4.8	19.6%	44.5%	51.9%	46.3%
Europe	Portugal	11.4	16.8%	37.0%	43.5%	52.0%
Europe	Spain	97.9	42.0%	49.7%	51.9%	56.2%
Europe	Sweden	39.8	40.3%	54.0%	54.7%	47.9%
Europe	Switzerland	44.0	42.5%	56.7%	55.1%	48.5%
Europe	UK	169.5	39.6%	55.1%	51.4%	45.1%
Mean		53.1	41.1%	55.1%	53.2%	51.2%
Total		743.5				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 8: Equity and average equity return correlation by bank (Europe)

No.	Bank name	Country	Equity[1]	Average equity return correlation[2]			
				Period 1	*Period 2*	*Period 3*	*Period 4*
1	Erste Group Bank	Austria	8.1	28.7%	49.1%	53.2%	51.9%
2	Dexia	Belgium	14.2	40.6%	53.6%	44.4%	53.7%
3	KBC Bank	Belgium	5.6	40.5%	57.1%	50.7%	56.5%
4	DANSKE Bank	Denmark	13.2	30.2%	50.5%	51.5%	39.3%
5	BNP Paribas	France	53.2	47.9%	61.3%	57.6%	60.2%
6	Crédit Agricole	France	41.7	41.6%	58.8%	58.5%	58.8%
7	Societé Generale	France	37.5	49.1%	56.4%	56.3%	59.7%
8	Commerzbank	Germany	19.2	38.6%	55.1%	48.4%	48.3%
9	Deutsche Bank	Germany	30.7	46.4%	56.9%	55.0%	53.1%
10	IKB - Deutsche Industriebank	Germany	1.8	33.8%	30.0%	25.6%	0.8%
11	Alpha Bank	Greece	3.0	25.3%	38.0%	41.1%	34.7%
12	EFG Eurobank	Greece	3.6	22.9%	34.4%	42.7%	36.3%
13	Allied Irish Banks	Ireland	9.3	37.9%	53.3%	41.2%	34.6%
14	Bank of Ireland	Ireland	6.4	26.6%	49.4%	39.2%	35.3%
15	Banca Monte d.P. die Siena	Italy	14.8	34.4%	50.3%	50.8%	54.7%
16	Banco Popolare	Italy	9.8	29.7%	47.0%	47.4%	52.7%
17	Intesa Sanpaolo	Italy	49.0	32.9%	51.2%	55.7%	57.8%
18	Unicredit Group	Italy	55.0	42.9%	56.3%	56.5%	58.0%
19	SNS REAAL Bank	Netherlands	4.8	19.6%	44.5%	51.9%	46.3%
20	Banco BPI	Portugal	1.5	14.4%	29.4%	47.4%	49.3%
21	Banco Comercial Portuges	Portugal	6.0	19.3%	35.4%	43.5%	52.9%
22	Espirito Santo Financial Group	Portugal	3.9	15.0%	43.3%	41.1%	52.5%
23	Banco de Sabadell	Spain	4.4	37.6%	53.6%	57.0%	54.1%
24	Banco Pastor	Spain	1.5	26.5%	46.0%	35.3%	32.9%
25	Banco Popular	Spain	6.8	39.4%	55.5%	59.2%	56.2%
26	Bankinter	Spain	2.0	37.1%	52.8%	43.9%	56.4%
27	Grupo BBVA	Spain	25.7	36.1%	29.8%	35.2%	48.2%
28	Grupo Santander	Spain	57.6	46.4%	59.1%	60.3%	61.1%
29	Nordea	Sweden	17.5	41.0%	54.3%	55.7%	49.6%
30	Skand Enskilda Banken	Sweden	7.6	41.2%	56.9%	55.0%	48.0%
31	Svenska Handelsbanken	Sweden	6.8	39.6%	49.7%	54.0%	45.5%
32	Swedbank	Sweden	7.8	38.3%	54.4%	52.4%	45.9%
33	Crédit Suisse	Switzerland	21.8	40.7%	57.2%	53.1%	49.3%
34	UBS	Switzerland	22.2	43.5%	56.4%	56.3%	48.1%
35	Barclay's	UK	34.1	41.9%	57.3%	53.3%	51.2%
36	HSBC	UK	64.8	38.6%	53.5%	53.7%	42.2%
37	Lloyds Banking Group	UK	9.7	38.0%	56.8%	46.9%	41.2%
38	Royal Bank of Scotland	UK	60.9	38.6%	54.1%	48.8%	42.6%
	Mean		19.6	41.1%	55.1%	53.2%	51.2%
	Total		743.5				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 9: Equity and average equity return correlation by bank (Middle East and Russia)

No.	Bank name	Country	Equity[1]	Average equity return correlation[2] *Period 1*	*Period 2*	*Period 3*	*Period 4*
1	Arab Banking Corp	Bahrain	1.3	13.9%	7.1%	5.0%	17.0%
2	Commercial Bank of Qatar	Qatar	2.0	12.4%	12.3%	18.7%	21.5%
3	Abu Dhabi Commercial Bank	UAE	2.2	24.6%	19.1%	22.9%	19.4%
4	Dubai Islamic Bank	UAE	1.7	19.4%	17.9%	22.4%	20.7%
5	Mashreqbank	UAE	2.0	11.0%	11.3%	3.2%	18.6%
6	National Bank of Abu Dhabi	UAE	2.8	21.7%	19.3%	24.8%	24.2%
7	Bank of Moscow	Russia	1.6	14.9%	17.4%	17.2%	22.5%
8	Sberbank	Russia	17.6	14.8%	17.6%	15.7%	20.8%
9	WTB/VTB (Wneschtorgbank)	Russia	9.5	43.4%	22.8%	17.4%	20.7%
	Mean		4.5	22.6%	18.0%	16.7%	20.7%
	Total		40.6				

Notes: 1. Total equity as of 31.12.2008 in billion EUR. 2. Mean of daily pairwise stock return correlations between the bank and all other banks. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011. The mean of the correlations is obtained by weighting the period correlations with the liabilities as of 31.12.2008.

Table 10: Sovereign CDS spreads by country

		Average daily CDS spread			
Region	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*
America	US	3.1	6.7	40.9	44.5
Asia-Pacific	Australia	9.8	18.9	68.4	46.6
	China	18.6	35.9	121.5	72.5
	Hong Kong	8.5	21.8	81.2	45.1
	India	60.1	130.2	266.6	171.1
	Japan	4.3	13.2	51.3	69.2
	Kazakhstan	59.8	148.2	570.2	175.4
	Korea	23.5	50.3	223.3	101.5
	Malaysia	25.2	50.8	165.0	87.4
	Singapore	4.1	9.1	40.7	42.3
Europe	Austria	1.9	5.8	95.3	76.5
	Belgium	2.1	10.7	60.6	120.0
	Denmark	14.7	8.6	59.1	39.3
	France	1.9	6.3	38.5	73.1
	Germany	2.0	4.8	33.8	45.0
	Greece	11.5	24.0	158.1	748.9
	Ireland	5.5	14.8	171.0	371.8
	Italy	10.1	20.2	104.0	164.1
	Netherlands	4.8	6.5	50.8	45.1
	Portugal	6.8	18.3	76.6	348.5
	Spain	3.0	17.1	86.4	217.5
	Sweden	11.0	24.2	67.3	34.6
	Switzerland	3.7	8.8	63.6	45.7
	UK	2.7	7.9	76.1	69.5
Middle East and Russia	Bahrain	30.3	75.1	323.5	196.4
	Qatar	21.7	32.5	166.4	90.3
	UAE	28.2	66.1	326.6	277.9
	Russia	57.5	83.7	407.5	152.0
Mean (unweighted)		15.6	32.9	142.7	141.8

Notes: Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 11: CDS spreads of non-bank corporates by region and industry

Region	Industry	Sample size	Average daily CDS spread[1] *Period 1*	*Period 2*	*Period 3*	*Period 4*
Global	Automotive	19	193.7	199.0	765.4	172.0
	Basic materials	17	29.1	65.0	295.6	112.5
	Chemicals, healthcare and pharma	40	23.3	43.5	108.1	67.2
	Commerce and consumer	76	32.7	55.3	143.2	87.0
	Construction and logistics	13	23.9	45.8	127.7	86.4
	Energy and utilities	49	19.4	39.0	112.7	92.6
	Financial services (excl. banking)	30	18.6	63.4	267.5	139.7
	Industrial	46	27.5	40.0	111.3	62.7
	Telecommunication, media and tech.	62	38.6	64.0	137.0	89.0
	Overall	352	38.7	66.4	231.0	110.8
America	Automotive	3	699.3	763.0	3,101.4	424.2
	Basic materials	7	30.7	59.9	331.0	132.3
	Chemicals, healthcare and pharma	22	21.3	41.3	108.6	70.2
	Commerce and consumer	35	34.0	55.3	129.1	82.9
	Construction and logistics	5	18.0	45.4	112.8	61.4
	Energy and utilities	22	25.1	40.2	120.3	78.2
	Financial services (excl. banking)	16	30.4	94.4	431.5	196.0
	Industrial	23	24.4	26.6	63.3	31.4
	Telecommunication, media and tech.	24	34.4	66.5	126.0	82.4
	Overall	157	67.6	95.0	329.3	116.7
Asia-Pacific	Automotive	7	10.8	27.7	164.8	73.2
	Basic materials	6	23.6	59.3	240.5	84.3
	Chemicals, healthcare and pharma	3	32.9	76.7	190.4	78.2
	Commerce and consumer	11	29.2	53.0	234.9	89.3
	Construction and logistics	3	33.7	103.8	489.5	182.9
	Energy and utilities	8	25.4	52.3	165.6	89.6
	Financial services (excl. banking)	3	30.2	52.1	137.6	134.6
	Industrial	9	20.3	48.0	172.1	89.6
	Telecommunication, media and tech.	18	39.3	60.2	177.5	78.3
	Overall	68	26.7	51.7	187.3	85.9
Europe	Automotive	9	55.2	69.2	299.6	162.5
	Basic materials	4	33.8	76.6	340.4	138.3
	Chemicals, healthcare and pharma	15	23.6	38.5	88.6	60.3
	Commerce and consumer	30	32.5	56.1	126.3	89.9
	Construction and logistics	5	24.4	43.2	101.3	84.1
	Energy and utilities	19	15.3	36.7	101.9	99.4
	Financial services (excl. banking)	11	14.3	54.6	214.0	118.2
	Industrial	14	42.1	71.4	208.4	130.2
	Telecommunication, media and tech.	20	43.4	63.9	119.3	106.3
	Overall	127	22.9	53.6	181.5	113.1

Notes: 1. The average CDS spreads of the non-bank corporates were obtained by weighting with the total liabilities of the respective firm. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 12: Corporate equity return by region and industry

Region	Industry	Sample size	Average daily equity return[1] *Period 1*	*Period 2*	*Period 3*	*Period 4*
Global	Automotive	19	0.03%	-0.09%	-0.01%	0.09%
	Basic materials	17	0.09%	0.02%	-0.06%	0.03%
	Chemicals, healthcare and pharma	40	0.03%	-0.06%	0.01%	0.05%
	Commerce and consumer	76	0.04%	-0.06%	0.00%	0.03%
	Construction and logistics	13	0.06%	-0.11%	-0.04%	0.02%
	Energy and utilities	49	0.02%	-0.02%	-0.04%	0.01%
	Financial services (excl. banking)	30	0.07%	-0.13%	-0.06%	0.04%
	Industrial	46	0.02%	-0.07%	-0.08%	0.08%
	Telecommunication, media and tech.	62	0.02%	-0.07%	-0.02%	0.02%
	Overall	352	0.04%	-0.09%	-0.04%	0.04%
America	Automotive	3	-0.08%	-0.16%	0.20%	0.11%
	Basic materials	7	0.04%	0.05%	-0.10%	0.06%
	Chemicals, healthcare and pharma	22	0.00%	-0.09%	0.02%	0.05%
	Commerce and consumer	35	0.01%	-0.06%	0.01%	0.03%
	Construction and logistics	5	0.00%	-0.07%	0.01%	0.06%
	Energy and utilities	22	-0.01%	-0.01%	-0.03%	0.06%
	Financial services (excl. banking)	16	0.02%	-0.13%	-0.08%	0.06%
	Industrial	23	0.01%	-0.07%	-0.10%	0.09%
	Telecommunication, media and tech.	24	0.02%	-0.08%	-0.01%	0.04%
	Overall	157	0.01%	-0.09%	-0.04%	0.06%
Asia-Pacific	Automotive	7	0.04%	-0.14%	0.02%	0.00%
	Basic materials	6	0.09%	0.06%	-0.04%	-0.01%
	Chemicals, healthcare and pharma	3	0.08%	-0.09%	-0.05%	0.06%
	Commerce and consumer	11	0.05%	-0.05%	-0.04%	0.04%
	Construction and logistics	3	-0.01%	-0.20%	-0.06%	0.06%
	Energy and utilities	8	0.07%	-0.07%	-0.02%	0.01%
	Financial services (excl. banking)	3	0.10%	-0.10%	0.05%	-0.02%
	Industrial	9	0.02%	-0.03%	-0.02%	0.06%
	Telecommunication, media and tech.	18	0.03%	-0.05%	-0.05%	0.03%
	Overall	68	0.05%	-0.06%	-0.02%	0.02%
Europe	Automotive	9	0.08%	-0.03%	-0.09%	0.13%
	Basic materials	4	0.12%	-0.05%	-0.05%	0.05%
	Chemicals, healthcare and pharma	15	0.04%	-0.02%	0.01%	0.04%
	Commerce and consumer	30	0.08%	-0.06%	0.01%	0.03%
	Construction and logistics	5	0.07%	-0.11%	-0.04%	0.00%
	Energy and utilities	19	0.03%	-0.02%	-0.04%	-0.01%
	Financial services (excl. banking)	11	0.08%	-0.13%	-0.05%	0.03%
	Industrial	14	0.07%	-0.06%	-0.04%	0.07%
	Telecommunication, media and tech.	20	0.01%	-0.06%	-0.02%	0.01%
	Overall	127	0.07%	-0.09%	-0.04%	0.03%

Notes: The average equity returns of the non-bank corporates were obtained by weighting with the total liabilities of the respective firm. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 13: Input variable determinants of the ESS-indicator

Global

Independent variables	Regression 1		Regression 2		Regression 3		Regression 4	
Constant term	0.00		0.00		0.00		0.00	
	(24.59)		(8.32)		(32.50)		(25.23)	
Risk-neutral PD (average)	0.23				0.21		0.32	
	(101.29)			*1.08*	(128.66)	*8.52*	(61.46)	
Correlation (average)			0.02		0.01		0.01	
			(20.35)	*1.08*	(30.80)	*3.10*	(16.90)	
PD dispersion							-0.11	
						8.04	(21.34)	
Correlation dispersion							0.01	
						3.29	(8.17)	
Adjusted-R^2	0.89		0.23		0.94		0.97	

America

Independent variables	Regression 1		Regression 2		Regression 3		Regression 4	
Constant term	0.00		-0.01		0.00		0.00	
	(14.83)		(12.43)		(28.90)		(13.95)	
Risk-neutral PD (average)	0.45				0.44		0.47	
	(237.30)			*1.15*	(217.28)	*5.52*	(139.14)	
Correlation (average)			0.03		0.00		0.00	
			(19.89)	*1.15*	(25.24)	*1.81*	(17.76)	
PD dispersion							-0.08	
						5.84	(10.22)	
Correlation dispersion							0.00	
						1.59	(5.93)	
Adjusted-R^2	0.99		0.17		0.99		0.99	

Asia-Pacific

Independent variables	Regression 1		Regression 2		Regression 3		Regression 4	
Constant term	0.00		0.00		0.00		0.00	
	(31.73)		(1.85)		(22.25)		(10.71)	
Risk-neutral PD (average)	0.28				0.28		0.30	
	(187.17)			*1.11*	(204.44)	*3.59*	(123.47)	
Correlation (average)			0.01		0.00		0.00	
			(13.04)	*1.11*	(10.17)	*1.46*	(5.21)	
PD dispersion							-0.03	
						3.38	(15.28)	
Correlation dispersion							0.00	
						1.37	(0.04)	
Adjusted-R^2	0.97		0.12		0.97		0.97	

Europe

Independent variables	Regression 1		Regression 2		Regression 3		Regression 4
Constant term	0.00		0.00		0.00		0.00
	(12.31)		(8.65)		(31.80)		(22.92)
Risk-neutral PD (average)	0.32				0.30		0.34
	(110.65)			*1.09*	(157.02)	*11.28*	(46.81)
Correlation (average)			0.01		0.01		0.01
			(20.13)	*1.09*	(32.28)	*1.76*	(27.03)
PD dispersion							-0.04
						11.25	(6.06)
Correlation dispersion							0.01
						1.47	(5.12)
Adjusted-R^2	0.92		0.22		0.96		0.96

Middle East and Russia

Independent variables	Regression 1		Regression 2		Regression 3		Regression 4
Constant term	0.00		0.01		0.00		0.00
	(15.96)		(11.94)		(13.66)		(18.10)
Risk-neutral PD (average)	0.43				0.43		0.51
	(122.64)			*1.00*	(134.76)	*4.23*	(160.73)
Correlation (average)			0.00		0.01		0.00
			(0.28)	*1.00*	(9.31)	*1.15*	(5.49)
PD dispersion							-0.20
						4.23	(38.95)
Correlation dispersion							0.03
						1.15	(18.07)
Adjusted-R^2	0.97		0.00		0.97		0.99

Notes: The dependent variable in the regression is the relative ESS-indicator of the banks in the sample. Average PD and average correlation denote the risk-neutral default probability of all banks and the correlation between the bank and all other banks at a particular point in time, respectively. Dispersion denotes the standard deviation of the respective variable at a particular point in time for all sample banks. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 14: Risk premium determinants of the ESS-indicator

Global

Independent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant term	0.00	0.00	0.00	0.00
	(5.66)	(23.98)	(21.85)	(16.00)
Baa-Aaa spread	0.27			0.16
	(34.57)		*1.44*	(20.87)
Ted spread		0.08		0.02
		(21.72)	*1.27*	(6.99)
Term spread			0.13	0.10
			(45.19) *1.20*	(38.93)
Adjusted-R^2	0.46	0.19	0.53	0.72

America

Independent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant term	0.00	0.01	0.00	0.00
	(7.45)	(30.91)	(32.36)	(15.86)
Baa-Aaa spread	0.76			0.54
	(33.67)		*1.44*	(23.43)
Ted spread		0.18		0.02
		(23.64)	*1.27*	(3.26)
Term spread			0.32	0.22
			(50.29) *1.20*	(60.34)
Adjusted-R^2	0.62	0.18	0.55	0.84

Asia-Pacific

Independent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant term	0.00	0.00	0.00	0.00
	(18.37)	(29.44)	(28.71)	(31.80)
Baa-Aaa spread	0.41			0.33
	(54.78)		*1.44*	(38.41)
Ted spread		0.09		0.00
		(16.46)	*1.27*	(1.19)
Term spread			0.15	0.09
			(42.35) *1.20*	(38.64)
Adjusted-R^2	0.71	0.17	0.45	0.84

Europe

Independent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant term	0.00	0.00	0.00	0.00
	(4.26)	(26.35)	(22.92)	(3.42)
Baa-Aaa spread	0.26			0.09
	(28.11)		*1.44*	(11.74)
Ted spread		0.08		0.02
		(17.12)	*1.27*	(5.29)
Term spread			0.19	0.16
			(56.11) *1.20*	(45.22)
Adjusted-R^2	0.26	0.11	0.65	0.69

Middle East and Russia

Independent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant term	-0.01	0.01	0.01	-0.01
	(21.25)	(36.22)	(43.04)	(28.58)
Baa-Aaa spread	1.67			1.49
	(55.05)		*1.44*	(43.83)
Ted spread		0.31		-0.04
		(13.61)	*1.27*	(3.58)
Term spread			0.50	0.24
			(38.00) *1.20*	(57.77)
Adjusted-R^2	0.83	0.15	0.37	0.90

Notes: The dependent regression variable is the relative ESS-indicator of the European banks in the sample during the observation period. Baa-Aaa spread is the spread between Moody's Baa and Aaa bond indices, Ted spread is the spread between the 3-month LIBOR and the yield of a 3-month T-Bill, Term spread is the spread between the yields of 10-year and 3-month maturity T-Bills. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 15: Relative systemic loss contribution by country (Global)

		Relative systemic loss contribution				
Region	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
America	US	20.8%	19.0%	22.1%	16.5%	19.6%
Asia-Pacific	Australia	0.4%	0.6%	1.6%	1.4%	1.0%
Asia-Pacific	China	0.2%	0.2%	0.3%	0.4%	0.3%
Asia-Pacific	Hong Kong	0.5%	0.7%	0.8%	0.7%	0.7%
Asia-Pacific	India	0.2%	0.3%	0.5%	0.3%	0.3%
Asia-Pacific	Japan	1.8%	0.4%	1.1%	0.6%	1.0%
Asia-Pacific	Kazakhstan	0.0%	0.0%	0.0%	0.0%	0.0%
Asia-Pacific	Korea	0.4%	0.5%	0.9%	0.4%	0.5%
Asia-Pacific	Malaysia	0.0%	0.0%	0.0%	0.0%	0.0%
Asia-Pacific	Singapore	0.1%	0.2%	0.3%	0.1%	0.2%
Europe	Austria	0.3%	0.3%	0.7%	0.5%	0.4%
Europe	Belgium	2.4%	2.9%	3.1%	3.6%	3.0%
Europe	Denmark	0.3%	0.5%	1.1%	0.5%	0.6%
Europe	France	19.3%	15.2%	14.5%	18.9%	17.0%
Europe	Germany	10.1%	11.8%	9.0%	8.1%	9.8%
Europe	Greece	0.1%	0.1%	0.1%	0.5%	0.2%
Europe	Ireland	0.4%	0.9%	1.0%	0.9%	0.8%
Europe	Italy	5.0%	4.7%	5.3%	6.7%	5.4%
Europe	Netherlands	0.1%	0.1%	0.5%	0.4%	0.3%
Europe	Portugal	0.1%	0.2%	0.3%	0.9%	0.4%
Europe	Spain	6.2%	3.8%	5.2%	7.3%	5.6%
Europe	Sweden	2.6%	1.6%	2.9%	2.0%	2.3%
Europe	Switzerland	9.8%	8.5%	6.6%	4.5%	7.4%
Europe	UK	18.5%	27.2%	21.4%	24.3%	22.9%
Middle East	Bahrain	0.0%	0.0%	0.0%	0.0%	0.0%
Middle East	Qatar	0.0%	0.0%	0.0%	0.0%	0.0%
Middle East	UAE	0.0%	0.0%	0.1%	0.1%	0.0%
Russia	Russia	0.3%	0.3%	0.9%	0.5%	0.5%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 16: Relative systemic loss contribution by bank (Global)

No.	Bank name	Region	Country	Relative systemic loss contribution				
				Period 1	*Period 2*	*Period 3*	*Period 4*	*Average*
1	American Express	America	US	0.2%	0.2%	0.2%	0.1%	0.2%
2	Bank of America	America	US	3.6%	3.0%	4.8%	4.3%	3.9%
3	Bank of New York Mellon	America	US	0.1%	0.2%	0.3%	0.3%	0.2%
4	Capital One Financial	America	US	0.2%	0.3%	0.3%	0.2%	0.2%
5	Citigroup	America	US	4.8%	5.0%	4.8%	3.0%	4.4%
6	Goldman Sachs	America	US	2.0%	2.3%	2.0%	1.0%	1.8%
7	JPMorgan Chase & Co.	America	US	4.1%	2.9%	3.4%	3.0%	3.4%
8	MetLife	America	US	0.8%	0.8%	1.4%	1.1%	1.0%
9	Morgan Stanley	America	US	3.6%	2.9%	1.9%	1.4%	2.4%
10	PNC Financial Services	America	US	0.1%	0.2%	0.5%	0.3%	0.3%
11	US Bancorp	America	US	0.4%	0.4%	0.5%	0.4%	0.4%
12	Wells Fargo	America	US	0.9%	0.8%	2.0%	1.6%	1.3%
13	ANZ Banking Group	Asia-Pacific	Australia	0.1%	0.1%	0.3%	0.2%	0.2%
14	Commonwealth Bank	Asia-Pacific	Australia	0.1%	0.2%	0.4%	0.3%	0.2%
15	Macquarie Bank	Asia-Pacific	Australia	0.0%	0.1%	0.2%	0.1%	0.1%
16	National Australia Bank	Asia-Pacific	Australia	0.1%	0.1%	0.4%	0.4%	0.3%
17	Westspac Banking Corp	Asia-Pacific	Australia	0.1%	0.1%	0.3%	0.3%	0.2%
18	Bank of China	Asia-Pacific	China	0.2%	0.2%	0.3%	0.4%	0.3%
19	Standard Chartered Bank	Asia-Pacific	Hong Kong	0.5%	0.7%	0.8%	0.7%	0.7%
20	Bank of India	Asia-Pacific	India	0.0%	0.0%	0.0%	0.0%	0.0%
21	ICICI Bank	Asia-Pacific	India	0.0%	0.1%	0.2%	0.1%	0.1%
22	State Bank of India	Asia-Pacific	India	0.1%	0.2%	0.2%	0.2%	0.2%
23	Mizuho Financial Group	Asia-Pacific	Japan	1.1%	0.2%	0.5%	0.3%	0.6%
24	Resona Holdings	Asia-Pacific	Japan	0.3%	0.1%	0.2%	0.1%	0.1%
25	Sumitomo Mitsui Banking	Asia-Pacific	Japan	0.4%	0.1%	0.3%	0.2%	0.3%
26	Halyk Bank of Kazakhstan	Asia-Pacific	Kazakhstan	0.0%	0.0%	0.0%	0.0%	0.0%
27	Kazkommertsbank	Asia-Pacific	Kazakhstan	0.0%	0.0%	0.0%	0.0%	0.0%
28	Hana Bank	Asia-Pacific	Korea	0.0%	0.1%	0.1%	0.0%	0.1%
29	Industrial Bank of Korea	Asia-Pacific	Korea	0.0%	0.1%	0.1%	0.0%	0.1%
30	Kookmin Bank	Asia-Pacific	Korea	0.1%	0.1%	0.2%	0.1%	0.1%
31	Shinhan Financial Group	Asia-Pacific	Korea	0.1%	0.1%	0.2%	0.1%	0.1%
32	Woori Bank	Asia-Pacific	Korea	0.1%	0.2%	0.2%	0.1%	0.2%
33	Malayan Banking Berhad	Asia-Pacific	Malaysia	0.0%	0.0%	0.0%	0.0%	0.0%
34	DBS Bank	Asia-Pacific	Singapore	0.0%	0.1%	0.1%	0.0%	0.1%
35	Oversea Chinese Banking	Asia-Pacific	Singapore	0.0%	0.0%	0.1%	0.0%	0.0%
36	United Overseas Bank	Asia-Pacific	Singapore	0.0%	0.0%	0.1%	0.0%	0.0%
37	Erste Group Bank	Europe	Austria	0.3%	0.3%	0.7%	0.5%	0.4%
38	Dexia	Europe	Belgium	1.6%	1.8%	1.9%	2.6%	2.0%
39	KBC Bank	Europe	Belgium	0.9%	1.1%	1.2%	1.1%	1.0%
40	DANSKE Bank	Europe	Denmark	0.3%	0.5%	1.1%	0.5%	0.6%
41	BNP Paribas	Europe	France	8.8%	6.5%	6.0%	7.7%	7.2%
42	Crédit Agricole	Europe	France	5.0%	5.3%	5.3%	6.8%	5.6%
43	Societé Generale	Europe	France	5.5%	3.4%	3.3%	4.4%	4.1%
44	Commerzbank	Europe	Germany	2.0%	2.1%	1.8%	2.0%	1.9%
45	Deutsche Bank	Europe	Germany	8.0%	9.6%	7.1%	6.1%	7.8%
46	IKB - Deutsche Industriebank	Europe	Germany	0.1%	0.1%	0.1%	0.0%	0.1%
47	Alpha Bank	Europe	Greece	0.1%	0.0%	0.1%	0.2%	0.1%
48	EFG Eurobank	Europe	Greece	0.0%	0.0%	0.1%	0.3%	0.1%
49	Allied Irish Banks	Europe	Ireland	0.3%	0.5%	0.5%	0.5%	0.4%

No.	Bank name	Region	Country	Relative systemic loss contribution				
				Period 1	*Period 2*	*Period 3*	*Period 4*	*Average*
50	Bank of Ireland	Europe	Ireland	0.1%	0.4%	0.5%	0.4%	0.4%
51	Banca Monte d.P. die Siena	Europe	Italy	0.3%	0.4%	0.4%	0.8%	0.5%
52	Banco Popolare	Europe	Italy	0.2%	0.2%	0.3%	0.4%	0.3%
53	Intesa Sanpaolo	Europe	Italy	0.5%	1.1%	1.4%	2.1%	1.3%
54	Unicredit Group	Europe	Italy	4.0%	2.9%	3.2%	3.4%	3.4%
55	SNS REAAL Bank	Europe	Netherlands	0.1%	0.1%	0.5%	0.4%	0.3%
56	Banco BPI	Europe	Portugal	0.0%	0.0%	0.1%	0.2%	0.1%
57	Banco Comercial Portuges	Europe	Portugal	0.0%	0.1%	0.1%	0.4%	0.2%
58	Espirito Santo Financial Group	Europe	Portugal	0.0%	0.1%	0.1%	0.3%	0.1%
59	Banco de Sabadell	Europe	Spain	0.2%	0.2%	0.3%	0.3%	0.3%
60	Banco Pastor	Europe	Spain	0.0%	0.0%	0.1%	0.1%	0.0%
61	Banco Popular	Europe	Spain	0.2%	0.2%	0.5%	0.5%	0.3%
62	Bankinter	Europe	Spain	0.1%	0.1%	0.1%	0.2%	0.1%
63	Grupo BBVA	Europe	Spain	0.7%	0.4%	0.7%	1.4%	0.8%
64	Grupo Santander	Europe	Spain	4.8%	2.9%	3.5%	4.8%	4.0%
65	Nordea	Europe	Sweden	0.9%	0.7%	1.2%	0.9%	0.9%
66	Skand Enskilda Banken	Europe	Sweden	0.7%	0.4%	0.7%	0.4%	0.6%
67	Svenska Handelsbanken	Europe	Sweden	0.5%	0.2%	0.4%	0.3%	0.4%
68	Swedbank	Europe	Sweden	0.5%	0.3%	0.5%	0.3%	0.4%
69	Crédit Suisse	Europe	Switzerland	4.0%	3.1%	2.2%	1.9%	2.8%
70	UBS	Europe	Switzerland	5.8%	5.4%	4.4%	2.5%	4.6%
71	Barclay's	Europe	UK	7.2%	8.7%	6.6%	6.0%	7.2%
72	HSBC	Europe	UK	5.6%	5.5%	4.9%	4.3%	5.1%
73	Lloyds Banking Group	Europe	UK	1.1%	1.5%	2.5%	7.7%	3.1%
74	Royal Bank of Scotland	Europe	UK	4.7%	11.6%	7.4%	6.2%	7.5%
75	Arab Banking Corp	Middle East	Bahrain	0.0%	0.0%	0.0%	0.0%	0.0%
76	Commercial Bank of Qatar	Middle East	Qatar	0.0%	0.0%	0.0%	0.0%	0.0%
77	Abu Dhabi Commercial Bank	Middle East	UAE	0.0%	0.0%	0.0%	0.0%	0.0%
78	Dubai Islamic Bank	Middle East	UAE	0.0%	0.0%	0.0%	0.0%	0.0%
79	Mashreqbank	Middle East	UAE	0.0%	0.0%	0.0%	0.0%	0.0%
80	National Bank of Abu Dhabi	Middle East	UAE	0.0%	0.0%	0.0%	0.0%	0.0%
81	Bank of Moscow	Russia	Russia	0.0%	0.0%	0.1%	0.0%	0.0%
82	Sberbank	Russia	Russia	0.3%	0.3%	0.5%	0.3%	0.3%
83	WTB/VTB (Wneschtorgbank)	Russia	Russia	0.0%	0.1%	0.3%	0.2%	0.1%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 17: Relative systemic loss contribution by bank (America)

			Relative systemic loss contribution				
No.	Bank name	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
1	American Express	US	0.8%	1.0%	1.0%	0.5%	0.8%
2	Bank of America	US	17.0%	15.0%	20.7%	27.7%	19.9%
3	Bank of New York Mellon	US	0.5%	1.2%	1.6%	1.4%	1.2%
4	Capital One Financial	US	0.6%	1.4%	1.2%	1.0%	1.0%
5	Citigroup	US	21.3%	25.9%	27.5%	23.1%	24.5%
6	Goldman Sachs	US	9.8%	12.1%	8.3%	5.9%	9.1%
7	JPMorgan Chase & Co.	US	23.0%	15.9%	14.1%	15.1%	17.1%
8	MetLife	US	2.9%	3.4%	5.7%	5.2%	4.3%
9	Morgan Stanley	US	18.5%	17.0%	7.6%	7.3%	12.7%
10	PNC Financial Services	US	0.6%	1.2%	2.0%	1.7%	1.4%
11	US Bancorp	US	1.6%	1.9%	2.3%	2.3%	2.0%
12	Wells Fargo	US	3.3%	3.9%	8.2%	8.8%	6.0%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 18: Relative systemic loss contribution by country (Asia-Pacific)

		Relative systemic loss contribution				
Region	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
Asia-Pacific	Australia	2.5%	16.9%	16.4%	20.9%	14.1%
Asia-Pacific	China	3.0%	8.0%	17.7%	24.5%	13.1%
Asia-Pacific	Hong Kong	0.2%	1.5%	2.2%	1.1%	1.3%
Asia-Pacific	India	0.9%	2.5%	2.9%	1.8%	2.0%
Asia-Pacific	Japan	88.4%	58.6%	46.2%	44.8%	59.7%
Asia-Pacific	Kazakhstan	0.1%	0.3%	0.4%	0.2%	0.2%
Asia-Pacific	Korea	4.4%	9.7%	11.5%	5.3%	7.8%
Asia-Pacific	Malaysia	0.1%	0.3%	0.3%	0.2%	0.2%
Asia-Pacific	Singapore	0.4%	2.4%	2.4%	1.2%	1.6%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 19: Relative systemic loss contribution by bank (Asia-Pacific)

			Relative systemic loss contribution				
No.	Bank name	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
1	ANZ Banking Group	Australia	0.2%	2.1%	2.2%	3.2%	1.9%
2	Commonwealth Bank	Australia	0.7%	4.2%	3.9%	5.3%	3.5%
3	Macquarie Bank	Australia	0.2%	1.5%	1.6%	1.0%	1.1%
4	National Australia Bank	Australia	1.0%	5.6%	5.1%	6.1%	4.4%
5	Westspac Banking Corp	Australia	0.4%	3.5%	3.6%	5.2%	3.2%
6	Bank of China	China	3.0%	8.0%	17.7%	24.5%	13.1%
7	Standard Chartered Bank	Hong Kong	0.2%	1.5%	2.2%	1.1%	1.3%
8	Bank of India	India	0.1%	0.2%	0.2%	0.2%	0.2%
9	ICICI Bank	India	0.2%	1.0%	1.1%	0.4%	0.7%
10	State Bank of India	India	0.5%	1.3%	1.6%	1.1%	1.2%
11	Mizuho Financial Group	Japan	58.1%	35.1%	27.4%	27.1%	37.1%
12	Resona Holdings	Japan	8.5%	5.8%	4.5%	2.2%	5.3%
13	Sumitomo Mitsui Banking	Japan	21.8%	17.7%	14.3%	15.5%	17.3%
14	Halyk Bank of Kazakhstan	Kazakhstan	0.0%	0.1%	0.2%	0.1%	0.1%
15	Kazkommertsbank	Kazakhstan	0.1%	0.2%	0.2%	0.1%	0.1%
16	Hana Bank	Korea	1.0%	1.1%	1.4%	0.7%	1.1%
17	Industrial Bank of Korea	Korea	0.4%	1.0%	1.4%	0.7%	0.9%
18	Kookmin Bank	Korea	1.1%	2.4%	2.8%	1.3%	1.9%
19	Shinhan Financial Group	Korea	0.8%	2.4%	2.9%	1.2%	1.8%
20	Woori Bank	Korea	1.0%	2.8%	3.0%	1.5%	2.1%
21	Malayan Banking Berhad	Malaysia	0.1%	0.3%	0.3%	0.2%	0.2%
22	DBS Bank	Singapore	0.2%	1.1%	1.1%	0.5%	0.7%
23	Oversea Chinese Banking	Singapore	0.1%	0.7%	0.7%	0.4%	0.5%
24	United Overseas Bank	Singapore	0.1%	0.6%	0.7%	0.3%	0.5%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 20: Relative systemic loss contribution by country (Europe)

	Relative systemic loss contribution				
Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
Austria	0.4%	0.4%	0.9%	0.7%	0.6%
Belgium	3.2%	3.7%	4.3%	4.7%	4.0%
Denmark	0.4%	0.6%	1.5%	0.6%	0.8%
France	25.7%	19.6%	20.2%	23.2%	22.2%
Germany	13.5%	13.5%	11.9%	9.4%	12.1%
Greece	0.1%	0.1%	0.2%	0.6%	0.3%
Ireland	0.5%	1.1%	1.3%	1.4%	1.0%
Italy	6.7%	5.9%	7.0%	8.7%	7.0%
Netherlands	0.1%	0.1%	0.7%	0.5%	0.3%
Portugal	0.1%	0.3%	0.5%	1.2%	0.5%
Spain	8.0%	4.8%	7.1%	9.8%	7.4%
Sweden	3.5%	2.1%	3.9%	2.4%	3.0%
Switzerland	13.7%	11.1%	9.1%	5.3%	9.9%
UK	24.3%	36.8%	31.6%	31.4%	31.1%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 21: Relative systemic loss contribution by bank (Europe)

			Relative systemic loss contribution				
No.	Bank name	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
1	Erste Group Bank	Austria	0.4%	0.4%	0.9%	0.7%	0.6%
2	Dexia	Belgium	2.1%	2.3%	2.7%	3.4%	2.6%
3	KBC Bank	Belgium	1.1%	1.5%	1.6%	1.3%	1.4%
4	DANSKE Bank	Denmark	0.4%	0.6%	1.5%	0.6%	0.8%
5	BNP Paribas	France	11.9%	8.2%	8.4%	9.3%	9.4%
6	Crédit Agricole	France	6.4%	6.9%	7.3%	8.6%	7.3%
7	Societé Generale	France	7.4%	4.5%	4.5%	5.4%	5.5%
8	Commerzbank	Germany	2.6%	2.4%	2.4%	2.4%	2.4%
9	Deutsche Bank	Germany	10.7%	11.0%	9.3%	7.1%	9.6%
10	IKB - Deutsche Industriebank	Germany	0.1%	0.1%	0.2%	0.0%	0.1%
11	Alpha Bank	Greece	0.1%	0.1%	0.1%	0.3%	0.1%
12	EFG Eurobank	Greece	0.1%	0.0%	0.1%	0.4%	0.1%
13	Allied Irish Banks	Ireland	0.3%	0.6%	0.7%	0.6%	0.5%
14	Bank of Ireland	Ireland	0.1%	0.5%	0.7%	0.6%	0.5%
15	Banca Monte d.P. die Siena	Italy	0.4%	0.4%	0.5%	1.0%	0.6%
16	Banco Popolare	Italy	0.2%	0.3%	0.4%	0.5%	0.4%
17	Intesa Sanpaolo	Italy	0.7%	1.4%	1.9%	2.7%	1.7%
18	Unicredit Group	Italy	5.3%	3.8%	4.2%	4.4%	4.4%
19	SNS REAAL Bank	Netherlands	0.1%	0.1%	0.7%	0.5%	0.3%
20	Banco BPI	Portugal	0.0%	0.0%	0.1%	0.2%	0.1%
21	Banco Comercial Portuges	Portugal	0.0%	0.1%	0.2%	0.5%	0.2%
22	Espirito Santo Financial Group	Portugal	0.0%	0.1%	0.2%	0.4%	0.2%
23	Banco de Sabadell	Spain	0.3%	0.3%	0.4%	0.5%	0.4%
24	Banco Pastor	Spain	0.0%	0.0%	0.1%	0.1%	0.1%
25	Banco Popular	Spain	0.3%	0.2%	0.7%	0.7%	0.5%
26	Bankinter	Spain	0.1%	0.1%	0.2%	0.3%	0.2%
27	Grupo BBVA	Spain	1.0%	0.5%	0.9%	1.9%	1.1%
28	Grupo Santander	Spain	6.3%	3.7%	4.8%	6.4%	5.3%
29	Nordea	Sweden	1.2%	0.9%	1.6%	1.1%	1.2%
30	Skand Enskilda Banken	Sweden	1.0%	0.5%	1.0%	0.5%	0.7%
31	Svenska Handelsbanken	Sweden	0.7%	0.3%	0.6%	0.4%	0.5%
32	Swedbank	Sweden	0.7%	0.3%	0.7%	0.4%	0.5%
33	Crédit Suisse	Switzerland	5.5%	4.0%	2.9%	2.2%	3.7%
34	UBS	Switzerland	8.2%	7.0%	6.1%	3.0%	6.2%
35	Barclay's	UK	10.2%	11.3%	9.7%	7.3%	9.7%
36	HSBC	UK	6.5%	7.0%	6.6%	5.1%	6.3%
37	Lloyds Banking Group	UK	1.3%	1.8%	3.8%	10.5%	4.3%
38	Royal Bank of Scotland	UK	6.3%	16.6%	11.5%	8.6%	10.8%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 22: Relative systemic loss contribution by country (Middle East and Russia)

	Relative systemic loss contribution				
Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
Bahrain	0.8%	0.7%	1.0%	1.3%	1.0%
Qatar	0.1%	0.2%	0.5%	0.6%	0.3%
UAE	3.5%	3.0%	8.0%	10.2%	6.1%
Russia	95.6%	96.1%	90.5%	88.0%	92.6%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 23: Relative systemic loss contribution by bank (Middle East and Russia)

			Relative systemic loss contribution				
No.	Bank name	Country	*Period 1*	*Period 2*	*Period 3*	*Period 4*	*Average*
1	Arab Banking Corp	Bahrain	0.8%	0.7%	1.0%	1.3%	1.0%
2	Commercial Bank of Qatar	Qatar	0.1%	0.2%	0.5%	0.6%	0.3%
3	Abu Dhabi Commercial Bank	UAE	1.1%	0.9%	2.5%	3.4%	1.9%
4	Dubai Islamic Bank	UAE	0.8%	0.5%	1.7%	1.7%	1.2%
5	Mashreqbank	UAE	0.2%	0.5%	0.9%	1.4%	0.7%
6	National Bank of Abu Dhabi	UAE	1.4%	1.1%	2.9%	3.7%	2.3%
7	Bank of Moscow	Russia	1.4%	2.6%	4.6%	4.5%	3.2%
8	Sberbank	Russia	73.5%	67.3%	49.3%	53.3%	61.0%
9	WTB/VTB (Wneschtorgbank)	Russia	20.7%	26.2%	36.6%	30.2%	28.4%

Notes: Relative systemic loss contribution is defined as the relative loss share of a bank when the total portfolio loss exceeds the systemic loss threshold. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 24: Determinants of the relative contributions to the ESS-indicator (Global)

Independent variables	Regression 1		Regression 2		Regression 3	
Constant term	0.01		0.00		0.00	
	(172.74)		(105.11)		(119.41)	
Risk-neutral PD	-0.11				0.05	
	(75.77)			*1.05*	(80.01)	
Liability weight			1.26		1.28	
			(302.20)	*1.05*	(307.16)	
Average correlation						
Adjusted-R^2	0.02		0.77		0.78	
	Regression 4		Regression 5		Regression 6	
Constant term	-0.01		0.00		0.00	
	(135.50)		(82.15)		(52.66)	
Risk-neutral PD	0.06				0.04	
	1.05	(86.93)			*1.29*	(43.23)
Liability weight	1.23		0.59		0.63	
	1.16	(282.42)	*6.28*	(58.55)	*8.20*	(54.76)
Average correlation	0.02				0.00	
	1.12	(80.50)			*1.64*	(4.24)
Risk-neutral PD*liability weight			2.06		0.38	
			1.75	(7.81)	*2.11*	(1.25)
Average correlation*liability weight			1.98		1.99	
			5.97	(81.40)	*8.66*	(70.22)
Adjusted-R^2	0.79		0.81		0.82	

Notes: The dependent regression variable is the relative contribution to the ESS-indicator of each bank i (in percentage terms) over time. Independent variables are the risk-neutral default probability, the percentage weight (share) of total liabilities, the bank-specific correlations (average of bilateral correlations of one bank with all other banks) as well as interaction terms of each bank *i* over time. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 25: Determinants of the relative contributions to the ESS-indicator (America)

Independent variables	Regression 1		Regression 2		Regression 3	
Constant term		0.09		-0.01		-0.02
		(90.89)		(53.60)		(54.11)
Risk-neutral PD		-0.17				0.40
		(4.86)			*1.02*	(33.93)
Liability weight				1.13		1.14
				(258.94)	*1.02*	(265.76)
Average correlation						
Adjusted-R^2		0.00		0.87		0.87
	Regression 4		Regression 5		Regression 6	
Constant term		0.00		-0.01		-0.05
		(1.17)		(67.50)		(41.44)
Risk-neutral PD		0.46				-0.07
	1.10	(35.19)			*2.56*	(7.27)
Liability weight		1.15		1.52		1.81
	1.05	(263.91)	*18.78*	(77.47)	*38.44*	(75.61)
Average correlation		-0.04				0.06
	1.10	(14.68)			*2.58*	(32.53)
Risk-neutral PD*liability weight				6.31		6.74
			1.47	(36.90)	*3.37*	(29.29)
Average correlation*liability weight				-0.70		-1.15
			18.95	(25.64)	*43.79*	(33.68)
Adjusted-R^2		0.88		0.89		0.89

Notes: The dependent regression variable is the relative contribution to the ESS-indicator of each bank i (in percentage terms) over time. Independent variables are the risk-neutral default probability, the percentage weight (share) of total liabilities, the bank-specific correlations (average of bilateral correlations of one bank with all other banks) as well as interaction terms of each bank *i* over time. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 26: Determinants of the relative contributions to the ESS-indicator (Asia-Pacific)

Independent variables		Regression 1		Regression 2		Regression 3
Constant term		0.05		-0.03		-0.04
		(73.16)		(61.81)		(72.04)
Risk-neutral PD		-0.36				0.32
		(36.57)			*1.07*	(75.92)
Liability weight				1.70		1.75
				(105.67)	*1.07*	(107.59)
Average correlation						
Adjusted-R^2		0.01		0.74		0.75
		Regression 4		Regression 5		Regression 6
Constant term		-0.05		-0.03		-0.06
		(62.92)		(74.04)		(45.33)
Risk-neutral PD		0.34				0.46
	1.08	(79.40)			*1.35*	(38.45)
Liability weight		1.75		1.68		2.02
	1.07	(107.99)	*4.18*	(53.29)	*7.83*	(47.94)
Average correlation		0.03				0.06
	1.02	(16.98)			*1.95*	(17.04)
Risk-neutral PD*liability weight				-2.19		-10.91
			1.49	(3.02)	*1.89*	(11.96)
Average correlation*liability weight				0.18		-0.52
			3.53	(2.31)	*6.62*	(4.70)
Adjusted-R^2		0.75		0.74		0.76

Notes: The dependent regression variable is the relative contribution to the ESS-indicator of each bank i (in percentage terms) over time. Independent variables are the risk-neutral default probability, the percentage weight (share) of total liabilities, the bank-specific correlations (average of bilateral correlations of one bank with all other banks) as well as interaction terms of each bank *i* over time. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 27: Determinants of the relative contributions to the ESS-indicator (Europe)

Independent variables	Regression 1		Regression 2		Regression 3	
Constant term	0.03		0.00		-0.01	
	(153.83)		(76.04)		(86.89)	
Risk-neutral PD	-0.22				0.08	
	(52.40)				*1.04*	(54.93)
Liability weight			1.17		1.18	
			(313.41)		*1.04*	(319.04)
Average correlation						
Adjusted-R^2	0.02		0.85		0.85	
	Regression 4		Regression 5		Regression 6	
Constant term	-0.01		0.00		-0.01	
	(72.23)		(74.41)		(39.30)	
Risk-neutral PD	0.08				0.07	
	1.04	(57.53)			*1.36*	(37.40)
Liability weight	1.16		0.85		0.90	
	1.11	(297.29)	*9.05*	(62.55)	*12.84*	(56.95)
Average correlation	0.01				0.00	
	1.07	(36.78)			*1.69*	(6.79)
Risk-neutral PD*liability weight			2.07		0.13	
			1.76	(8.23)	*2.30*	(0.44)
Average correlation*liability weight			0.57		0.53	
			9.24	(26.31)	*14.40*	(20.40)
Adjusted-R^2	0.86		0.86		0.86	

Notes: The dependent regression variable is the relative contribution to the ESS-indicator of each bank i (in percentage terms) over time. Independent variables are the risk-neutral default probability, the percentage weight (share) of total liabilities, the bank-specific correlations (average of bilateral correlations of one bank with all other banks) as well as interaction terms of each bank *i* over time. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 28: Determinants of the relative contributions to the ESS-indicator (Middle East and Russia)

Independent variables	Regression 1		Regression 2		Regression 3	
Constant term	0.10		-0.07		-0.08	
	(38.92)		(125.11)		(124.05)	
Risk-neutral PD	0.26				0.35	
	(6.17)			*1.00*	(36.21)	
Liability weight			1.59		1.59	
			(251.10)	*1.00*	(242.64)	
Average correlation						
Adjusted-R^2	0.00		0.94		0.94	
	Regression 4		Regression 5		Regression 6	
Constant term	-0.08		-0.07		-0.10	
	(96.00)		(127.95)		(82.77)	
Risk-neutral PD	0.35				0.58	
	1.00	(36.44)			*1.94*	(52.43)
Liability weight	1.59		1.61		1.76	
	1.00	(240.37)	*3.83*	(121.00)	*6.29*	(112.73)
Average correlation	0.02				0.07	
	1.01	(4.99)			*2.12*	(11.33)
Risk-neutral PD*liability weight			0.41		-2.44	
			1.72	(2.97)	*3.34*	(16.43)
Average correlation*liability weight			-0.21		-0.50	
			3.11	(3.94)	*6.58*	(6.73)
Adjusted-R^2	0.94		0.94		0.94	

Notes: The dependent regression variable is the relative contribution to the ESS-indicator of each bank i (in percentage terms) over time. Independent variables are the risk-neutral default probability, the percentage weight (share) of total liabilities, the bank-specific correlations (average of bilateral correlations of one bank with all other banks) as well as interaction terms of each bank *i* over time. Variance inflation factors are provided in italics. Heteroskedacity-consistent t-statistics are shown in parenthesis. Critical values for the t-statistic at the *ten*, *five* and *one* percent significance level are respectively *1.28*, *1.65* and *2.33*.

Table 29: Granger causality test results for inter-regional relative ESS analysis

Without control variables

	Period 1		Period 2		Period 3		Period 4	
Systemic risk causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America ~→ Asia-Pacific	1.08	*0.36*	1.40	*0.24*	17.83***	*0.00*	15.30***	*0.00*
Asia-Pacific ~→ America	1.63	*0.18*	0.43	*0.73*	0.63	*0.60*	0.02	*1.00*
America ~→ Europe	0.05	*0.99*	5.44***	*0.00*	12.38***	*0.00*	5.26***	*0.00*
Europe ~→ America	1.24	*0.29*	1.33	*0.26*	0.71	*0.55*	0.94	*0.42*
America ~→ Middle East & Russia	0.61	*0.61*	0.23	*0.88*	7.72***	*0.00*	7.09***	*0.00*
Middle East & Russia ~→ America	0.19	*0.90*	2.11*	*0.10*	2.84**	*0.04*	1.64	*0.18*
Asia-Pacific ~→ Europe	0.90	*0.44*	3.63**	*0.01*	1.00	*0.39*	1.42	*0.24*
Europe ~→ Asia-Pacific	3.32**	*0.02*	4.23***	*0.01*	11.17***	*0.00*	6.45***	*0.00*
Asia-Pacific ~→ Middle East & Russia	1.03	*0.38*	0.63	*0.60*	1.46	*0.23*	2.15*	*0.09*
Middle East & Russia ~→ Asia-Pacific	1.34	*0.26*	0.12	*0.95*	8.87***	*0.00*	2.93**	*0.03*
Europe ~→ Middle East & Russia	0.47	*0.70*	4.07***	*0.01*	3.27**	*0.02*	8.82***	*0.00*
Middle East & Russia ~→ Europe	4.29***	*0.01*	0.39	*0.76*	0.34	*0.79*	0.97	*0.41*

Incl. stock index and federal funds rate

	Period 1		Period 2		Period 3		Period 4	
Systemic risk causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America ~→ Asia-Pacific	0.95	*0.42*	1.36	*0.26*	16.85***	*0.00*	13.53***	*0.00*
Asia-Pacific ~→ America	1.90	*0.13*	0.34	*0.80*	0.73	*0.54*	0.10	*0.96*
America ~→ Europe	0.19	*0.90*	3.76**	*0.01*	12.34***	*0.00*	5.98***	*0.00*
Europe ~→ America	0.77	*0.51*	1.27	*0.29*	1.29	*0.28*	0.81	*0.49*
America ~→ Middle East & Russia	0.44	*0.72*	0.53	*0.66*	7.04***	*0.00*	5.88***	*0.00*
Middle East & Russia ~→ America	0.15	*0.93*	1.99	*0.11*	2.91**	*0.03*	1.39	*0.25*
Asia-Pacific ~→ Europe	1.04	*0.37*	3.90***	*0.01*	0.92	*0.43*	1.68	*0.17*
Europe ~→ Asia-Pacific	2.90**	*0.03*	6.04***	*0.00*	10.11***	*0.00*	4.74***	*0.00*
Asia-Pacific ~→ Middle East & Russia	0.58	*0.63*	0.74	*0.53*	1.62	*0.19*	0.72	*0.54*
Middle East & Russia ~→ Asia-Pacific	1.28	*0.28*	0.10	*0.96*	8.75***	*0.00*	3.03**	*0.03*
Europe ~→ Middle East & Russia	0.32	*0.81*	4.55***	*0.00*	4.16***	*0.01*	8.94***	*0.00*
Middle East & Russia ~→ Europe	5.04***	*0.00*	0.34	*0.80*	0.32	*0.81*	0.92	*0.43*

Notes: We evaluate the null hypothesis that the relative ESS-indicator in region *i* does *not* impact the relative ESS-indicator in region *j*, i.e., $H_0 : ESS_i^{rel} \sim\!\!\rightarrow ESS_j^{rel}$ using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 30: Granger causality test results for inter-regional bank CDS analysis

Without control variables

	Period 1		Period 2		Period 3		Period 4	
Regional bank CDS causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America ~→ Asia-Pacific	0.81	*0.49*	24.89***	*0.00*	40.02***	*0.00*	43.73***	*0.00*
Asia-Pacific ~→ America	0.77	*0.51*	2.14*	*0.09*	1.07	*0.36*	1.57	*0.20*
America ~→ Europe	0.27	*0.85*	33.00***	*0.00*	5.80***	*0.00*	17.66***	*0.00*
Europe ~→ America	6.59***	*0.00*	0.70	*0.55*	2.11*	*0.10*	3.01**	*0.03*
America ~→ Middle East & Russia	3.00**	*0.03*	1.60	*0.19*	8.26***	*0.00*	13.02***	*0.00*
Middle East & Russia ~→ America	0.97	*0.41*	1.34	*0.26*	6.39***	*0.00*	0.80	*0.50*
Asia-Pacific ~→ Europe	3.96***	*0.01*	2.40*	*0.07*	3.66**	*0.01*	6.50***	*0.00*
Europe ~→ Asia-Pacific	2.87**	*0.04*	4.44***	*0.00*	25.88***	*0.00*	15.53***	*0.00*
Asia-Pacific ~→ Middle East & Russia	0.18	*0.91*	0.77	*0.51*	1.03	*0.38*	0.46	*0.71*
Middle East & Russia ~→ Asia-Pacific	0.28	*0.84*	0.23	*0.87*	4.82***	*0.00*	4.80***	*0.00*
Europe ~→ Middle East & Russia	4.49***	*0.00*	0.54	*0.65*	6.65***	*0.00*	10.04***	*0.00*
Middle East & Russia ~→ Europe	0.56	*0.64*	0.27	*0.85*	3.95***	*0.01*	2.87**	*0.04*

Incl. stock index and federal funds rate

	Period 1		Period 2		Period 3		Period 4	
Regional bank CDS causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America ~→ Asia-Pacific	0.55	*0.65*	30.62***	*0.00*	42.09***	*0.00*	39.14***	*0.00*
Asia-Pacific ~→ America	0.86	*0.46*	2.31*	*0.08*	1.99	*0.12*	1.54	*0.20*
America ~→ Europe	1.42	*0.24*	38.69***	*0.00*	5.99***	*0.00*	17.61***	*0.00*
Europe ~→ America	7.16***	*0.00*	0.83	*0.48*	3.61**	*0.01*	3.07**	*0.03*
America ~→ Middle East & Russia	4.07***	*0.01*	1.69	*0.17*	7.51***	*0.00*	12.61***	*0.00*
Middle East & Russia ~→ America	1.90	*0.13*	0.68	*0.56*	6.51***	*0.00*	0.72	*0.54*
Asia-Pacific ~→ Europe	3.63**	*0.01*	2.66**	*0.05*	3.58**	*0.01*	6.48***	*0.00*
Europe ~→ Asia-Pacific	2.25*	*0.08*	5.14***	*0.00*	24.79***	*0.00*	15.16***	*0.00*
Asia-Pacific ~→ Middle East & Russia	0.19	*0.90*	0.67	*0.57*	1.17	*0.32*	0.40	*0.75*
Middle East & Russia ~→ Asia-Pacific	0.32	*0.81*	0.17	*0.92*	3.90***	*0.01*	4.58***	*0.00*
Europe ~→ Middle East & Russia	4.56***	*0.00*	1.28	*0.28*	7.22***	*0.00*	10.35***	*0.00*
Middle East & Russia ~→ Europe	0.49	*0.69*	0.37	*0.77*	3.62**	*0.01*	4.49***	*0.00*

Notes: We evaluate the null hypothesis that the average regional bank CDS in region *i* do *not* impact the bank CDS in region *j*, i.e., $H_0 : CDS_i^{bank} \sim\!\!\rightarrow CDS_j^{bank}$ using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 31: Granger causality test results for <u>regional</u> sovereign risk vs. bank CDS analysis

<u>Without control variables</u>

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America sovereign ~→ America bank CDS	18.90***	*0.00*	0.74	*0.53*	0.30	*0.83*	1.96	*0.12*
America bank CDS ~→ America sovereign	7.66***	*0.00*	2.86**	*0.04*	5.68***	*0.00*	5.51***	*0.00*
America sovereign ~→ Asia-Pacific bank CDS	3.86***	*0.01*	2.34*	*0.07*	5.19***	*0.00*	9.71***	*0.00*
Asia-Pacific bank CDS ~→ America sovereign	1.63	*0.18*	0.38	*0.76*	3.29**	*0.02*	1.71	*0.17*
America sovereign ~→ Europe bank CDS	16.26***	*0.00*	1.99	*0.11*	0.72	*0.54*	7.19***	*0.00*
Europe bank CDS ~→ America sovereign	6.40***	*0.00*	0.74	*0.53*	1.82	*0.14*	1.26	*0.29*
America sovereign ~→ Middle East & Russia bank CDS	0.66	*0.58*	0.19	*0.90*	0.50	*0.68*	3.61**	*0.01*
Middle East & Russia bank CDS ~→ America sovereign	0.14	*0.94*	0.15	*0.93*	0.99	*0.40*	1.23	*0.30*
Asia-Pacific sovereign ~→ America bank CDS	2.43*	*0.06*	0.19	*0.91*	2.45*	*0.06*	2.88**	*0.04*
America bank CDS ~→ Asia-Pacific sovereign	0.76	*0.52*	6.29***	*0.00*	13.23***	*0.00*	30.17***	*0.00*
Asia-Pacific sovereign ~→ Asia-Pacific bank CDS	1.66	*0.17*	3.91***	*0.01*	6.31***	*0.00*	12.42***	*0.00*
Asia-Pacific bank CDS ~→ Asia-Pacific sovereign	1.09	*0.35*	5.65***	*0.00*	2.47*	*0.06*	1.96	*0.12*
Asia-Pacific sovereign ~→ Europe bank CDS	2.77**	*0.04*	1.88	*0.13*	1.71	*0.16*	4.95***	*0.00*
Europe bank CDS ~→ Asia-Pacific sovereign	0.71	*0.54*	2.98**	*0.03*	10.54***	*0.00*	6.34***	*0.00*
Asia-Pacific sovereign ~→ Middle East & Russia bank CDS	0.90	*0.44*	0.36	*0.78*	4.38***	*0.00*	2.87**	*0.04*
Middle East & Russia bank CDS ~→ Asia-Pacific sovereign	2.95**	*0.03*	0.56	*0.64*	5.00***	*0.00*	5.22***	*0.00*
Europe sovereign ~→ America bank CDS	1.81	*0.15*	0.27	*0.85*	2.18*	*0.09*	2.69**	*0.05*
America bank CDS ~→ Europe sovereign	0.78	*0.50*	0.12	*0.95*	2.22*	*0.09*	3.25**	*0.02*
Europe sovereign ~→ Asia-Pacific bank CDS	0.82	*0.48*	0.29	*0.83*	7.30***	*0.00*	17.13***	*0.00*
Asia-Pacific bank CDS ~→ Europe sovereign	1.17	*0.32*	0.13	*0.94*	0.06	*0.98*	1.80	*0.15*
Europe sovereign ~→ Europe bank CDS	0.40	*0.75*	0.05	*0.98*	1.16	*0.32*	12.10***	*0.00*
Europe bank CDS ~→ Europe sovereign	2.47*	*0.06*	0.07	*0.98*	3.87***	*0.01*	5.60***	*0.00*
Europe sovereign ~→ Middle East & Russia bank CDS	1.25	*0.29*	5.74***	*0.00*	1.01	*0.39*	10.60***	*0.00*
Middle East & Russia bank CDS ~→ Europe sovereign	2.14*	*0.10*	3.08**	*0.03*	0.93	*0.43*	1.98	*0.12*
Middle East & Russia sovereign ~→ America bank CDS	0.87	*0.46*	0.29	*0.83*	2.65**	*0.05*	1.20	*0.31*
America bank CDS ~→ Middle East & Russia sovereign risk	4.42***	*0.00*	3.83**	*0.01*	3.32**	*0.02*	13.19***	*0.00*
Middle East & Russia sovereign ~→ Asia-Pacific bank CDS	1.22	*0.30*	0.87	*0.46*	12.60***	*0.00*	16.96***	*0.00*
Asia-Pacific bank CDS ~→ Middle East & Russia sovereign	0.44	*0.72*	0.59	*0.62*	1.87	*0.13*	0.99	*0.40*
Middle East & Russia sovereign ~→ Europe bank CDS	1.13	*0.34*	1.01	*0.39*	0.96	*0.41*	0.18	*0.91*
Europe bank CDS ~→ Middle East & Russia sovereign	5.91***	*0.00*	0.45	*0.72*	4.99***	*0.00*	0.68	*0.57*
Middle East & Russia sovereign ~→ Middle East & Russia bank CDS	2.98**	*0.03*	3.50**	*0.02*	25.05***	*0.00*	14.13***	*0.00*
Middle East & Russia bank CDS ~→ Middle East & Russia sovereign	1.29	*0.28*	2.34*	*0.07*	9.82***	*0.00*	1.82	*0.14*

Incl. stock index and federal funds rate

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
America sovereign ~→ America bank CDS	16.47***	*0.00*	0.65	*0.58*	0.36	*0.78*	1.84	*0.14*
America bank CDS ~→ America sovereign	8.82***	*0.00*	2.61*	*0.05*	4.92***	*0.00*	5.46***	*0.00*
America sovereign ~→ Asia-Pacific bank CDS	3.61**	*0.01*	2.92**	*0.03*	4.05***	*0.01*	9.45***	*0.00*
Asia-Pacific bank CDS ~→ America sovereign	1.69	*0.17*	0.52	*0.67*	3.08**	*0.03*	1.66	*0.18*
America sovereign ~→ Europe bank CDS	13.21***	*0.00*	1.67	*0.17*	0.62	*0.60*	7.02***	*0.00*
Europe bank CDS ~→ America sovereign	5.76***	*0.00*	1.56	*0.20*	2.28*	*0.08*	1.32	*0.27*
America sovereign ~→ Middle East & Russia bank CDS	1.02	*0.38*	0.11	*0.96*	0.37	*0.78*	3.60**	*0.01*
Middle East & Russia bank CDS ~→ America sovereign	0.15	*0.93*	0.04	*0.99*	0.72	*0.54*	1.59	*0.19*
Asia-Pacific sovereign ~→ America bank CDS	2.40*	*0.07*	0.73	*0.53*	2.50*	*0.06*	2.01	*0.11*
America bank CDS ~→ Asia-Pacific sovereign	0.80	*0.49*	8.93***	*0.00*	12.52***	*0.00*	30.36***	*0.00*
Asia-Pacific sovereign ~→ Asia-Pacific bank CDS	1.86	*0.14*	4.40***	*0.00*	4.21***	*0.01*	8.14***	*0.00*
Asia-Pacific bank CDS ~→ Asia-Pacific sovereign	1.34	*0.26*	7.17***	*0.00*	1.86	*0.14*	0.48	*0.69*
Asia-Pacific sovereign ~→ Europe bank CDS	2.84**	*0.04*	2.45*	*0.06*	1.76	*0.15*	4.84***	*0.00*
Europe bank CDS ~→ Asia-Pacific sovereign	0.56	*0.64*	2.86**	*0.04*	9.80***	*0.00*	6.20***	*0.00*
Asia-Pacific sovereign ~→ Middle East & Russia bank CDS	0.66	*0.58*	0.31	*0.82*	3.51**	*0.02*	3.32**	*0.02*
Middle East & Russia bank CDS ~→ Asia-Pacific sovereign	1.80	*0.15*	0.82	*0.48*	4.28***	*0.01*	5.09***	*0.00*
Europe sovereign ~→ America bank CDS	1.96	*0.12*	0.21	*0.89*	1.77	*0.15*	2.51*	*0.06*
America bank CDS ~→ Europe sovereign	1.22	*0.30*	0.17	*0.92*	1.98	*0.12*	3.22**	*0.02*
Europe sovereign ~→ Asia-Pacific bank CDS	1.86	*0.14*	0.32	*0.81*	5.32***	*0.00*	15.99***	*0.00*
Asia-Pacific bank CDS ~→ Europe sovereign	1.01	*0.39*	0.17	*0.91*	0.04	*0.99*	1.60	*0.19*
Europe sovereign ~→ Europe bank CDS	0.57	*0.64*	0.06	*0.98*	1.25	*0.29*	11.35***	*0.00*
Europe bank CDS ~→ Europe sovereign	2.36*	*0.07*	0.22	*0.88*	3.76**	*0.01*	4.79***	*0.00*
Europe sovereign ~→ Middle East & Russia bank CDS	1.79	*0.15*	6.92***	*0.00*	0.28	*0.84*	10.80***	*0.00*
Middle East & Russia bank CDS ~→ Europe sovereign	2.04	*0.11*	3.96***	*0.01*	0.45	*0.72*	3.72**	*0.01*
Middle East & Russia sovereign ~→ America bank CDS	0.83	*0.48*	0.14	*0.93*	3.08**	*0.03*	0.95	*0.42*
America bank CDS ~→ Middle East & Russia sovereign risk	5.93***	*0.00*	3.23**	*0.02*	4.10***	*0.01*	13.22***	*0.00*
Middle East & Russia sovereign ~→ Asia-Pacific bank CDS	1.63	*0.18*	1.35	*0.26*	10.57***	*0.00*	16.73***	*0.00*
Asia-Pacific bank CDS ~→ Middle East & Russia sovereign	0.31	*0.82*	0.86	*0.46*	3.23**	*0.02*	1.25	*0.29*
Middle East & Russia sovereign ~→ Europe bank CDS	0.98	*0.40*	1.22	*0.30*	2.12*	*0.10*	0.16	*0.92*
Europe bank CDS ~→ Middle East & Russia sovereign	5.18***	*0.00*	0.54	*0.65*	5.66***	*0.00*	0.63	*0.59*
Middle East & Russia sovereign ~→ Middle East & Russia bank CDS	2.96**	*0.03*	3.52**	*0.02*	21.11***	*0.00*	12.44***	*0.00*
Middle East & Russia bank CDS ~→ Middle East & Russia sovereign	1.81	*0.14*	1.98	*0.12*	8.16***	*0.00*	1.72	*0.16*

Notes: We evaluate the null hypothesis that the sovereign CDS in region *i* does *not* impact the bank CDS in in region *j*, i.e., $H_0 : CDS_i^{sov} \sim\!\!\rightarrow CDS_j^{bank}$, using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively.

Table 32: Correlation between regional sovereign and bank CDS

		Average correlation			
Sovereign CDS	Banking sector CDS	*Period 1*	*Period 2*	*Period 3*	*Period 4*
America	America	4.68%	22.52%	23.16%	42.29%
	Asia-Pacific	10.94%	29.64%	28.97%	33.56%
	Europe	-4.19%	30.63%	44.08%	57.29%
	Middle East and Russia	12.03%	19.40%	32.89%	46.81%
Asia-Pacific	America	-2.55%	11.57%	29.32%	38.09%
	Asia-Pacific	4.93%	11.96%	63.98%	63.01%
	Europe	-8.76%	13.81%	58.23%	53.18%
	Middle East and Russia	11.18%	14.47%	56.09%	61.07%
Europe	America	-1.75%	12.93%	37.01%	44.63%
	Asia-Pacific	0.28%	14.40%	46.93%	26.40%
	Europe	6.24%	21.73%	62.51%	71.52%
	Middle East and Russia	2.38%	16.32%	51.15%	45.36%
Middle East and Russia	America	7.08%	41.23%	51.83%	52.85%
	Asia-Pacific	-0.43%	38.38%	43.76%	42.93%
	Europe	5.68%	53.18%	64.82%	61.60%
	Middle East and Russia	16.48%	40.13%	73.87%	69.24%

Notes: The table shows the correlation between regional sovereign CDS and regional banking sector CDS during the four sub-periods. Period 1 ranges from November 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 33: Granger causality test results for country sovereign CDS vs. bank CDS analysis

Without control variables

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
US sovereign CDS ~→ US bank CDS	18.90***	*0.00*	0.74	*0.53*	0.30	*0.83*	1.96	*0.12*
US bank CDS ~→ US sovereign CDS	7.66***	*0.00*	2.86**	*0.04*	5.68***	*0.00*	5.51***	*0.00*
Australia sovereign CDS ~→ Australia bank CDS	0.57	*0.64*	3.13**	*0.03*	5.73***	*0.00*	10.10***	*0.00*
Australia bank CDS ~→ Australia sovereign CDS	0.81	*0.49*	1.78	*0.15*	1.95	*0.12*	1.33	*0.26*
China sovereign CDS ~→ China bank CDS	2.39*	*0.07*	14.41***	*0.00*	5.02***	*0.00*	13.64***	*0.00*
China bank CDS ~→ China sovereign CDS	11.68***	*0.00*	1.44	*0.23*	3.53**	*0.02*	1.02	*0.38*
Hong Kong sovereign CDS ~→ Hong Kong bank CDS	1.26	*0.29*	0.41	*0.75*	3.24**	*0.02*	0.68	*0.56*
Hong Kong bank CDS ~→ Hong Kong sovereign CDS	0.46	*0.71*	0.55	*0.65*	10.95***	*0.00*	5.19***	*0.00*
India sovereign CDS ~→ India bank CDS	7.93***	*0.00*	2.33*	*0.07*	1.54	*0.20*	0.23	*0.88*
India bank CDS ~→ India sovereign CDS	3.22**	*0.02*	4.21***	*0.01*	3.13**	*0.03*	0.75	*0.52*
Japan sovereign CDS ~→ Japan bank CDS	0.29	*0.83*	1.14	*0.33*	1.70	*0.17*	5.02***	*0.00*
Japan bank CDS ~→ Japan sovereign CDS	0.64	*0.59*	1.59	*0.19*	3.53**	*0.02*	1.11	*0.34*
Kazakhstan sovereign CDS ~→ Kazakhstan bank CDS	0.57	*0.64*	13.15***	*0.00*	1.02	*0.38*	1.14	*0.33*
Kazakhstan bank CDS ~→ Kazakhstan sovereign CDS	0.41	*0.74*	0.29	*0.84*	1.38	*0.25*	2.51*	*0.06*
Korea sovereign CDS ~→ Korea bank CDS	3.94***	*0.01*	9.15***	*0.00*	20.60***	*0.00*	5.01***	*0.00*
Korea bank CDS ~→ Korea sovereign CDS	1.19	*0.31*	0.41	*0.74*	4.07***	*0.01*	2.19*	*0.09*
Malaysia sovereign CDS ~→ Malaysia bank CDS	2.82**	*0.04*	1.05	*0.37*	3.91***	*0.01*	1.75	*0.16*
Malaysia bank CDS ~→ Malaysia sovereign CDS	0.52	*0.67*	2.09	*0.10*	2.09	*0.10*	8.32***	*0.00*
Singapore sovereign CDS ~→ Singapore bank CDS	12.46***	*0.00*	1.25	*0.29*	1.76	*0.15*	0.25	*0.86*
Singapore bank CDS ~→ Singapore sovereign CDS	2.71**	*0.05*	3.52**	*0.02*	4.10***	*0.01*	0.78	*0.50*
Austria sovereign CDS ~→ Austria bank CDS	1.50	*0.21*	2.36*	*0.07*	14.47***	*0.00*	9.24***	*0.00*
Austria bank CDS ~→ Austria sovereign CDS	1.28	*0.28*	2.25*	*0.08*	6.27***	*0.00*	3.84***	*0.01*
Belgium sovereign CDS ~→ Belgium bank CDS	0.91	*0.43*	0.13	*0.94*	0.62	*0.60*	2.05	*0.11*
Belgium bank CDS ~→ Belgium sovereign CDS	0.48	*0.69*	0.92	*0.43*	1.22	*0.30*	0.90	*0.44*
Denmark sovereign CDS ~→ Denmark bank CDS	0.18	*0.91*	0.84	*0.47*	5.45***	*0.00*	5.73***	*0.00*
Denmark bank CDS ~→ Denmark sovereign CDS	3.18**	*0.02*	0.18	*0.91*	1.02	*0.39*	3.11**	*0.03*
France sovereign CDS ~→ France bank CDS	1.05	*0.37*	0.57	*0.64*	0.53	*0.66*	8.37***	*0.00*
France bank CDS ~→ France sovereign CDS	2.02	*0.11*	0.48	*0.69*	1.91	*0.13*	2.05	*0.11*
Germany sovereign CDS ~→ Germany bank CDS	0.48	*0.70*	0.78	*0.51*	0.14	*0.94*	3.73**	*0.01*
Germany bank CDS ~→ Germany sovereign CDS	2.79**	*0.04*	1.78	*0.15*	8.60***	*0.00*	0.09	*0.96*
Greece sovereign CDS ~→ Greece bank CDS	3.94***	*0.01*	0.47	*0.70*	0.12	*0.95*	1.49	*0.22*
Greece bank CDS ~→ Greece sovereign CDS	3.45**	*0.02*	0.11	*0.96*	0.04	*0.99*	7.26***	*0.00*
Ireland sovereign CDS ~→ Ireland bank CDS	0.44	*0.73*	1.77	*0.15*	0.80	*0.49*	8.66***	*0.00*
Ireland bank CDS ~→ Ireland sovereign CDS	0.23	*0.88*	0.74	*0.53*	6.44***	*0.00*	1.64	*0.18*
Italy sovereign CDS ~→ Italy bank CDS	0.61	*0.61*	1.75	*0.16*	0.42	*0.74*	11.89***	*0.00*
Italy bank CDS ~→ Italy sovereign CDS	1.66	*0.17*	7.77***	*0.00*	3.16**	*0.02*	5.78***	*0.00*
Netherlands sovereign CDS ~→ Netherlands bank CDS	4.19***	*0.01*	0.47	*0.70*	1.94	*0.12*	3.02**	*0.03*
Netherlands bank CDS ~→ Netherlands sovereign CDS	1.51	*0.21*	0.13	*0.94*	1.56	*0.20*	6.31***	*0.00*
Portugal sovereign CDS ~→ Portugal bank CDS	0.29	*0.83*	0.06	*0.98*	0.77	*0.51*	16.24***	*0.00*
Portugal bank CDS ~→ Portugal sovereign CDS	0.87	*0.46*	6.15***	*0.00*	1.34	*0.26*	3.52**	*0.02*
Spain sovereign CDS ~→ Spain bank CDS	0.40	*0.75*	1.93	*0.12*	0.78	*0.51*	10.07***	*0.00*
Spain bank CDS ~→ Spain sovereign CDS	3.25**	*0.02*	0.53	*0.66*	4.97***	*0.00*	0.95	*0.41*

Sweden sovereign CDS ~→ Sweden bank CDS	1.59	*0.19*	1.11	*0.34*	13.70***	*0.00*	6.82***	*0.00*
Sweden bank CDS ~→ Sweden sovereign CDS	1.88	*0.13*	0.94	*0.42*	0.50	*0.68*	1.32	*0.27*
Switzerland sovereign CDS ~→ Switzerland bank CDS	0.23	*0.87*	0.15	*0.93*	0.20	*0.90*	1.49	*0.22*
Switzerland bank CDS ~→ Switzerland sovereign CDS	1.63	*0.18*	0.11	*0.96*	4.61***	*0.00*	4.59***	*0.00*
UK sovereign CDS ~→ UK bank CDS	0.71	*0.55*	0.16	*0.92*	4.76***	*0.00*	2.22*	*0.09*
UK bank CDS ~→ UK sovereign CDS	3.26**	*0.02*	0.94	*0.42*	8.37***	*0.00*	1.70	*0.17*
Bahrain sovereign CDS ~→ Bahrain bank CDS	0.86	*0.46*	0.55	*0.65*	11.70***	*0.00*	3.57**	*0.01*
Bahrain bank CDS ~→ Bahrain sovereign CDS	3.04**	*0.03*	0.22	*0.88*	1.27	*0.29*	2.66**	*0.05*
Qatar sovereign CDS ~→ Qatar bank CDS	0.28	*0.84*	1.73	*0.16*	1.69	*0.17*	4.32***	*0.01*
Qatar bank CDS ~→ Qatar sovereign CDS	0.56	*0.64*	2.94**	*0.03*	0.40	*0.76*	1.24	*0.30*
UAE sovereign CDS ~→ UAE bank CDS	0.82	*0.48*	0.79	*0.50*	12.66***	*0.00*	3.81**	*0.01*
UAE bank CDS ~→ UAE sovereign CDS	2.07	*0.10*	0.14	*0.93*	1.65	*0.18*	0.59	*0.62*
Russia sovereign CDS ~→ Russia bank CDS	3.33**	*0.02*	1.37	*0.25*	23.85***	*0.00*	15.65***	*0.00*
Russia bank CDS ~→ Russia sovereign CDS	0.62	*0.60*	2.57*	*0.05*	7.59***	*0.00*	2.30*	*0.08*

Incl. stock index and federal funds rate

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
US sovereign CDS ~→ US bank CDS	16.47***	*0.00*	0.65	*0.58*	0.36	*0.78*	1.84	*0.14*
US bank CDS ~→ US sovereign CDS	8.82***	*0.00*	2.61*	*0.05*	4.92***	*0.00*	5.46***	*0.00*
Australia sovereign CDS ~→ Australia bank CDS	1.90	*0.13*	3.50**	*0.02*	3.45**	*0.02*	11.10***	*0.00*
Australia bank CDS ~→ Australia sovereign CDS	0.96	*0.41*	2.56*	*0.05*	2.19*	*0.09*	1.71	*0.17*
China sovereign CDS ~→ China bank CDS	3.06**	*0.03*	18.62***	*0.00*	3.86***	*0.01*	11.09***	*0.00*
China bank CDS ~→ China sovereign CDS	11.41***	*0.00*	1.43	*0.24*	3.19**	*0.02*	0.87	*0.46*
Hong Kong sovereign CDS ~→ Hong Kong bank CDS	1.03	*0.38*	0.29	*0.83*	3.44**	*0.02*	0.78	*0.50*
Hong Kong bank CDS ~→ Hong Kong sovereign CDS	0.55	*0.65*	0.52	*0.67*	10.02***	*0.00*	5.27***	*0.00*
India sovereign CDS ~→ India bank CDS	7.56***	*0.00*	2.09	*0.10*	1.71	*0.17*	0.40	*0.75*
India bank CDS ~→ India sovereign CDS	3.13**	*0.03*	4.05***	*0.01*	3.51**	*0.02*	0.45	*0.72*
Japan sovereign CDS ~→ Japan bank CDS	0.53	*0.66*	1.10	*0.35*	0.88	*0.45*	4.62***	*0.00*
Japan bank CDS ~→ Japan sovereign CDS	0.93	*0.43*	1.66	*0.18*	3.45**	*0.02*	1.07	*0.36*
Kazakhstan sovereign CDS ~→ Kazakhstan bank CDS	0.51	*0.67*	14.93***	*0.00*	0.71	*0.54*	0.92	*0.43*
Kazakhstan bank CDS ~→ Kazakhstan sovereign CDS	0.96	*0.41*	0.29	*0.84*	2.05	*0.11*	3.02**	*0.03*
Korea sovereign CDS ~→ Korea bank CDS	3.38**	*0.02*	10.21***	*0.00*	17.64***	*0.00*	3.59**	*0.01*
Korea bank CDS ~→ Korea sovereign CDS	0.78	*0.50*	0.79	*0.50*	2.99**	*0.03*	2.15*	*0.09*
Malaysia sovereign CDS ~→ Malaysia bank CDS	0.67	*0.57*	1.15	*0.33*	3.35**	*0.02*	1.56	*0.20*
Malaysia bank CDS ~→ Malaysia sovereign CDS	0.40	*0.75*	2.08	*0.10*	2.62*	*0.05*	8.36***	*0.00*
Singapore sovereign CDS ~→ Singapore bank CDS	15.51***	*0.00*	1.54	*0.20*	1.48	*0.22*	0.52	*0.67*
Singapore bank CDS ~→ Singapore sovereign CDS	2.41*	*0.07*	3.12**	*0.03*	3.69**	*0.01*	0.83	*0.48*
Austria sovereign CDS ~→ Austria bank CDS	2.36*	*0.07*	2.31*	*0.08*	13.84***	*0.00*	7.80***	*0.00*
Austria bank CDS ~→ Austria sovereign CDS	0.60	*0.61*	2.43*	*0.07*	6.99***	*0.00*	3.16**	*0.02*
Belgium sovereign CDS ~→ Belgium bank CDS	1.04	*0.38*	0.18	*0.91*	0.61	*0.61*	1.92	*0.13*
Belgium bank CDS ~→ Belgium sovereign CDS	0.63	*0.60*	1.01	*0.39*	1.49	*0.22*	0.65	*0.58*
Denmark sovereign CDS ~→ Denmark bank CDS	0.06	*0.98*	0.92	*0.43*	3.94***	*0.01*	5.16***	*0.00*
Denmark bank CDS ~→ Denmark sovereign CDS	4.51***	*0.00*	0.32	*0.81*	1.65	*0.18*	3.12**	*0.03*
France sovereign CDS ~→ France bank CDS	1.76	*0.15*	0.90	*0.44*	0.47	*0.71*	8.39***	*0.00*
France bank CDS ~→ France sovereign CDS	2.65**	*0.05*	0.39	*0.76*	1.92	*0.13*	2.21*	*0.09*

Germany sovereign CDS ~→ Germany bank CDS	0.50	*0.68*	0.90	*0.44*	0.19	*0.90*	3.64**	*0.01*
Germany bank CDS ~→ Germany sovereign CDS	3.00**	*0.03*	1.67	*0.17*	7.41***	*0.00*	0.07	*0.98*
Greece sovereign CDS ~→ Greece bank CDS	4.65***	*0.00*	0.48	*0.70*	0.17	*0.92*	1.51	*0.21*
Greece bank CDS ~→ Greece sovereign CDS	3.34**	*0.02*	0.13	*0.94*	0.04	*0.99*	7.29***	*0.00*
Ireland sovereign CDS ~→ Ireland bank CDS	1.23	*0.30*	2.12*	*0.10*	0.27	*0.84*	9.63***	*0.00*
Ireland bank CDS ~→ Ireland sovereign CDS	1.00	*0.39*	0.76	*0.52*	7.43***	*0.00*	1.73	*0.16*
Italy sovereign CDS ~→ Italy bank CDS	0.62	*0.60*	1.81	*0.14*	0.62	*0.60*	11.85***	*0.00*
Italy bank CDS ~→ Italy sovereign CDS	1.79	*0.15*	7.30***	*0.00*	3.05**	*0.03*	6.28***	*0.00*
Netherlands sovereign CDS ~→ Netherlands bank CDS	4.42***	*0.00*	0.09	*0.96*	1.93	*0.12*	3.08**	*0.03*
Netherlands bank CDS ~→ Netherlands sovereign CDS	1.09	*0.36*	0.02	*1.00*	0.39	*0.76*	6.26***	*0.00*
Portugal sovereign CDS ~→ Portugal bank CDS	0.27	*0.85*	0.08	*0.97*	0.88	*0.45*	14.46***	*0.00*
Portugal bank CDS ~→ Portugal sovereign CDS	1.14	*0.33*	5.70***	*0.00*	1.03	*0.38*	3.30**	*0.02*
Spain sovereign CDS ~→ Spain bank CDS	0.22	*0.88*	2.17*	*0.09*	0.81	*0.49*	12.98***	*0.00*
Spain bank CDS ~→ Spain sovereign CDS	3.63**	*0.01*	1.69	*0.17*	5.30***	*0.00*	1.23	*0.30*
Sweden sovereign CDS ~→ Sweden bank CDS	4.84***	*0.00*	0.82	*0.48*	12.56***	*0.00*	6.70***	*0.00*
Sweden bank CDS ~→ Sweden sovereign CDS	1.24	*0.29*	0.84	*0.47*	0.62	*0.60*	1.25	*0.29*
Switzerland sovereign CDS ~→ Switzerland bank CDS	0.20	*0.89*	0.17	*0.91*	0.11	*0.96*	1.57	*0.20*
Switzerland bank CDS ~→ Switzerland sovereign CDS	1.54	*0.20*	0.12	*0.95*	3.97***	*0.01*	5.03***	*0.00*
UK sovereign CDS ~→ UK bank CDS	0.51	*0.68*	0.14	*0.94*	4.69***	*0.00*	2.26*	*0.08*
UK bank CDS ~→ UK sovereign CDS	2.46*	*0.06*	1.02	*0.38*	7.59***	*0.00*	1.75	*0.16*
Bahrain sovereign CDS ~→ Bahrain bank CDS	0.97	*0.41*	0.63	*0.59*	12.48***	*0.00*	3.70**	*0.01*
Bahrain bank CDS ~→ Bahrain sovereign CDS	3.37**	*0.02*	0.23	*0.87*	0.96	*0.41*	2.28*	*0.08*
Qatar sovereign CDS ~→ Qatar bank CDS	0.76	*0.52*	1.38	*0.25*	2.27*	*0.08*	4.32***	*0.01*
Qatar bank CDS ~→ Qatar sovereign CDS	0.63	*0.60*	4.60***	*0.00*	0.38	*0.77*	1.17	*0.32*
UAE sovereign CDS ~→ UAE bank CDS	0.87	*0.46*	0.82	*0.48*	6.40***	*0.00*	3.43**	*0.02*
UAE bank CDS ~→ UAE sovereign CDS	2.56*	*0.06*	0.36	*0.78*	1.58	*0.20*	0.48	*0.69*
Russia sovereign CDS ~→ Russia bank CDS	3.33**	*0.02*	1.63	*0.18*	21.03***	*0.00*	14.19***	*0.00*
Russia bank CDS ~→ Russia sovereign CDS	0.99	*0.40*	1.27	*0.28*	6.20***	*0.00*	2.34*	*0.07*

Notes: We evaluate the null hypothesis that the sovereign CDS in country *i* does *not* impact the bank CDS in the same country, i.,e., $H_0 : CDS_i^{sov} \sim\!\!\rightarrow CDS_i^{bank}$, using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 34: Granger causality test results for regional bank vs. non-bank corporate CDS

Without control variables

America

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	0.13	*0.94*	7.90***	*0.00*	6.12***	*0.00*	10.82***	*0.00*
Automotive ~→ Bank CDS	0.90	*0.44*	1.20	*0.31*	1.13	*0.34*	2.16*	*0.09*
Bank CDS ~→ Basic materials	4.14***	*0.01*	7.07***	*0.00*	5.63***	*0.00*	9.32***	*0.00*
Basic materials ~→ Bank CDS	0.26	*0.86*	0.61	*0.61*	0.20	*0.89*	2.66**	*0.05*
Bank CDS ~→ Chemicals, healthcare and pharma	1.67	*0.17*	7.25***	*0.00*	4.72***	*0.00*	7.63***	*0.00*
Chemicals, healthcare and pharma ~→ Bank CDS	0.03	*0.99*	0.68	*0.56*	0.15	*0.93*	1.53	*0.21*
Bank CDS ~→ Commerce and consumer	0.76	*0.52*	3.51**	*0.02*	4.46***	*0.00*	12.08***	*0.00*
Commerce and consumer ~→ Bank CDS	5.63***	*0.00*	1.35	*0.26*	0.18	*0.91*	2.35*	*0.07*
Bank CDS ~→ Construction and logistics	2.37*	*0.07*	8.25***	*0.00*	4.17***	*0.01*	11.90***	*0.00*
Construction and logistics ~→ Bank CDS	0.56	*0.64*	0.84	*0.47*	0.24	*0.87*	1.15	*0.33*
Bank CDS ~→ Energy and utilities	2.04	*0.11*	10.86***	*0.00*	3.69**	*0.01*	11.69***	*0.00*
Energy and utilities ~→ Bank CDS	0.82	*0.48*	3.67**	*0.01*	5.44***	*0.00*	0.95	*0.42*
Bank CDS ~→ Financial services (excl. banking)	0.23	*0.88*	8.42***	*0.00*	7.23***	*0.00*	8.66***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	1.28	*0.28*	1.03	*0.38*	3.49**	*0.02*	0.18	*0.91*
Bank CDS ~→ Industrial	2.56*	*0.05*	10.58***	*0.00*	3.27**	*0.02*	12.41***	*0.00*
Industrial ~→ Bank CDS	4.03***	*0.01*	2.28*	*0.08*	0.40	*0.76*	3.54**	*0.01*
Bank CDS ~→ Telecommunication, media and tech.	2.86**	*0.04*	5.06***	*0.00*	1.87	*0.13*	9.13***	*0.00*
Telecommunication, media and tech. ~→ Bank CDS	1.85	*0.14*	0.62	*0.61*	0.11	*0.96*	1.61	*0.19*
Bank CDS ~→ Overall corporate sector	2.48*	*0.06*	6.10***	*0.00*	6.37***	*0.00*	12.18***	*0.00*
Overall corporate sector ~→ Bank CDS	4.32***	*0.01*	1.48	*0.22*	1.55	*0.20*	1.59	*0.19*

Asia-Pacific

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	0.84	*0.47*	6.27***	*0.00*	1.68	*0.17*	1.61	*0.19*
Automotive ~→ Bank CDS	1.68	*0.17*	0.58	*0.63*	2.48*	*0.06*	14.38***	*0.00*
Bank CDS ~→ Basic materials	2.27*	*0.08*	9.30***	*0.00*	5.20***	*0.00*	5.34***	*0.00*
Basic materials ~→ Bank CDS	2.68**	*0.05*	1.20	*0.31*	2.28*	*0.08*	0.67	*0.57*
Bank CDS ~→ Chemicals, healthcare and pharma	2.00	*0.11*	0.43	*0.73*	1.45	*0.23*	1.68	*0.17*
Chemicals, healthcare and pharma ~→ Bank CDS	1.16	*0.32*	0.38	*0.77*	0.49	*0.69*	4.72***	*0.00*
Bank CDS ~→ Commerce and consumer	1.15	*0.33*	3.17**	*0.02*	3.09**	*0.03*	7.85***	*0.00*
Commerce and consumer ~→ Bank CDS	0.58	*0.63*	1.23	*0.30*	0.54	*0.66*	0.53	*0.66*
Bank CDS ~→ Construction and logistics	0.42	*0.74*	15.46***	*0.00*	5.31***	*0.00*	4.77***	*0.00*
Construction and logistics ~→ Bank CDS	0.11	*0.95*	0.99	*0.40*	1.79	*0.15*	0.34	*0.80*
Bank CDS ~→ Energy and utilities	1.32	*0.27*	8.82***	*0.00*	9.43***	*0.00*	4.44***	*0.00*
Energy and utilities ~→ Bank CDS	0.67	*0.57*	1.38	*0.25*	2.13*	*0.10*	1.11	*0.35*
Bank CDS ~→ Financial services (excl. banking)	0.62	*0.60*	1.69	*0.17*	0.61	*0.61*	10.89***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	0.08	*0.97*	0.19	*0.90*	1.48	*0.22*	6.20***	*0.00*
Bank CDS ~→ Industrial	2.47*	*0.06*	5.86***	*0.00*	3.57**	*0.01*	2.71**	*0.05*
Industrial ~→ Bank CDS	1.54	*0.20*	2.31*	*0.08*	0.86	*0.46*	0.70	*0.55*
Bank CDS ~→ Telecommunication, media and tech.	0.92	*0.43*	3.42**	*0.02*	2.93**	*0.03*	0.89	*0.45*
Telecommunication, media and tech. ~→ Bank CDS	0.27	*0.85*	1.93	*0.12*	0.35	*0.79*	2.51*	*0.06*
Bank CDS ~→ Overall corporate sector	0.54	*0.66*	6.92***	*0.00*	8.32***	*0.00*	1.78	*0.15*
Overall corporate sector ~→ Bank CDS	0.82	*0.48*	1.36	*0.26*	3.21**	*0.02*	4.00***	*0.01*

Europe

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	1.49	*0.22*	1.11	*0.34*	6.53***	*0.00*	5.35***	*0.00*
Automotive ~→ Bank CDS	2.20*	*0.09*	10.36***	*0.00*	1.42	*0.24*	7.45***	*0.00*
Bank CDS ~→ Basic materials	1.27	*0.28*	0.06	*0.98*	2.46*	*0.06*	0.65	*0.58*
Basic materials ~→ Bank CDS	0.75	*0.52*	3.01**	*0.03*	1.44	*0.23*	0.86	*0.46*
Bank CDS ~→ Chemicals, healthcare and pharma	0.58	*0.63*	0.37	*0.77*	0.36	*0.78*	3.50**	*0.02*
Chemicals, healthcare and pharma ~→ Bank CDS	3.65**	*0.01*	4.75***	*0.00*	1.21	*0.31*	8.96***	*0.00*
Bank CDS ~→ Commerce and consumer	1.50	*0.22*	1.87	*0.13*	2.55*	*0.06*	5.16***	*0.00*
Commerce and consumer ~→ Bank CDS	2.72**	*0.04*	9.11***	*0.00*	2.24*	*0.08*	9.95***	*0.00*
Bank CDS ~→ Construction and logistics	1.43	*0.23*	0.29	*0.83*	6.16***	*0.00*	3.97***	*0.01*
Construction and logistics ~→ Bank CDS	0.30	*0.83*	3.80**	*0.01*	1.21	*0.31*	5.49***	*0.00*
Bank CDS ~→ Energy and utilities	0.78	*0.51*	0.23	*0.87*	2.38*	*0.07*	1.33	*0.26*
Energy and utilities ~→ Bank CDS	3.50**	*0.02*	8.39***	*0.00*	1.63	*0.18*	1.95	*0.12*
Bank CDS ~→ Financial services (excl. banking)	5.05***	*0.00*	2.29*	*0.08*	6.82***	*0.00*	4.70***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	4.05***	*0.01*	6.35***	*0.00*	4.00***	*0.01*	4.74***	*0.00*
Bank CDS ~→ Industrial	5.77***	*0.00*	0.16	*0.92*	5.90***	*0.00*	9.83***	*0.00*
Industrial ~→ Bank CDS	2.24*	*0.08*	12.27***	*0.00*	0.92	*0.43*	7.99***	*0.00*
Bank CDS ~→ Telecommunication, media and tech.	1.07	*0.36*	1.49	*0.22*	1.32	*0.27*	0.38	*0.77*
Telecommunication, media and tech. ~→ Bank CDS	2.05	*0.11*	9.69***	*0.00*	2.55*	*0.06*	1.32	*0.27*
Bank CDS ~→ Overall corporate sector	0.81	*0.49*	1.55	*0.20*	4.65***	*0.00*	5.64***	*0.00*
Overall corporate sector ~→ Bank CDS	3.02**	*0.03*	12.73***	*0.00*	1.84	*0.14*	7.03***	*0.00*

Incl. stock index and federal funds rate

America

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	0.04	*0.99*	6.49***	*0.00*	6.02***	*0.00*	10.75***	*0.00*
Automotive ~→ Bank CDS	1.05	*0.37*	1.15	*0.33*	1.14	*0.33*	2.10	*0.10*
Bank CDS ~→ Basic materials	4.24***	*0.01*	7.09***	*0.00*	5.48***	*0.00*	9.26***	*0.00*
Basic materials ~→ Bank CDS	0.29	*0.83*	0.71	*0.55*	0.50	*0.69*	2.72**	*0.04*
Bank CDS ~→ Chemicals, healthcare and pharma	2.10	*0.10*	7.43***	*0.00*	5.53***	*0.00*	8.02***	*0.00*
Chemicals, healthcare and pharma ~→ Bank CDS	0.04	*0.99*	0.84	*0.47*	0.17	*0.91*	1.53	*0.21*
Bank CDS ~→ Commerce and consumer	0.97	*0.41*	3.56**	*0.01*	5.80***	*0.00*	12.13***	*0.00*
Commerce and consumer ~→ Bank CDS	5.69***	*0.00*	1.05	*0.37*	0.06	*0.98*	2.22*	*0.09*
Bank CDS ~→ Construction and logistics	2.38*	*0.07*	8.24***	*0.00*	4.36***	*0.00*	12.26***	*0.00*
Construction and logistics ~→ Bank CDS	0.61	*0.61*	0.79	*0.50*	0.39	*0.76*	1.08	*0.36*
Bank CDS ~→ Energy and utilities	2.01	*0.11*	13.86***	*0.00*	4.48***	*0.00*	11.58***	*0.00*
Energy and utilities ~→ Bank CDS	0.79	*0.50*	3.61**	*0.01*	5.42***	*0.00*	1.09	*0.35*
Bank CDS ~→ Financial services (excl. banking)	0.37	*0.77*	8.32***	*0.00*	7.70***	*0.00*	8.68***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	1.33	*0.26*	0.83	*0.48*	2.70**	*0.05*	0.21	*0.89*
Bank CDS ~→ Industrial	2.81**	*0.04*	10.33***	*0.00*	3.39**	*0.02*	12.34***	*0.00*
Industrial ~→ Bank CDS	3.85***	*0.01*	2.10	*0.10*	0.23	*0.88*	3.32**	*0.02*
Bank CDS ~→ Telecommunication, media and tech.	2.84**	*0.04*	5.15***	*0.00*	2.16*	*0.09*	9.16***	*0.00*
Telecommunication, media and tech. ~→ Bank CDS	1.94	*0.12*	0.67	*0.57*	0.05	*0.99*	1.73	*0.16*
Bank CDS ~→ Overall corporate sector	2.37*	*0.07*	6.15***	*0.00*	6.93***	*0.00*	12.01***	*0.00*
Overall corporate sector ~→ Bank CDS	4.43***	*0.00*	1.41	*0.24*	1.18	*0.32*	1.71	*0.17*

Asia-Pacific

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	1.02	*0.38*	9.22***	*0.00*	2.10	*0.10*	1.59	*0.19*
Automotive ~→ Bank CDS	1.00	*0.39*	1.03	*0.38*	2.25*	*0.08*	14.28***	*0.00*
Bank CDS ~→ Basic materials	1.51	*0.21*	9.19***	*0.00*	4.88***	*0.00*	4.89***	*0.00*
Basic materials ~→ Bank CDS	1.65	*0.18*	1.25	*0.29*	1.83	*0.14*	0.73	*0.54*
Bank CDS ~→ Chemicals, healthcare and pharma	1.92	*0.13*	0.81	*0.49*	1.29	*0.28*	1.47	*0.22*
Chemicals, healthcare and pharma ~→ Bank CDS	0.60	*0.61*	0.46	*0.71*	0.11	*0.95*	5.12***	*0.00*
Bank CDS ~→ Commerce and consumer	0.81	*0.49*	3.16**	*0.02*	2.83**	*0.04*	7.38***	*0.00*
Commerce and consumer ~→ Bank CDS	0.73	*0.54*	1.23	*0.30*	0.48	*0.70*	0.70	*0.55*
Bank CDS ~→ Construction and logistics	0.37	*0.77*	15.79***	*0.00*	4.08***	*0.01*	4.59***	*0.00*
Construction and logistics ~→ Bank CDS	0.04	*0.99*	1.25	*0.29*	1.77	*0.15*	0.18	*0.91*
Bank CDS ~→ Energy and utilities	1.24	*0.29*	9.30***	*0.00*	10.60***	*0.00*	5.72***	*0.00*
Energy and utilities ~→ Bank CDS	0.72	*0.54*	1.27	*0.28*	1.47	*0.22*	1.08	*0.36*
Bank CDS ~→ Financial services (excl. banking)	0.62	*0.60*	2.45*	*0.06*	0.58	*0.63*	10.55***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	0.20	*0.89*	0.24	*0.87*	1.88	*0.13*	6.12***	*0.00*
Bank CDS ~→ Industrial	1.56	*0.20*	8.81***	*0.00*	2.77**	*0.04*	2.56*	*0.05*
Industrial ~→ Bank CDS	1.25	*0.29*	2.77**	*0.04*	0.19	*0.90*	0.81	*0.49*
Bank CDS ~→ Telecommunication, media and tech.	0.93	*0.42*	4.54***	*0.00*	2.36*	*0.07*	0.76	*0.52*
Telecommunication, media and tech. ~→ Bank CDS	0.30	*0.82*	2.64**	*0.05*	0.65	*0.58*	2.59*	*0.05*
Bank CDS ~→ Overall corporate sector	0.45	*0.72*	7.61***	*0.00*	9.26***	*0.00*	1.64	*0.18*
Overall corporate sector ~→ Bank CDS	0.50	*0.68*	2.62*	*0.05*	3.06**	*0.03*	4.53***	*0.00*

Europe

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank CDS ~→ Automotive	1.41	*0.24*	1.11	*0.35*	8.07***	*0.00*	5.05***	*0.00*
Automotive ~→ Bank CDS	2.12*	*0.10*	10.39***	*0.00*	1.66	*0.18*	5.31***	*0.00*
Bank CDS ~→ Basic materials	0.90	*0.44*	0.02	*1.00*	2.22*	*0.09*	0.58	*0.63*
Basic materials ~→ Bank CDS	0.84	*0.47*	2.97**	*0.03*	3.37**	*0.02*	0.82	*0.48*
Bank CDS ~→ Chemicals, healthcare and pharma	0.60	*0.62*	0.33	*0.80*	0.79	*0.50*	3.54**	*0.01*
Chemicals, healthcare and pharma ~→ Bank CDS	4.50***	*0.00*	4.98***	*0.00*	1.59	*0.19*	7.28***	*0.00*
Bank CDS ~→ Commerce and consumer	1.65	*0.18*	1.89	*0.13*	3.51**	*0.02*	5.05***	*0.00*
Commerce and consumer ~→ Bank CDS	3.97***	*0.01*	9.09***	*0.00*	2.64**	*0.05*	9.50***	*0.00*
Bank CDS ~→ Construction and logistics	1.10	*0.35*	0.41	*0.75*	6.60***	*0.00*	5.60***	*0.00*
Construction and logistics ~→ Bank CDS	0.31	*0.82*	3.89***	*0.01*	1.24	*0.30*	4.70***	*0.00*
Bank CDS ~→ Energy and utilities	0.79	*0.50*	0.32	*0.81*	3.24**	*0.02*	1.27	*0.29*
Energy and utilities ~→ Bank CDS	2.74**	*0.04*	8.36***	*0.00*	1.63	*0.18*	1.90	*0.13*
Bank CDS ~→ Financial services (excl. banking)	5.22***	*0.00*	2.18*	*0.09*	6.97***	*0.00*	4.85***	*0.00*
Financial services (excl. banking) ~→ Bank CDS	3.51**	*0.02*	6.15***	*0.00*	4.08***	*0.01*	4.62***	*0.00*
Bank CDS ~→ Industrial	5.89***	*0.00*	0.19	*0.90*	6.42***	*0.00*	9.88***	*0.00*
Industrial ~→ Bank CDS	2.12*	*0.10*	11.91***	*0.00*	1.00	*0.39*	8.06***	*0.00*
Bank CDS ~→ Telecommunication, media and tech.	1.06	*0.36*	1.48	*0.22*	1.94	*0.12*	0.35	*0.79*
Telecommunication, media and tech. ~→ Bank CDS	2.10*	*0.10*	9.56***	*0.00*	2.39*	*0.07*	1.23	*0.30*
Bank CDS ~→ Overall corporate sector	0.63	*0.60*	1.58	*0.19*	5.41***	*0.00*	5.03***	*0.00*
Overall corporate sector ~→ Bank CDS	3.10**	*0.03*	12.73***	*0.00*	1.93	*0.12*	5.34***	*0.00*

Notes: We evaluate the null hypothesis that the bank CDS in region *i* does *not* impact the corporate CDS in the same region, i.e., $H_0 : CDS_i^{bank} \sim\!\!\rightarrow CDS_i^{corp}$, using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively.

Table 35: Granger causality test results for regional bank vs. non-bank corporate equity

Without control variables

America

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	1.67	*0.17*	0.20	*0.90*	0.80	*0.49*	1.30	*0.27*
Automotive ~→ Bank equity	0.85	*0.47*	0.07	*0.98*	1.74	*0.16*	1.27	*0.28*
Bank equity ~→ Basic materials	0.16	*0.93*	2.48*	*0.06*	2.23*	*0.08*	0.64	*0.59*
Basic materials ~→ Bank equity	2.40*	*0.07*	12.21***	*0.00*	0.12	*0.95*	3.18**	*0.02*
Bank equity ~→ Chemicals, healthcare and pharma	1.69	*0.17*	0.35	*0.79*	2.22*	*0.09*	0.22	*0.89*
Chemicals, healthcare and pharma ~→ Bank equity	0.53	*0.66*	0.37	*0.78*	4.45***	*0.00*	0.83	*0.48*
Bank equity ~→ Commerce and consumer	0.71	*0.55*	1.68	*0.17*	2.40*	*0.07*	0.58	*0.63*
Commerce and consumer ~→ Bank equity	0.10	*0.96*	1.86	*0.14*	3.26**	*0.02*	0.15	*0.93*
Bank equity ~→ Construction and logistics	0.52	*0.67*	0.64	*0.59*	1.14	*0.33*	0.27	*0.85*
Construction and logistics ~→ Bank equity	0.11	*0.95*	1.30	*0.27*	1.29	*0.28*	0.67	*0.57*
Bank equity ~→ Energy and utilities	0.28	*0.84*	0.73	*0.53*	2.67**	*0.05*	0.86	*0.46*
Energy and utilities ~→ Bank equity	2.27*	*0.08*	7.26***	*0.00*	1.88	*0.13*	1.46	*0.23*
Bank equity ~→ Financial services (excl. banking)	1.79	*0.15*	0.62	*0.60*	0.31	*0.82*	0.82	*0.48*
Financial services (excl. banking) ~→ Bank equity	0.65	*0.58*	3.41**	*0.02*	2.70**	*0.05*	1.41	*0.24*
Bank equity ~→ Industrial	0.40	*0.75*	2.21*	*0.09*	2.14*	*0.09*	0.46	*0.71*
Industrial ~→ Bank equity	1.15	*0.33*	3.18**	*0.02*	1.78	*0.15*	0.57	*0.63*
Bank equity ~→ Telecommunication, media and tech.	0.13	*0.94*	1.09	*0.35*	0.92	*0.43*	0.54	*0.66*
Telecommunication, media and tech. ~→ Bank equity	0.31	*0.82*	5.57***	*0.00*	2.91**	*0.03*	0.35	*0.79*
Bank equity ~→ Overall corporate sector	1.85	*0.14*	0.51	*0.67*	0.28	*0.84*	0.73	*0.53*
Overall corporate sector ~→ Bank equity	0.60	*0.61*	3.43**	*0.02*	2.70**	*0.05*	1.40	*0.24*

Asia-Pacific

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	0.18	*0.91*	3.32**	*0.02*	2.45*	*0.06*	1.22	*0.30*
Automotive ~→ Bank equity	0.60	*0.61*	1.36	*0.25*	2.29*	*0.08*	1.17	*0.32*
Bank equity ~→ Basic materials	0.09	*0.96*	0.49	*0.69*	7.75***	*0.00*	1.66	*0.17*
Basic materials ~→ Bank equity	0.41	*0.75*	1.29	*0.28*	7.71***	*0.00*	0.82	*0.48*
Bank equity ~→ Chemicals, healthcare and pharma	0.14	*0.94*	0.48	*0.70*	1.52	*0.21*	1.00	*0.39*
Chemicals, healthcare and pharma ~→ Bank equity	0.53	*0.66*	0.59	*0.62*	3.38**	*0.02*	1.84	*0.14*
Bank equity ~→ Commerce and consumer	1.97	*0.12*	0.79	*0.50*	0.27	*0.85*	2.40*	*0.07*
Commerce and consumer ~→ Bank equity	0.92	*0.43*	2.13*	*0.10*	5.10***	*0.00*	2.88**	*0.04*
Bank equity ~→ Construction and logistics	0.18	*0.91*	0.38	*0.77*	0.63	*0.60*	2.06	*0.11*
Construction and logistics ~→ Bank equity	3.10**	*0.03*	0.68	*0.57*	0.77	*0.51*	0.86	*0.46*
Bank equity ~→ Energy and utilities	0.37	*0.77*	1.24	*0.30*	6.36***	*0.00*	1.67	*0.17*
Energy and utilities ~→ Bank equity	2.99**	*0.03*	1.63	*0.18*	6.07***	*0.00*	1.92	*0.13*
Bank equity ~→ Financial services (excl. banking)	1.58	*0.19*	1.06	*0.37*	1.38	*0.25*	0.33	*0.80*
Financial services (excl. banking) ~→ Bank equity	3.69**	*0.01*	2.30*	*0.08*	2.29*	*0.08*	1.07	*0.36*
Bank equity ~→ Industrial	2.27*	*0.08*	4.77***	*0.00*	5.73***	*0.00*	5.10***	*0.00*
Industrial ~→ Bank equity	1.16	*0.33*	10.17***	*0.00*	1.98	*0.12*	2.80**	*0.04*
Bank equity ~→ Telecommunication, media and tech.	1.23	*0.30*	1.11	*0.35*	0.67	*0.57*	2.54*	*0.06*
Telecommunication, media and tech. ~→ Bank equity	1.08	*0.36*	4.10***	*0.01*	12.00***	*0.00*	3.66**	*0.01*
Bank equity ~→ Overall corporate sector	1.96	*0.12*	0.55	*0.65*	0.29	*0.83*	5.14***	*0.00*
Overall corporate sector ~→ Bank equity	0.67	*0.57*	3.71**	*0.01*	11.19***	*0.00*	5.01***	*0.00*

Europe

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	1.68	*0.17*	1.56	*0.20*	1.54	*0.20*	1.49	*0.22*
Automotive ~→ Bank equity	0.11	*0.95*	2.44*	*0.06*	1.00	*0.39*	0.51	*0.67*
Bank equity ~→ Basic materials	0.98	*0.40*	0.64	*0.59*	1.32	*0.27*	1.66	*0.18*
Basic materials ~→ Bank equity	2.14*	*0.09*	7.30***	*0.00*	0.19	*0.91*	1.34	*0.26*
Bank equity ~→ Chemicals, healthcare and pharma	0.17	*0.91*	0.21	*0.89*	1.61	*0.19*	1.21	*0.30*
Chemicals, healthcare and pharma ~→ Bank equity	1.58	*0.19*	1.88	*0.13*	1.15	*0.33*	2.24*	*0.08*
Bank equity ~→ Commerce and consumer	2.20*	*0.09*	0.42	*0.74*	2.17*	*0.09*	0.82	*0.48*
Commerce and consumer ~→ Bank equity	0.31	*0.82*	2.46*	*0.06*	0.65	*0.58*	3.65**	*0.01*
Bank equity ~→ Construction and logistics	1.52	*0.21*	0.59	*0.62*	0.33	*0.81*	1.98	*0.12*
Construction and logistics ~→ Bank equity	0.89	*0.45*	0.90	*0.44*	0.31	*0.82*	0.93	*0.43*
Bank equity ~→ Energy and utilities	1.52	*0.21*	2.30*	*0.08*	2.49*	*0.06*	1.23	*0.30*
Energy and utilities ~→ Bank equity	1.34	*0.26*	2.23*	*0.08*	0.43	*0.73*	2.50*	*0.06*
Bank equity ~→ Financial services (excl. banking)	0.61	*0.61*	0.43	*0.73*	1.09	*0.35*	2.30*	*0.08*
Financial services (excl. banking) ~→ Bank equity	0.29	*0.83*	0.91	*0.43*	1.56	*0.20*	1.68	*0.17*
Bank equity ~→ Industrial	1.35	*0.26*	0.44	*0.73*	3.35**	*0.02*	0.60	*0.62*
Industrial ~→ Bank equity	1.36	*0.26*	3.47**	*0.02*	0.43	*0.73*	1.31	*0.27*
Bank equity ~→ Telecommunication, media and tech.	1.15	*0.33*	1.05	*0.37*	1.61	*0.19*	0.99	*0.40*
Telecommunication, media and tech. ~→ Bank equity	1.98	*0.12*	7.05***	*0.00*	0.81	*0.49*	3.09**	*0.03*
Bank equity ~→ Overall corporate sector	0.15	*0.93*	0.98	*0.40*	1.30	*0.27*	0.63	*0.60*
Overall corporate sector ~→ Bank equity	0.92	*0.43*	3.69**	*0.01*	0.29	*0.83*	2.50*	*0.06*

Incl. stock index and federal funds rate

America

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	1.64	*0.18*	0.13	*0.94*	0.89	*0.45*	1.17	*0.32*
Automotive ~→ Bank equity	0.72	*0.54*	0.13	*0.94*	1.69	*0.17*	1.24	*0.29*
Bank equity ~→ Basic materials	0.14	*0.94*	1.27	*0.28*	1.68	*0.17*	0.63	*0.60*
Basic materials ~→ Bank equity	2.42*	*0.07*	12.35***	*0.00*	0.08	*0.97*	2.93**	*0.03*
Bank equity ~→ Chemicals, healthcare and pharma	1.63	*0.18*	0.27	*0.85*	1.90	*0.13*	0.18	*0.91*
Chemicals, healthcare and pharma ~→ Bank equity	0.49	*0.69*	0.16	*0.92*	4.04***	*0.01*	1.05	*0.37*
Bank equity ~→ Commerce and consumer	0.73	*0.54*	1.77	*0.15*	2.00	*0.11*	0.52	*0.67*
Commerce and consumer ~→ Bank equity	0.08	*0.97*	1.60	*0.19*	3.46**	*0.02*	0.19	*0.90*
Bank equity ~→ Construction and logistics	0.53	*0.66*	0.75	*0.52*	0.70	*0.55*	0.23	*0.87*
Construction and logistics ~→ Bank equity	0.13	*0.94*	1.23	*0.30*	1.22	*0.30*	0.70	*0.55*
Bank equity ~→ Energy and utilities	0.06	*0.98*	0.88	*0.45*	1.75	*0.16*	0.90	*0.44*
Energy and utilities ~→ Bank equity	3.88***	*0.01*	6.46***	*0.00*	1.72	*0.16*	1.45	*0.23*
Bank equity ~→ Financial services (excl. banking)	1.66	*0.17*	0.71	*0.55*	0.50	*0.68*	1.08	*0.36*
Financial services (excl. banking) ~→ Bank equity	0.61	*0.61*	3.10**	*0.03*	2.24*	*0.08*	1.72	*0.16*
Bank equity ~→ Industrial	0.43	*0.73*	1.98	*0.12*	1.65	*0.18*	0.43	*0.73*
Industrial ~→ Bank equity	1.35	*0.26*	2.15*	*0.09*	1.61	*0.19*	0.61	*0.61*
Bank equity ~→ Telecommunication, media and tech.	0.01	*1.00*	1.08	*0.36*	0.65	*0.58*	0.58	*0.63*
Telecommunication, media and tech. ~→ Bank equity	0.50	*0.68*	4.03***	*0.01*	2.83**	*0.04*	0.53	*0.66*
Bank equity ~→ Overall corporate sector	1.73	*0.16*	0.60	*0.62*	0.48	*0.69*	0.97	*0.41*
Overall corporate sector ~→ Bank equity	0.56	*0.64*	3.11**	*0.03*	2.25*	*0.08*	1.71	*0.16*

Asia-Pacific

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	0.20	*0.90*	3.63**	*0.01*	3.68**	*0.01*	1.32	*0.27*
Automotive ~→ Bank equity	0.58	*0.63*	1.50	*0.22*	2.37*	*0.07*	1.26	*0.29*
Bank equity ~→ Basic materials	0.07	*0.98*	0.44	*0.73*	7.64***	*0.00*	0.60	*0.62*
Basic materials ~→ Bank equity	0.41	*0.74*	1.26	*0.29*	6.14***	*0.00*	1.46	*0.23*
Bank equity ~→ Chemicals, healthcare and pharma	0.15	*0.93*	0.74	*0.53*	1.88	*0.13*	0.91	*0.44*
Chemicals, healthcare and pharma ~→ Bank equity	0.51	*0.68*	0.67	*0.57*	2.91**	*0.03*	1.65	*0.18*
Bank equity ~→ Commerce and consumer	2.08	*0.10*	0.77	*0.51*	0.36	*0.78*	2.28*	*0.08*
Commerce and consumer ~→ Bank equity	0.95	*0.42*	2.21*	*0.09*	5.37***	*0.00*	2.88**	*0.04*
Bank equity ~→ Construction and logistics	0.17	*0.92*	0.35	*0.79*	1.36	*0.25*	1.94	*0.12*
Construction and logistics ~→ Bank equity	2.74**	*0.04*	0.95	*0.42*	1.24	*0.29*	0.88	*0.45*
Bank equity ~→ Energy and utilities	0.40	*0.75*	0.91	*0.44*	7.10***	*0.00*	1.57	*0.20*
Energy and utilities ~→ Bank equity	3.01**	*0.03*	1.48	*0.22*	5.84***	*0.00*	3.84***	*0.01*
Bank equity ~→ Financial services (excl. banking)	1.53	*0.21*	0.98	*0.40*	2.06	*0.10*	0.31	*0.82*
Financial services (excl. banking) ~→ Bank equity	3.64**	*0.01*	2.39*	*0.07*	1.30	*0.27*	0.74	*0.53*
Bank equity ~→ Industrial	2.44*	*0.06*	4.16***	*0.01*	5.89***	*0.00*	5.29***	*0.00*
Industrial ~→ Bank equity	1.15	*0.33*	10.02***	*0.00*	2.48*	*0.06*	2.96**	*0.03*
Bank equity ~→ Telecommunication, media and tech.	1.24	*0.29*	1.06	*0.36*	1.11	*0.34*	2.27*	*0.08*
Telecommunication, media and tech. ~→ Bank equity	0.92	*0.43*	4.48***	*0.00*	11.75***	*0.00*	4.54***	*0.00*
Bank equity ~→ Overall corporate sector	2.09	*0.10*	0.53	*0.66*	0.66	*0.58*	4.63***	*0.00*
Overall corporate sector ~→ Bank equity	0.62	*0.60*	4.25***	*0.01*	11.88***	*0.00*	5.53***	*0.00*

Europe

	Period 1		Period 2		Period 3		Period 4	
Causality direction	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*	*F-Stat*	*p-val*
Bank equity ~→ Automotive	1.79	*0.15*	1.82	*0.14*	1.32	*0.27*	1.34	*0.26*
Automotive ~→ Bank equity	0.06	*0.98*	2.56*	*0.06*	0.49	*0.69*	0.51	*0.68*
Bank equity ~→ Basic materials	1.03	*0.38*	0.32	*0.81*	1.35	*0.26*	1.72	*0.16*
Basic materials ~→ Bank equity	2.25*	*0.08*	6.75***	*0.00*	0.16	*0.92*	1.32	*0.27*
Bank equity ~→ Chemicals, healthcare and pharma	0.13	*0.94*	0.16	*0.92*	1.97	*0.12*	1.26	*0.29*
Chemicals, healthcare and pharma ~→ Bank equity	1.62	*0.18*	1.49	*0.22*	1.37	*0.25*	2.21*	*0.09*
Bank equity ~→ Commerce and consumer	2.13*	*0.10*	0.59	*0.63*	2.29*	*0.08*	0.85	*0.47*
Commerce and consumer ~→ Bank equity	0.39	*0.76*	1.93	*0.12*	0.58	*0.63*	3.74**	*0.01*
Bank equity ~→ Construction and logistics	1.36	*0.25*	0.71	*0.55*	0.66	*0.58*	2.06	*0.11*
Construction and logistics ~→ Bank equity	0.83	*0.48*	0.90	*0.44*	0.49	*0.69*	0.98	*0.40*
Bank equity ~→ Energy and utilities	1.40	*0.24*	2.41*	*0.07*	2.52*	*0.06*	1.18	*0.32*
Energy and utilities ~→ Bank equity	1.26	*0.29*	1.92	*0.13*	0.53	*0.66*	2.36*	*0.07*
Bank equity ~→ Financial services (excl. banking)	0.70	*0.56*	0.64	*0.59*	1.65	*0.18*	2.29*	*0.08*
Financial services (excl. banking) ~→ Bank equity	0.33	*0.80*	1.06	*0.37*	2.82**	*0.04*	1.72	*0.16*
Bank equity ~→ Industrial	1.44	*0.23*	0.48	*0.69*	3.50**	*0.02*	0.62	*0.60*
Industrial ~→ Bank equity	1.34	*0.26*	3.34**	*0.02*	0.20	*0.90*	1.34	*0.26*
Bank equity ~→ Telecommunication, media and tech.	1.18	*0.32*	0.80	*0.49*	1.83	*0.14*	0.98	*0.40*
Telecommunication, media and tech. ~→ Bank equity	2.05	*0.11*	6.84***	*0.00*	1.03	*0.38*	3.06**	*0.03*
Bank equity ~→ Overall corporate sector	0.14	*0.94*	1.04	*0.38*	1.67	*0.17*	0.63	*0.59*
Overall corporate sector ~→ Bank equity	0.87	*0.46*	3.12**	*0.03*	0.22	*0.88*	2.51*	*0.06*

Notes: We evaluate the null hypothesis that the bank equity prices in region *i* do *not* impact the corporate equity prices in the same region, i.e., $H_0 : equity_i^{bank} \sim\!\!\rightarrow equity_i^{corp}$, using the F-Statistic. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively.

Table 36: Correlation between bank and corporate CDS spreads

		Average correlation with bank CDS spreads			
Region	Industry	*Period 1*	*Period 2*	*Period 3*	*Period 4*
America	Automotive	24.60%	59.95%	59.57%	59.73%
	Basic materials	6.63%	49.93%	62.48%	51.10%
	Chemicals, healthcare and pharma	16.69%	57.73%	63.18%	49.90%
	Commerce and consumer	26.47%	64.41%	70.52%	56.91%
	Construction and logistics	11.81%	47.94%	54.06%	41.62%
	Energy and utilities	24.45%	59.71%	64.67%	56.39%
	Financial services (excl. banking)	34.32%	63.88%	71.25%	68.48%
	Industrial	16.92%	59.59%	67.41%	59.71%
	Telecommunication, media and technology	27.13%	62.95%	67.41%	60.68%
	Overall	32.72%	68.65%	73.95%	66.25%
Asia-Pacific	Automotive	5.75%	39.94%	51.21%	54.09%
	Basic materials	2.17%	48.85%	60.68%	66.98%
	Chemicals, healthcare and pharma	-3.19%	25.48%	52.80%	44.64%
	Commerce and consumer	15.61%	51.53%	57.21%	59.57%
	Construction and logistics	10.80%	32.21%	46.24%	52.91%
	Energy and utilities	13.50%	32.50%	48.06%	53.50%
	Financial services (excl. banking)	9.53%	29.88%	48.35%	56.36%
	Industrial	8.23%	42.49%	56.19%	52.13%
	Telecommunication, media and technology	13.63%	51.97%	60.73%	65.10%
	Overall	16.11%	56.17%	73.90%	71.25%
Europe	Automotive	17.17%	66.39%	71.12%	77.47%
	Basic materials	9.29%	60.72%	69.34%	71.25%
	Chemicals, healthcare and pharma	1.81%	64.79%	73.87%	70.73%
	Commerce and consumer	17.82%	66.92%	81.13%	77.60%
	Construction and logistics	4.73%	60.31%	65.58%	52.98%
	Energy and utilities	12.71%	67.84%	79.22%	75.76%
	Financial services (excl. banking)	26.66%	69.94%	76.88%	85.08%
	Industrial	11.57%	66.37%	78.58%	76.58%
	Telecommunication, media and technology	15.13%	66.87%	76.73%	80.54%
	Overall	24.15%	73.60%	84.53%	84.63%

Notes: The table shows the correlation between banking sector CDS spreads and the CDS spreads of the non-bank corporate firms during the four sub-periods. Period 1 ranges from November 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 37: Correlation between bank and corporate equity returns

		Average correlation with bank equity returns			
Region	Industry	*Period 1*	*Period 2*	*Period 3*	*Period 4*
America	Automotive	55.81%	69.62%	52.82%	56.14%
	Basic materials	34.59%	39.58%	50.21%	53.42%
	Chemicals, healthcare and pharma	70.60%	72.28%	62.26%	66.41%
	Commerce and consumer	81.66%	84.17%	68.73%	69.96%
	Construction and logistics	63.68%	77.09%	67.87%	62.78%
	Energy and utilities	39.68%	57.76%	61.65%	66.82%
	Financial services (excl. banking)	75.07%	85.74%	82.68%	77.52%
	Industrial	74.21%	80.83%	73.99%	71.61%
	Telecommunication, media and technology	79.23%	78.81%	71.81%	73.81%
	Overall	81.54%	84.72%	77.17%	75.70%
Asia-Pacific	Automotive	62.60%	68.06%	62.43%	65.15%
	Basic materials	62.10%	64.55%	69.11%	72.38%
	Chemicals, healthcare and pharma	57.82%	64.71%	59.40%	62.07%
	Commerce and consumer	69.29%	72.07%	71.29%	74.05%
	Construction and logistics	57.66%	65.95%	56.90%	64.77%
	Energy and utilities	56.91%	61.71%	64.14%	68.57%
	Financial services (excl. banking)	53.81%	65.93%	66.03%	61.52%
	Industrial	71.26%	69.08%	74.54%	74.19%
	Telecommunication, media and technology	72.95%	74.58%	75.68%	73.60%
	Overall	79.60%	80.76%	81.69%	81.66%
Europe	Automotive	71.27%	76.87%	76.83%	63.40%
	Basic materials	69.71%	70.14%	76.19%	65.25%
	Chemicals, healthcare and pharma	75.21%	76.20%	72.67%	60.78%
	Commerce and consumer	79.33%	80.57%	75.11%	62.42%
	Construction and logistics	60.98%	66.73%	75.25%	71.69%
	Energy and utilities	66.85%	62.49%	70.18%	75.28%
	Financial services (excl. banking)	84.62%	88.72%	88.80%	83.05%
	Industrial	78.11%	78.46%	81.05%	69.54%
	Telecommunication, media and technology	74.73%	76.09%	75.07%	73.73%
	Overall	89.60%	85.68%	85.91%	77.54%

Notes: The table shows the correlation between banking sector equity returns and the equity returns of the non-bank corporate firms during the four sub-periods. Period 1 ranges from November 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Table 38: Regression of relative ESS-indicator on p-value of F-statistic

Region	Independent variables	Regression 1		Regression 2	
		Coeff	*P-val*	*Coeff*	*P-val*
America	Constant	0.08	*0.0%*	1.16	*0.0%*
	Regional_rel_ESS	-2.79	*0.0%*	-2.50	*0.3%*
	Stock_index			-0.14	*0.0%*
	Federal_funds_rate			0.02	*0.0%*
	Adjusted_R²	*0.19*		*0.45*	
Asia-Pacific	Constant	0.18	*0.0%*	-2.24	*0.0%*
	Regional_rel_ESS	-1.66	*0.0%*	6.05	*8.5%*
	Stock_index			0.51	*0.0%*
	Federal_funds_rate			-0.01	*4.2%*
	Adjusted_R²	*0.30*		*0.38*	
Europe	Constant	0.53	*0.0%*	0.55	*5.0%*
	Regional_rel_ESS	-5.89	*0.0%*	-2.92	*0.0%*
	Stock_index			0.03	*38.5%*
	Federal_funds_rate			0.08	*0.0%*
	Adjusted_R²	*0.49*		*0.63*	

Notes: The table shows the results from the regressions of the p-value of the F-Statistic from the banking vs. cross-industry (i.e., overall) corporate CDS Granger-causality analysis using the regional relative ESS-indicator (and control variables) as explanatory variables. *Coeff* denotes the value of the estimated coefficient and *P-val* denotes the p-value of the coefficient's t-statistic. The regression equation is estimated using White (1980) heteroskedasticity-consistent estimators.

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APPENDIX

Appendix A: Relationship between asset and equity correlations[157]

In the Merton (1974) framework, the market value of the firm's assets are characterized by the following stochastic process:

$$dV = \mu V dt + \sigma V dW \tag{8}$$

with V denoting the firm's asset value, μ and σ are the drift rate and volatility of the stochastic process, respectively. W denotes a Wiener process. The liability side of the firm's balance sheet consists of only two liabilities, namely equity and debt. The debt has a book value of X and a matures at time T. By interpreting the equity as a call option on the firm's assets, Merton (1974) applies the well-known Black-Scholes-Merton equation for pricing European options to show that he equity value is determined by

$$E = VN(d_1) - e^{-rT} XN(d_2) \tag{9}$$

where $d_1 \equiv \frac{\ln(V/X) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$, $d_2 = d1 - \sigma\sqrt{T} = \frac{\ln(V/X) + (r - \sigma^2/2)T}{\sigma\sqrt{T}}$ and r denotes the risk-free interest rate.

Under the assumption of constant risk-free interest rate, volatility and constant leverage V/X it can be easily seen that the value of the equity is proportional to the asset value since d_1 and d_2 are constant and V is proportional to X. Consequently, it must hold that $fd(\ln(E)) = fd(\ln(V))$ with fd denoting the first difference. Under this condition the equity return correlation is equal to the asset return correlation:

$$cor\left[fd(\ln(E_1)), fd(\ln(E_2)) \right] = cor\left[fd(\ln(V_1)), fd(\ln(V_2)) \right]. \tag{10}$$

[157] This appendix is based on Huang/Zhou/Zhu (2009), p. 2047 (Appendix A).

Appendix B: Sample entities in the non-bank corporate sample

Region	Country	Entity name	Industry
America	Canada	Agrium	Commerce and consumer
America	Canada	Barrick Gold	Basic materials
America	Canada	Bell Canadian Enterprises	Telecommunication, media and technology
America	Canada	Bombardier	Industrial
America	Canada	Brookfield Asset Management	Financial services (excl. banking)
America	Canada	Canadian Natural Resources Limited	Basic materials
America	Canada	Canadian National Railway	Construction and logistics
America	Canada	Canadian Pacific Railway	Construction and logistics
America	Canada	Celestica	Industrial
America	Canada	Enbridge	Energy and utilities
America	Canada	Encana	Energy and utilities
America	Canada	Fairfax Financial Holdings	Financial services (excl. banking)
America	Canada	Methanex	Basic materials
America	Canada	Nexen	Energy and utilities
America	Canada	Norbord	Industrial
America	Canada	Potash Corporation	Basic materials
America	Canada	Shaw Communications	Telecommunication, media and technology
America	Canada	Suncor Energy	Basic materials
America	Canada	Talisman Energy	Energy and utilities
America	Canada	Teck Resources	Basic materials
America	Canada	Telus Corp	Telecommunication, media and technology
America	Canada	TransCanada	Energy and utilities
America	US	3M	Chemicals, healthcare and pharma
America	US	Abbott Laboratories	Chemicals, healthcare and pharma
America	US	ACE Limited	Financial services (excl. banking)
America	US	Aetna	Chemicals, healthcare and pharma
America	US	Alcoa	Basic materials
America	US	Altria	Commerce and consumer
America	US	Allstate	Financial services (excl. banking)
America	US	AmerisourceBergen	Chemicals, healthcare and pharma
America	US	Amgen	Telecommunication, media and technology
America	US	Anadarko Petroleum Corporation	Energy and utilities
America	US	Archer Daniels Midland	Commerce and consumer
America	US	AT&T	Telecommunication, media and technology
America	US	AutoZone	Automotive
America	US	Avnet	Commerce and consumer
America	US	Baxter International	Chemicals, healthcare and pharma
America	US	Berkshire Hathaway	Financial services (excl. banking)
America	US	Best Buy	Commerce and consumer
America	US	Black & Decker	Commerce and consumer
America	US	Boeing	Industrial
America	US	Bristol-Myers Squibb	Chemicals, healthcare and pharma
America	US	Bunge	Commerce and consumer
America	US	CA, Inc.	Telecommunication, media and technology
America	US	Campbell Soup	Commerce and consumer

Region	Country	Entity name	Industry
America	US	Cardinal Health	Chemicals, healthcare and pharma
America	US	Carnival Corporation	Construction and logistics
America	US	Caterpillar	Industrial
America	US	CBS Corporation	Telecommunication, media and technology
America	US	Chevron	Energy and utilities
America	US	Chubb Corp	Financial services (excl. banking)
America	US	Cigna	Chemicals, healthcare and pharma
America	US	Cisco	Telecommunication, media and technology
America	US	Coca Cola	Commerce and consumer
America	US	Comcast	Telecommunication, media and technology
America	US	ConAgra Foods	Commerce and consumer
America	US	Constellation Energy	Energy and utilities
America	US	Costco Wholesale	Commerce and consumer
America	US	CSX Corporation	Industrial
America	US	CVS Caremark	Chemicals, healthcare and pharma
America	US	Darden Restaurants	Commerce and consumer
America	US	Deere & Company	Industrial
America	US	Dell	Telecommunication, media and technology
America	US	Devon Energy	Energy and utilities
America	US	DIRECTV Holdings	Telecommunication, media and technology
America	US	Dominion Resources	Energy and utilities
America	US	Dow Chemical	Chemicals, healthcare and pharma
America	US	Duke Energy Carolinas	Energy and utilities
America	US	Du Pont	Chemicals, healthcare and pharma
America	US	Eastman Chemical Company	Chemicals, healthcare and pharma
America	US	Enterprise Products	Energy and utilities
America	US	Express Scripts	Chemicals, healthcare and pharma
America	US	Exxon Mobil	Energy and utilities
America	US	FedEx	Construction and logistics
America	US	FirstEnergy	Energy and utilities
America	US	Ford	Automotive
America	US	Fortune Brands	Commerce and consumer
America	US	General Dynamics	Industrial
America	US	General Electric	Industrial
America	US	General Mills	Commerce and consumer
America	US	Goodrich	Industrial
America	US	Halliburton	Energy and utilities
America	US	Hartford Financial Services	Financial services (excl. banking)
America	US	Hess	Energy and utilities
America	US	Hewlett-Packard	Telecommunication, media and technology
America	US	Home Depot	Commerce and consumer
America	US	Honeywell	Industrial
America	US	Humana	Chemicals, healthcare and pharma
America	US	IBM	Telecommunication, media and technology
America	US	Ingersoll-Rand	Industrial
America	US	International Paper	Industrial
America	US	Johnson & Johnson	Chemicals, healthcare and pharma

Region	Country	Entity name	Industry
America	US	Johnson Controls	Industrial
America	US	Kinder Morgan	Energy and utilities
America	US	Kraft Foods	Commerce and consumer
America	US	Kroger	Automotive
America	US	Liberty Mutual	Financial services (excl. banking)
America	US	Lockheed Martin	Industrial
America	US	Loews Corporation	Financial services (excl. banking)
America	US	Lowe's	Commerce and consumer
America	US	Marathon Oil	Energy and utilities
America	US	Marriott International	Commerce and consumer
America	US	Marsh & McLennan	Financial services (excl. banking)
America	US	McDonalds	Commerce and consumer
America	US	McKesson	Chemicals, healthcare and pharma
America	US	MedCo Health	Chemicals, healthcare and pharma
America	US	Merck & Co	Chemicals, healthcare and pharma
America	US	Motorola	Telecommunication, media and technology
America	US	Newell Rubbermaid	Commerce and consumer
America	US	Norfolk Southern	Industrial
America	US	Northrop Grumman	Industrial
America	US	Omnicom Group	Telecommunication, media and technology
America	US	PepsiCo	Commerce and consumer
America	US	Pfizer	Chemicals, healthcare and pharma
America	US	Pitney Bowes	Telecommunication, media and technology
America	US	Procter & Gamble	Commerce and consumer
America	US	Progress Energy	Energy and utilities
America	US	Prudential Financial	Financial services (excl. banking)
America	US	Quest Diagnostics	Chemicals, healthcare and pharma
America	US	R.R. Donneley	Telecommunication, media and technology
America	US	Raytheon Company	Industrial
America	US	Reynolds American	Commerce and consumer
America	US	Ryder System	Industrial
America	US	Safeway Inc.	Commerce and consumer
America	US	Sara Lee	Commerce and consumer
America	US	Sears	Commerce and consumer
America	US	Sempra Energy	Energy and utilities
America	US	Sherwin-Williams	Industrial
America	US	Simon Property	Financial services (excl. banking)
America	US	SLM Corp	Financial services (excl. banking)
America	US	Southwest Airlines	Commerce and consumer
America	US	Sprint Nextel	Telecommunication, media and technology
America	US	Sunoco	Energy and utilities
America	US	Supervalu	Commerce and consumer
America	US	Sysco	Commerce and consumer
America	US	Target Corp	Commerce and consumer
America	US	Time Warner	Telecommunication, media and technology
America	US	TJX Companies	Commerce and consumer
America	US	Toll Brothers	Industrial

Region	Country	Entity name	Industry
America	US	Transocean	Telecommunication, media and technology
America	US	Travellers Companies	Financial services (excl. banking)
America	US	Tyson Foods	Commerce and consumer
America	US	UnitedHealth Group	Chemicals, healthcare and pharma
America	US	United Technologies	Industrial
America	US	Union Pacific	Industrial
America	US	United Parcel Service	Construction and logistics
America	US	Valero Energy Corporation	Energy and utilities
America	US	Verizon	Telecommunication, media and technology
America	US	Viacom	Telecommunication, media and technology
America	US	Vornado Realty	Financial services (excl. banking)
America	US	Wal-Mart	Commerce and consumer
America	US	Walt Disney	Telecommunication, media and technology
America	US	Wellpoint	Chemicals, healthcare and pharma
America	US	Whirlpool	Commerce and consumer
America	US	Xerox	Telecommunication, media and technology
America	US	XL Group	Financial services (excl. banking)
America	US	YUM! Brands	Commerce and consumer
Asia-Pacific	Australia	Amcor	Industrial
Asia-Pacific	Australia	AMP Limited	Financial services (excl. banking)
Asia-Pacific	Australia	BHP Billiton	Basic materials
Asia-Pacific	Australia	CSR Limited	Industrial
Asia-Pacific	Australia	Fairfax Media	Telecommunication, media and technology
Asia-Pacific	Australia	Foster's Group	Commerce and consumer
Asia-Pacific	Australia	GPT Group	Construction and logistics
Asia-Pacific	Australia	Lend Lease Group	Construction and logistics
Asia-Pacific	Australia	Qantas	Commerce and consumer
Asia-Pacific	Australia	QBE Insurance	Financial services (excl. banking)
Asia-Pacific	Australia	Rio Tinto	Basic materials
Asia-Pacific	Australia	Telstra	Chemicals, healthcare and pharma
Asia-Pacific	Australia	Wesfarmers	Commerce and consumer
Asia-Pacific	Australia	Woodside Petroleum	Energy and utilities
Asia-Pacific	Australia	Woolworths	Commerce and consumer
Asia-Pacific	China	China Mobile Limited	Telecommunication, media and technology
Asia-Pacific	Hong Kong	Hutchison Whampoa	Industrial
Asia-Pacific	Hong Kong	Noble Group	Basic materials
Asia-Pacific	India	Reliance Industries	Energy and utilities
Asia-Pacific	India	Tata Group	Industrial
Asia-Pacific	Japan	Aeon	Commerce and consumer
Asia-Pacific	Japan	All Nippon Airways	Commerce and consumer
Asia-Pacific	Japan	Bridgestone	Automotive
Asia-Pacific	Japan	Canon	Telecommunication, media and technology
Asia-Pacific	Japan	Chubu Electric Power	Energy and utilities
Asia-Pacific	Japan	East Japan Railway	Commerce and consumer
Asia-Pacific	Japan	Fujitsu	Telecommunication, media and technology
Asia-Pacific	Japan	Hitachi	Telecommunication, media and technology
Asia-Pacific	Japan	Honda Motor	Automotive

Region	Country	Entity name	Industry
Asia-Pacific	Japan	Itochu	Commerce and consumer
Asia-Pacific	Japan	Japan Tobaccco	Commerce and consumer
Asia-Pacific	Japan	JFE Steel	Basic materials
Asia-Pacific	Japan	Kansai Electric Power	Energy and utilities
Asia-Pacific	Japan	Kawasaki Heavy Industries	Industrial
Asia-Pacific	Japan	Komatsu	Industrial
Asia-Pacific	Japan	KDDI Corporation	Telecommunication, media and technology
Asia-Pacific	Japan	Mazda	Automotive
Asia-Pacific	Japan	Marubeni	Commerce and consumer
Asia-Pacific	Japan	Mitsubishi Group	Industrial
Asia-Pacific	Japan	Mitsui	Industrial
Asia-Pacific	Japan	NEC	Telecommunication, media and technology
Asia-Pacific	Japan	Nippon Paper Group	Industrial
Asia-Pacific	Japan	Nippon Steel	Basic materials
Asia-Pacific	Japan	Nippon Telegraph & Telephone	Telecommunication, media and technology
Asia-Pacific	Japan	Nissan Motor	Automotive
Asia-Pacific	Japan	Sharp	Telecommunication, media and technology
Asia-Pacific	Japan	Softbank	Telecommunication, media and technology
Asia-Pacific	Japan	Sony	Telecommunication, media and technology
Asia-Pacific	Japan	Sumitomo Chemicals	Chemicals, healthcare and pharma
Asia-Pacific	Japan	Suzuki	Automotive
Asia-Pacific	Japan	Taisei Corporation	Construction and logistics
Asia-Pacific	Japan	Tokyo Gas	Energy and utilities
Asia-Pacific	Japan	Toshiba	Telecommunication, media and technology
Asia-Pacific	Japan	Toyota	Automotive
Asia-Pacific	Korea	GS Caltex	Energy and utilities
Asia-Pacific	Korea	Hyundai Motor	Automotive
Asia-Pacific	Korea	Hynix	Chemicals, healthcare and pharma
Asia-Pacific	Korea	Korea Electric Power	Energy and utilities
Asia-Pacific	Korea	KT Corp	Telecommunication, media and technology
Asia-Pacific	Korea	LG Electronics	Telecommunication, media and technology
Asia-Pacific	Korea	POSCO	Basic materials
Asia-Pacific	Korea	Samsung	Telecommunication, media and technology
Asia-Pacific	Korea	SK Holdings	Energy and utilities
Asia-Pacific	Malaysia	Telekom Malaysia	Telecommunication, media and technology
Asia-Pacific	Singapore	CapitaLand	Financial services (excl. banking)
Asia-Pacific	Singapore	Flextronics	Telecommunication, media and technology
Asia-Pacific	Singapore	Genting Group	Commerce and consumer
Asia-Pacific	Singapore	Singapore Telecommunications	Telecommunication, media and technology
Europe	Austria	Telekom Austria	Telecommunication, media and technology
Europe	Belgium	Anheuser-Busch InBev	Commerce and consumer
Europe	Belgium	Solvay	Chemicals, healthcare and pharma
Europe	Denmark	Carlsberg	Commerce and consumer
Europe	Finnland	Fortum	Energy and utilities
Europe	Finnland	Metso	Industrial
Europe	Finnland	M-Real	Industrial
Europe	Finnland	Nokia	Telecommunication, media and technology

Region	Country	Entity name	Industry
Europe	Finnland	Stora Enso	Industrial
Europe	France	Air France KLM Group	Commerce and consumer
Europe	France	Air Liquide-SA	Chemicals, healthcare and pharma
Europe	France	Alstom	Industrial
Europe	France	Axa	Financial services (excl. banking)
Europe	France	Bouygues	Construction and logistics
Europe	France	Carrefour	Commerce and consumer
Europe	France	Compagnie de Saint-Gobain	Basic materials
Europe	France	Danone	Commerce and consumer
Europe	France	France Telecom	Telecommunication, media and technology
Europe	France	GDF Suez	Commerce and consumer
Europe	France	Groupe Casino	Commerce and consumer
Europe	France	L'Oreal	Commerce and consumer
Europe	France	LVMH	Commerce and consumer
Europe	France	Peugeot	Automotive
Europe	France	PPR	Commerce and consumer
Europe	France	Publicis	Telecommunication, media and technology
Europe	France	Renault	Automotive
Europe	France	Sanofi-Aventis	Chemicals, healthcare and pharma
Europe	France	Schneider Electric	Industrial
Europe	France	Total	Energy and utilities
Europe	France	Unibail-Rodamco	Financial services (excl. banking)
Europe	France	Veolia Environnement	Energy and utilities
Europe	France	Vinci	Construction and logistics
Europe	France	Vivendi	Telecommunication, media and technology
Europe	Germany	Adidas	Commerce and consumer
Europe	Germany	Allianz	Financial services (excl. banking)
Europe	Germany	BASF	Chemicals, healthcare and pharma
Europe	Germany	Bayer	Chemicals, healthcare and pharma
Europe	Germany	BMW	Automotive
Europe	Germany	Continental	Automotive
Europe	Germany	Daimler	Automotive
Europe	Germany	Deutsche Lufthansa	Commerce and consumer
Europe	Germany	Deutsche Post	Construction and logistics
Europe	Germany	Deutsche Telekom	Telecommunication, media and technology
Europe	Germany	E.ON	Energy and utilities
Europe	Germany	ENBW	Energy and utilities
Europe	Germany	Fresenius Medical	Chemicals, healthcare and pharma
Europe	Germany	Hannover Re	Financial services (excl. banking)
Europe	Germany	Henkel	Chemicals, healthcare and pharma
Europe	Germany	Lanxess	Chemicals, healthcare and pharma
Europe	Germany	Linde	Chemicals, healthcare and pharma
Europe	Germany	Metro	Commerce and consumer
Europe	Germany	RWE	Energy and utilities
Europe	Germany	Siemens	Industrial
Europe	Germany	Suedzuckker	Commerce and consumer
Europe	Germany	ThyssenKrupp	Industrial

Region	Country	Entity name	Industry
Europe	Germany	Volkswagen	Automotive
Europe	Greece	Hellenic Telecom	Telecommunication, media and technology
Europe	Italy	Assicurazioni Generali	Financial services (excl. banking)
Europe	Italy	ENI	Energy and utilities
Europe	Italy	Enel	Energy and utilities
Europe	Italy	Fiat	Automotive
Europe	Italy	Finmeccanica	Industrial
Europe	Italy	Telecom Italia	Telecommunication, media and technology
Europe	Netherlands	Aegon	Financial services (excl. banking)
Europe	Netherlands	Ahold	Commerce and consumer
Europe	Netherlands	AkzoNobel	Chemicals, healthcare and pharma
Europe	Netherlands	EADS	Industrial
Europe	Netherlands	DSM	Chemicals, healthcare and pharma
Europe	Netherlands	KPN	Telecommunication, media and technology
Europe	Netherlands	Philips	Telecommunication, media and technology
Europe	Netherlands	TNT	Construction and logistics
Europe	Netherlands	WoltersKluwer	Telecommunication, media and technology
Europe	Norway	Norske Skog	Industrial
Europe	Norway	Statoil	Energy and utilities
Europe	Norway	Telenor	Telecommunication, media and technology
Europe	Portugal	Brisa-Auto-Estradas	Construction and logistics
Europe	Portugal	Energias de Portugal	Energy and utilities
Europe	Portugal	Portugal Telecom	Telecommunication, media and technology
Europe	Spain	Endesa	Energy and utilities
Europe	Spain	Gas Natural	Energy and utilities
Europe	Spain	Iberdrola	Energy and utilities
Europe	Spain	Repsol YPF	Energy and utilities
Europe	Spain	Telefonica	Telecommunication, media and technology
Europe	Sweden	Electrolux	Commerce and consumer
Europe	Sweden	Svenska Cellulosa	Commerce and consumer
Europe	Sweden	TeliaSonera	Telecommunication, media and technology
Europe	Sweden	Volvo	Automotive
Europe	Switzerland	ABB	Industrial
Europe	Switzerland	Adecco	Industrial
Europe	Switzerland	Holcim	Basic materials
Europe	Switzerland	Nestlé	Commerce and consumer
Europe	Switzerland	Novartis	Chemicals, healthcare and pharma
Europe	Switzerland	Roche	Chemicals, healthcare and pharma
Europe	Switzerland	STMicroelectronics	Telecommunication, media and technology
Europe	Switzerland	Swiss Reinsurance	Financial services (excl. banking)
Europe	Switzerland	Xstrata	Basic materials
Europe	UK	AngloAmerican	Basic materials
Europe	UK	AstraZeneca	Chemicals, healthcare and pharma
Europe	UK	Aviva	Financial services (excl. banking)
Europe	UK	BAE Systems	Industrial
Europe	UK	BP	Energy and utilities
Europe	UK	British American Tobacco	Commerce and consumer

Region	Country	Entity name	Industry
Europe	UK	British Telecommunications	Telecommunication, media and technology
Europe	UK	Centrica	Energy and utilities
Europe	UK	Compass Group	Commerce and consumer
Europe	UK	Diageo	Commerce and consumer
Europe	UK	GlaxoSmithKline	Chemicals, healthcare and pharma
Europe	UK	Imperial Tobacco	Commerce and consumer
Europe	UK	J. Sainsbury's	Commerce and consumer
Europe	UK	Kingfisher PLC	Commerce and consumer
Europe	UK	Legal & General	Financial services (excl. banking)
Europe	UK	Marks and Spencer	Commerce and consumer
Europe	UK	National Grid	Energy and utilities
Europe	UK	Next PLC	Commerce and consumer
Europe	UK	Old Mutual	Financial services (excl. banking)
Europe	UK	Pearson	Telecommunication, media and technology
Europe	UK	Prudential	Financial services (excl. banking)
Europe	UK	Reed Elsevier	Telecommunication, media and technology
Europe	UK	Rentokil Initial	Industrial
Europe	UK	Rolls-Royce	Automotive
Europe	UK	Royal Dutch Shell	Energy and utilities
Europe	UK	Safeway / WM Morrisons	Commerce and consumer
Europe	UK	Tate & Lyle	Commerce and consumer
Europe	UK	Tesco	Commerce and consumer
Europe	UK	Unilever	Commerce and consumer
Europe	UK	United Utilities	Energy and utilities
Europe	UK	Vodafone	Telecommunication, media and technology

Appendix C: Unit root test results for the regional relative ESS-indicator

Period	Relative ESS-Indicator	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	America	-0.20	-0.19	1.53***	-28.81***	-30.91***	0.02
	Asia-Pacific	-0.13	0.09	0.36***	-30.74***	-35.44***	0.00
	Europe	-0.22	-0.11	2.91***	-32.21***	-35.93***	0.01
	Middle East & Russia	-0.07	0.01	3.25***	-24.80***	-25.65***	0.01
Period 2	America	-1.41	-1.50	2.72***	-21.97***	-21.94***	0.05
	Asia-Pacific	-1.13	-1.38	1.50***	-26.13***	-26.43***	0.05
	Europe	-1.56	-1.76*	4.45***	-25.27***	-25.03***	0.05
	Middle East & Russia	-0.75	-0.81	4.22***	-22.68***	-22.77***	0.03
Period 3	America	0.18	0.15	6.29***	-17.16***	-17.14***	0.03
	Asia-Pacific	-0.18	-0.18	4.57***	-19.50***	-19.50***	0.22***
	Europe	0.03	0.04	3.11***	-19.45***	-19.45***	0.04
	Middle East & Russia	-0.53	-0.50	5.25***	-16.89***	-16.88***	0.24***
Period 4	America	-0.26	-0.26	4.22***	-20.15***	-20.17***	0.02
	Asia-Pacific	-0.61	-0.69	2.88***	-22.46***	-22.67***	0.08
	Europe	-0.37	-0.38	3.50***	-20.56***	-20.55***	0.05
	Middle East & Russia	0.46	0.54	1.30***	-21.86***	-21.92***	0.02

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix D: Unit root test results for regional bank CDS spreads

Period	Regional bank CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	America	0.22	0.22	1.52***	-19.99***	-20.00***	0.10
	Asia-Pacific	0.19	0.34	1.85***	-29.02***	-31.06***	0.01
	Europe	0.78	1.02	1.45***	-22.18***	-22.51***	0.01
	Middle East & Russia	0.12	0.20	3.77***	-21.56***	-21.82***	0.02
Period 2	America	-1.86*	-1.66*	2.87***	-15.49***	-15.48***	0.08
	Asia-Pacific	-2.54**	-2.12**	2.37***	-13.52***	-13.48***	0.17**
	Europe	-2.28**	-2.07**	4.30***	-15.50***	-15.49***	0.09
	Middle East & Russia	-1.14	-1.24	4.92***	-21.31***	-21.33***	0.07
Period 3	America	0.10	0.05	5.70***	-15.12***	-15.08***	0.03
	Asia-Pacific	0.11	0.06	5.09***	-14.24***	-14.22***	0.25***
	Europe	-0.17	-0.18	5.96***	-15.09***	-15.03***	0.04
	Middle East & Russia	-0.94	-0.84	5.25***	-14.60***	-14.54***	0.28***
Period 4	America	-0.31	-0.30	4.34***	-15.58***	-15.54***	0.03
	Asia-Pacific	-0.55	-0.49	2.03***	-14.68***	-14.65***	0.09
	Europe	-0.85	-0.79	2.46***	-16.23***	-16.23***	0.04
	Middle East & Russia	1.09	0.90	1.56***	-15.38***	-15.39***	0.04

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix E: Cointegration test results for regional relative ESS-indicator

Period	Variable 1 Regional ESS_rel	Variable 2 Regional ESS_rel	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	America	Asia-Pacific	114.13***	13.59***	100.54***	13.59***	-7.18***
	America	Europe	60.37***	9.73**	50.63***	9.73**	-6.57***
	America	Middle East & Russia	39.18***	13.68***	25.49***	13.68***	-4.35***
	Asia-Pacific	Europe	85.86***	15.64***	70.23***	15.64***	-8.72***
	Asia-Pacific	Middle East & Russia	79.82***	19.09***	60.73***	19.09***	-8.09***
	Europe	Middle East & Russia	50.07***	12.04**	38.03***	12.04**	-5.60***
Period 2	America	Asia-Pacific	47.06***	2.75	44.31***	2.75	-4.51***
	America	Europe	34.25***	2.81	31.44***	2.81	-4.45***
	America	Middle East & Russia	30.11***	2.76	27.35***	2.76	-4.87***
	Asia-Pacific	Europe	20.73**	3.75	16.98**	3.75	-3.64**
	Asia-Pacific	Middle East & Russia	24.44**	2.11	22.33***	2.11	-4.57***
	Europe	Middle East & Russia	23.67**	3.61	20.06**	3.61	-4.28***
Period 3	America	Asia-Pacific	6.78	0.96	5.83	0.96	-2.32
	America	Europe	17.60	2.15	15.44*	2.15	-3.64**
	America	Middle East & Russia	8.37	1.24	7.13	1.24	-2.18
	Asia-Pacific	Europe	13.55	1.29	12.26	1.29	-2.54
	Asia-Pacific	Middle East & Russia	10.49	1.11	9.38	1.11	-2.63
	Europe	Middle East & Russia	14.63	2.00	12.63	2.00	-2.52
Period 4	America	Asia-Pacific	16.00	3.87	12.13	3.87	-3.45**
	America	Europe	27.28***	4.41	22.87***	4.41	-4.82***
	America	Middle East & Russia	31.08***	8.17*	22.91***	8.17*	-4.27***
	Asia-Pacific	Europe	11.22	4.43	6.79	4.43	-2.07
	Asia-Pacific	Middle East & Russia	15.95	3.59	12.36	3.59	-1.69
	Europe	Middle East & Russia	19.36*	6.02	13.34	6.02	-2.14

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix F: Cointegration test results for regional bank CDS spreads

Period	Variable 1 Regional bank CDS	Variable 2 Regional bank CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	America	Asia-Pacific	48.59***	3.11	45.48***	3.11	-4.13***
	America	Europe	24.22**	3.50	20.71***	3.50	-2.72
	America	Middle East & Russia	25.27***	3.89	21.37***	3.89	-1.99
	Asia-Pacific	Europe	69.70***	3.11	66.59***	3.11	-8.50***
	Asia-Pacific	Middle East & Russia	43.37***	10.40**	32.98***	10.40**	-5.79***
	Europe	Middle East & Russia	18.12*	3.06	15.06*	3.06	-2.52
Period 2	America	Asia-Pacific	87.61***	2.91	84.70***	2.91	-3.52**
	America	Europe	73.61***	2.71	70.90***	2.71	-4.98***
	America	Middle East & Russia	29.93***	3.71	26.22***	3.71	-4.26***
	Asia-Pacific	Europe	26.95***	4.95	22.00***	4.95	-2.55
	Asia-Pacific	Middle East & Russia	25.56***	6.79	18.77**	6.79	-4.27***
	Europe	Middle East & Russia	28.55***	6.03	22.51***	6.03	-4.39***
Period 3	America	Asia-Pacific	6.53	0.35	6.18	0.35	-2.46
	America	Europe	14.48	2.78	11.70	2.78	-3.09*
	America	Middle East & Russia	12.10	1.97	10.13	1.97	-1.94
	Asia-Pacific	Europe	5.91	0.28	5.62	0.28	-1.49
	Asia-Pacific	Middle East & Russia	12.67	0.57	12.10	0.57	-2.06
	Europe	Middle East & Russia	9.05	3.63	5.42	3.63	-2.08
Period 4	America	Asia-Pacific	20.39**	7.53	12.86	7.53	-2.83
	America	Europe	12.45	3.84	8.61	3.84	-2.49
	America	Middle East & Russia	21.32**	3.86	17.46**	3.86	-3.06*
	Asia-Pacific	Europe	23.98**	9.24**	14.74*	9.24**	-1.81
	Asia-Pacific	Middle East & Russia	12.70	4.90	7.79	4.90	-2.01
	Europe	Middle East & Russia	25.15***	5.98	19.17**	5.98	-2.74

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix G: Unit root test results for regional sovereign CDS spreads

Period	Regional sovereign CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	America	0.13	0.24	3.34***	-31.16***	-31.63***	0.01
	Asia-Pacific	0.07	0.15	0.52***	-27.17***	-28.65***	0.00
	Europe	-0.16	-0.08	2.90***	-23.49***	-23.89***	0.01
	Middle East & Russia	0.05	0.10	1.23***	-24.45***	-24.82***	0.01
Period 2	America	-1.20	-1.37	2.89***	-23.10***	-23.19***	0.03
	Asia-Pacific	-0.96	-1.08	1.82***	-22.03***	-22.46***	0.02
	Europe	-0.61	-0.72	1.85***	-26.19***	-26.41***	0.02
	Middle East & Russia	-0.70	-0.84	3.50***	-27.26***	-27.15***	0.04
Period 3	America	-0.97	-1.01	6.38***	-20.26***	-20.27***	0.18**
	Asia-Pacific	-0.55	-0.50	5.83***	-15.11***	-15.20***	0.23***
	Europe	-1.93*	-1.58	6.65***	-13.26***	-13.25***	0.37***
	Middle East & Russia	-1.06	-0.94	5.79***	-14.13***	-14.10***	0.29***
Period 4	America	-0.47	-0.45	1.38***	-16.77***	-16.80***	0.03
	Asia-Pacific	-0.05	-0.05	2.27***	-17.23***	-17.24***	0.06
	Europe	-0.55	-0.51	2.34***	-14.51***	-14.51***	0.04
	Middle East & Russia	0.58	0.55	1.05***	-16.62***	-16.56***	0.03

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix H: Cointegration test for regional sovereign and bank CDS spreads

Period	Variable 1 Sovereign CDS	Variable 2 Bank CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	America	America	43.91***	2.91	41.00***	2.91	-5.72***
		Asia-Pacific	94.87***	12.49**	82.38***	12.49**	-8.64***
		Europe	56.73***	2.67	54.06***	2.67	-7.53***
		Middle East & Russia	53.48***	7.88*	45.61***	7.88*	-6.67***
	Asia-Pacific	America	75.25***	3.02	72.23***	3.02	-8.51***
		Asia-Pacific	104.39***	19.10***	85.29***	19.10***	-9.34***
		Europe	100.66***	3.10	97.56***	3.10	-10.54***
		Middle East & Russia	50.92***	10.76**	40.15***	10.76**	-6.42***
	Europe	America	38.79***	3.06	35.73***	3.06	-6.10***
		Asia-Pacific	53.36***	20.37***	32.99***	20.37***	-5.44***
		Europe	39.20***	3.22	35.97***	3.22	-6.13***
		Middle East & Russia	36.44***	11.02**	25.42***	11.02**	-5.11***
	Middle East & Russia	America	30.19***	3.00	27.19***	3.00	-5.11***
		Asia-Pacific	52.03***	9.26**	42.77***	9.26**	-5.22***
		Europe	35.30***	2.93	32.37***	2.93	-5.77***
		Middle East & Russia	29.81***	7.49	22.32***	7.49	-4.36***
Period 2	America	America	47.80***	3.10	44.70***	3.10	-5.13***
		Asia-Pacific	32.77***	6.13	26.64***	6.13	-4.98***
		Europe	32.72***	5.67	27.05***	5.67	-4.71***
		Middle East & Russia	36.73***	2.80	33.92***	2.80	-5.88***
	Asia-Pacific	America	33.19***	2.80	30.38***	2.80	-4.11***
		Asia-Pacific	32.35***	5.97	26.38***	5.97	-4.90***
		Europe	20.80**	5.40	15.40*	5.40	-3.60**
		Middle East & Russia	22.14**	2.53	19.61**	2.53	-4.21***
	Europe	America	63.38***	3.91	59.48***	3.91	-7.97***
		Asia-Pacific	80.86***	6.47	74.39***	6.47	-8.96***
		Europe	61.43***	5.95	55.48***	5.95	-7.67***
		Middle East & Russia	53.11***	2.33	50.79***	2.33	-7.28***
	Middle East & Russia	America	49.35***	3.56	45.79***	3.56	-5.93***
		Asia-Pacific	41.12***	6.23	34.89***	6.23	-5.91***
		Europe	52.54***	6.00	46.54***	6.00	-7.02***
		Middle East & Russia	36.55***	2.33	34.22***	2.33	-5.96***
Period 3	America	America	6.79	2.23	4.56	2.23	-1.75
		Asia-Pacific	10.03	0.90	9.13	0.90	-1.86
		Europe	9.62	4.40	5.23	4.40	-2.02
		Middle East & Russia	13.27	3.62	9.65	3.62	-2.06
	Asia-Pacific	America	7.36	1.69	5.67	1.69	-2.00
		Asia-Pacific	9.39	0.70	8.69	0.70	-2.18
		Europe	7.40	2.46	4.94	2.46	-1.83
		Middle East & Russia	10.99	3.49	7.50	3.49	-2.40
	Europe	America	11.97	2.15	9.82	2.15	-1.72
		Asia-Pacific	18.33*	3.85	14.48*	3.85	-2.05
		Europe	13.17	3.31	9.85	3.31	-1.75
		Middle East & Russia	22.20**	4.39	17.81**	4.39	-1.11
	Middle East & Russia	America	10.37	1.98	8.38	1.98	-2.14
		Asia-Pacific	11.99	0.68	11.31	0.68	-2.63
		Europe	10.25	4.12	6.13	4.12	-1.97
		Middle East & Russia	14.69	4.81	9.88	4.81	-3.14*

Period	Variable 1 Sovereign CDS	Variable 2 Bank CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 4	America	America	15.84	3.90	11.93	3.90	-2.54
		Asia-Pacific	15.69	5.54	10.15	5.54	-2.50
		Europe	13.63	5.92	7.71	5.92	-2.48
		Middle East & Russia	17.22	5.55	11.67	5.55	-2.91
	Asia-Pacific	America	18.48*	4.15	14.33*	4.15	-3.19*
		Asia-Pacific	22.44**	9.49**	12.94	9.49**	-1.95
		Europe	10.24	2.32	7.92	2.32	-1.69
		Middle East & Russia	16.23	4.63	11.60	4.63	-2.18
	Europe	America	13.07	3.77	9.30	3.77	-1.92
		Asia-Pacific	25.93***	11.96**	13.98*	11.96**	-2.17
		Europe	25.71***	7.70*	18.00**	7.70*	-2.72
		Middle East & Russia	25.72***	5.63	20.09**	5.63	-2.62
	Middle East & Russia	America	19.89*	4.29	15.60*	4.29	-3.09*
		Asia-Pacific	13.09	4.71	8.38	4.71	-2.07
		Europe	17.75	4.71	13.04	4.71	-2.30
		Middle East & Russia	22.80**	5.35	17.45**	5.35	-2.99

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix I: Unit root test results for country sovereign CDS spreads

Period	Sovereign CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	US	0.13	0.24	3.34***	-31.16***	-31.63***	0.01
	Australia	-0.49	-0.29	3.87***	-27.95***	-31.27***	0.00
	China	1.18	1.49	7.45***	-25.47***	-25.63***	0.05
	Hong Kong	0.13	0.29	6.10***	-29.49***	-31.77***	0.01
	India	-0.11	0.02	3.26***	-32.88***	-33.32***	0.01
	Japan	-0.30	-0.29	4.31***	-24.92***	-25.50***	0.01
	Kazakhstan	0.10	0.11	2.78***	-18.65***	-18.64***	0.03
	Korea	0.64	0.74	3.37***	-21.96***	-22.06***	0.03
	Malaysia	0.42	0.51	6.83***	-24.00***	-24.05***	0.03
	Singapore	0.21	0.33	4.09***	-30.63***	-30.89***	0.01
	Austria	-0.10	-0.04	0.44***	-24.09***	-24.70***	0.00
	Belgium	-0.07	0.04	0.32***	-27.28***	-30.56***	0.00
	Denmark	-0.84	-0.69	3.81***	-22.61***	-23.53***	0.01
	France	-0.15	-0.09	0.55***	-25.46***	-26.40***	0.00
	Germany	-0.24	-0.24	3.06***	-27.97***	-29.83***	0.01
	Greece	0.61	0.81	7.26***	-25.97***	-26.43***	0.01
	Ireland	-0.31	-0.21	3.37***	-21.21***	-21.54***	0.01
	Italy	0.22	0.28	6.59***	-21.91***	-22.25***	0.03
	Netherlands	-0.41	-0.31	0.97***	-21.40***	-21.81***	0.01
	Portugal	0.23	0.36	6.59***	-26.56***	-27.49***	0.01
	Spain	-0.25	-0.22	0.31***	-21.96***	-22.13***	0.01
	Sweden	-0.90	-0.67	3.56***	-26.00***	-27.09***	0.00
	Switzerland	-0.13	-0.05	1.91***	-23.84***	-24.28***	0.01
	UK	-0.13	-0.04	1.84***	-23.85***	-24.30***	0.01
	Bahrain	-0.34	-0.22	2.47***	-24.28***	-24.84***	0.00
	Qatar	0.32	0.40	6.42***	-21.68***	-21.92***	0.03
	UAE	-0.30	-0.20	1.58***	-24.75***	-25.25***	0.00
	Russia	0.06	0.08	1.43***	-22.60***	-22.63***	0.03
Period 2	US	-1.20	-1.37	2.89***	-23.10***	-23.19***	0.03
	Australia	-0.39	-0.40	1.24***	-23.59***	-23.73***	0.03
	China	-1.77*	-1.70*	2.14***	-17.50***	-17.48***	0.08
	Hong Kong	-1.07	-1.06	0.88***	-18.42***	-18.42***	0.03
	India	-1.74*	-1.68*	2.63***	-18.32***	-18.33***	0.10
	Japan	-0.60	-0.57	3.15***	-22.85***	-23.56***	0.01
	Kazakhstan	-1.88*	-1.64*	5.31***	-15.81***	-15.87***	0.20**
	Korea	-1.77*	-1.65*	2.00***	-16.58***	-16.54***	0.11
	Malaysia	-1.78*	-1.65*	1.43***	-16.75***	-16.74***	0.10
	Singapore	-2.01**	-1.84*	3.32***	-16.33***	-16.30***	0.13*
	Austria	-0.75	-0.81	0.99***	-23.67***	-24.39***	0.01
	Belgium	-1.78*	-1.95**	4.16***	-21.52***	-21.56***	0.14*
	Denmark	-0.25	-0.20	2.42***	-22.60***	-22.73***	0.01
	France	-0.70	-0.75	2.59***	-24.53***	-25.18***	0.01
	Germany	-0.48	-0.48	2.34***	-25.39***	-26.06***	0.01
	Greece	-2.56**	-2.52**	3.49***	-19.49***	-19.49***	0.25***
	Ireland	-0.62	-0.51	2.74***	-27.72***	-29.40***	0.01

Period	Sovereign CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
	Italy	-1.70*	-1.72*	3.24***	-19.18***	-19.18***	0.14*
	Netherlands	-0.76	-0.73	1.38***	-24.17***	-25.51***	0.00
	Portugal	-1.96**	-2.07**	3.35***	-21.37***	-21.34***	0.09
	Spain	-1.28	-1.50	2.97***	-24.40***	-24.60***	0.02
	Sweden	-0.41	-0.25	2.55***	-25.58***	-25.99***	0.01
	Switzerland	-0.56	-0.64	1.32***	-30.09***	-30.51***	0.01
	UK	-0.66	-0.76	1.57***	-29.69***	-30.24***	0.01
	Bahrain	-0.61	-0.61	1.12***	-29.79***	-30.19***	0.01
	Qatar	-1.02	-1.09	3.65***	-22.21***	-22.15***	0.13*
	UAE	-0.60	-0.61	1.19***	-31.25***	-32.20***	0.01
	Russia	-1.02	-0.93	4.01***	-16.71***	-16.73***	0.11
Period 3	US	-0.97	-1.01	6.38***	-20.26***	-20.27***	0.18**
	Australia	-0.71	-0.69	7.26***	-19.11***	-19.12***	0.15*
	China	-0.34	-0.33	5.27***	-17.74***	-17.75***	0.13*
	Hong Kong	-0.26	-0.26	6.73***	-19.83***	-19.85***	0.07
	India	0.61	0.55	4.63***	-17.54***	-17.56***	0.17**
	Japan	-1.35	-1.25	5.20***	-16.91***	-16.96***	0.12
	Kazakhstan	-0.20	-0.22	6.88***	-14.84***	-14.79***	0.15**
	Korea	-0.08	-0.10	5.74***	-17.49***	-17.49***	0.12
	Malaysia	0.01	-0.02	4.70***	-16.56***	-16.54***	0.11
	Singapore	-1.43	-1.31	5.10***	-16.04***	-16.02***	0.11
	Austria	-2.14**	-1.85*	6.96***	-14.42***	-14.39***	0.27***
	Belgium	-1.23	-1.09	6.51***	-15.20***	-15.22***	0.25***
	Denmark	-1.29	-1.17	6.45***	-16.43***	-16.46***	0.30***
	France	-1.26	-1.10	6.58***	-15.03***	-15.06***	0.25***
	Germany	-1.38	-1.28	6.99***	-16.98***	-17.01***	0.19**
	Greece	-2.26**	-1.96**	5.35***	-14.58***	-14.53***	0.41***
	Ireland	-2.09**	-1.83*	7.34***	-14.67***	-14.64***	0.17**
	Italy	-1.37	-1.19	5.98***	-14.52***	-14.50***	0.29***
	Netherlands	-1.19	-1.07	7.04***	-16.39***	-16.45***	0.23***
	Portugal	-1.10	-0.99	5.30***	-15.30***	-15.24***	0.20**
	Spain	-1.40	-1.23	5.61***	-15.05***	-15.04***	0.19**
	Sweden	-1.93*	-1.60	6.19***	-13.19***	-13.12***	0.31***
	Switzerland	-1.36	-1.28	7.36***	-16.66***	-16.65***	0.21**
	UK	-2.09**	-1.90*	6.79***	-17.03***	-17.10***	0.33***
	Bahrain	-0.83	-0.82	7.91***	-19.49***	-19.48***	0.17**
	Qatar	-0.92	-0.86	7.17***	-17.19***	-17.25***	0.21**
	UAE	-1.50	-1.35	6.92***	-15.78***	-15.82***	0.18**
	Russia	-0.80	-0.74	5.34***	-14.85***	-14.83***	0.23***
Period 4	US	-0.47	-0.45	1.38***	-16.77***	-16.80***	0.03
	Australia	-0.25	-0.25	1.61***	-17.54***	-17.56***	0.03
	China	0.05	0.05	1.73***	-19.14***	-19.14***	0.04
	Hong Kong	0.32	0.33	2.03***	-18.99***	-18.98***	0.02
	India	-0.75	-0.70	4.92***	-16.39***	-16.40***	0.06
	Japan	0.20	0.20	2.21***	-18.37***	-18.37***	0.09
	Kazakhstan	0.84	0.80	4.21***	-17.55***	-17.54***	0.04
	Korea	-0.24	-0.24	1.65***	-18.93***	-18.93***	0.04

Period	Sovereign CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
	Malaysia	0.11	0.12	1.02***	-18.60***	-18.62***	0.03
	Singapore	-0.80	-0.88	5.51***	-22.64***	-22.48***	0.10
	Austria	0.48	0.42	2.52***	-15.69***	-15.68***	0.07
	Belgium	-1.13	-1.04	3.78***	-15.71***	-15.73***	0.06
	Denmark	-0.20	-0.19	1.46***	-16.46***	-16.46***	0.06
	France	-1.02	-0.88	3.28***	-13.70***	-13.75***	0.05
	Germany	-0.61	-0.60	1.18***	-18.03***	-18.03***	0.05
	Greece	-1.82*	-1.69*	4.34***	-15.41***	-15.39***	0.06
	Ireland	-1.69*	-1.54	2.93***	-15.40***	-15.40***	0.06
	Italy	-0.33	-0.33	4.49***	-14.42***	-14.37***	0.03
	Netherlands	-0.26	-0.25	3.25***	-15.76***	-15.75***	0.04
	Portugal	-1.92*	-1.72*	1.61***	-14.11***	-14.09***	0.04
	Spain	-0.81	-0.76	3.76***	-14.94***	-14.93***	0.03
	Sweden	1.04	1.15	0.97***	-19.81***	-19.88***	0.03
	Switzerland	0.55	0.52	1.20***	-16.95***	-16.95***	0.05
	UK	0.55	0.53	0.90***	-17.43***	-17.43***	0.02
	Bahrain	-0.65	-0.63	5.61***	-17.29***	-17.28***	0.08
	Qatar	0.22	0.23	1.55***	-18.70***	-18.71***	0.03
	UAE	0.66	0.59	0.53***	-15.38***	-15.34***	0.05
	Russia	0.50	0.50	2.00***	-17.16***	-17.12***	0.03

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix J: Unit root test results for country bank CDS spreads

Period	Bank CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	US	0.22	0.22	1.52***	-19.36***	-19.36***	0.11
	Australia	0.61	0.77	1.90***	-22.92***	-23.38***	0.01
	China	0.66	0.78	5.62***	-23.33***	-23.38***	0.05
	Hong Kong	0.71	1.18	2.04***	-30.96***	-33.37***	0.01
	India	-0.09	-0.01	2.69***	-29.38***	-29.51***	0.01
	Japan	-0.05	0.13	0.72***	-30.27***	-33.09***	0.00
	Kazakhstan	-0.15	-0.14	1.87***	-21.85***	-21.90***	0.01
	Korea	0.02	0.07	1.72***	-24.63***	-25.27***	0.01
	Malaysia	0.43	0.68	6.89***	-26.92***	-28.38***	0.01
	Singapore	0.51	0.64	6.89***	-22.78***	-23.16***	0.03
	Austria	-1.04	-0.62	0.59***	-28.68***	-33.53***	0.00
	Belgium	0.58	0.82	1.02***	-26.37***	-27.43***	0.01
	Denmark	0.51	0.74	4.23***	-24.36***	-25.71***	0.01
	France	0.45	0.63	1.13***	-25.01***	-25.92***	0.01
	Germany	0.51	0.67	1.57***	-24.55***	-25.00***	0.01
	Greece	0.09	0.18	1.98***	-25.04***	-25.41***	0.02
	Ireland	0.26	0.36	3.47***	-23.30***	-23.96***	0.01
	Italy	1.16	1.33	2.25***	-21.36***	-21.49***	0.03
	Netherlands	0.18	0.27	1.10***	-25.86***	-26.38***	0.01
	Portugal	0.17	0.27	1.36***	-25.56***	-26.28***	0.01
	Spain	0.34	0.44	3.46***	-23.05***	-23.50***	0.02
	Sweden	0.06	0.12	3.47***	-22.64***	-23.50***	0.03
	Switzerland	0.75	1.05	1.42***	-26.07***	-27.04***	0.01
	UK	0.76	0.95	1.72***	-23.25***	-23.61***	0.02
	Bahrain	0.49	0.56	2.60***	-22.81***	-22.77***	0.02
	Qatar	0.50	0.56	2.60***	-22.81***	-22.77***	0.02
	UAE	0.54	0.61	2.47***	-22.74***	-22.70***	0.03
	Russia	0.03	0.11	3.78***	-22.15***	-22.55***	0.02
Period 2	US	-1.86*	-1.66*	2.87***	-15.39***	-15.38***	0.08
	Australia	-2.71***	-2.31**	3.77***	-14.56***	-14.55***	0.18**
	China	-1.93*	-1.87*	1.91***	-18.71***	-18.72***	0.08
	Hong Kong	-2.06**	-1.93*	5.90***	-16.66***	-16.64***	0.09
	India	-1.82*	-1.72*	3.17***	-17.30***	-17.29***	0.13*
	Japan	-1.40	-1.25	1.10***	-15.97***	-15.99***	0.08
	Kazakhstan	-1.76*	-1.80*	6.39***	-20.47***	-20.45***	0.05
	Korea	-1.51	-1.84*	3.13***	-24.86***	-25.20***	0.08
	Malaysia	-1.21	-1.26	3.15***	-20.35***	-20.36***	0.05
	Singapore	-1.80*	-1.70*	4.94***	-16.93***	-16.90***	0.10
	Austria	-1.43	-0.91	1.28***	-32.68***	-38.79***	0.00
	Belgium	-2.89***	-2.66***	5.69***	-16.66***	-16.69***	0.10
	Denmark	-1.26	-1.26	3.97***	-19.11***	-19.11***	0.07
	France	-1.97**	-1.80*	3.97***	-16.42***	-16.43***	0.10
	Germany	-1.79*	-1.69*	4.14***	-16.81***	-16.76***	0.06
	Greece	-0.31	-0.35	0.66***	-23.69***	-23.74***	0.03
	Ireland	-2.76***	-2.56**	5.71***	-16.17***	-16.13***	0.09

Period	Bank CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
	Italy	-1.63*	-1.50	5.34***	-16.08***	-16.05***	0.10
	Netherlands	-1.03	-1.03	4.56***	-19.15***	-19.15***	0.07
	Portugal	-2.21**	-1.98**	3.44***	-15.67***	-15.66***	0.07
	Spain	-2.12**	-1.94*	4.46***	-16.29***	-16.29***	0.07
	Sweden	-1.90*	-1.88*	6.52***	-18.64***	-18.64***	0.06
	Switzerland	-2.09**	-2.02**	3.25***	-17.49***	-17.47***	0.06
	UK	-2.33**	-2.13**	5.00***	-16.39***	-16.41***	0.07
	Bahrain	-2.79***	-2.36**	3.71***	-14.26***	-14.23***	0.17**
	Qatar	-2.92***	-2.46**	3.63***	-14.19***	-14.16***	0.16**
	UAE	-2.79***	-2.35**	3.87***	-14.40***	-14.40***	0.16**
	Russia	-0.90	-0.98	4.94***	-22.36***	-22.48***	0.04
Period 3	US	0.10	0.05	5.70***	-15.28***	-15.23***	0.03
	Australia	0.04	0.01	5.53***	-16.28***	-16.28***	0.07
	China	0.06	0.06	4.74***	-18.67***	-18.67***	0.29***
	Hong Kong	-0.11	-0.12	7.77***	-17.11***	-17.08***	0.08
	India	0.70	0.58	4.31***	-16.04***	-16.07***	0.22***
	Japan	-0.49	-0.46	3.64***	-15.03***	-15.05***	0.24***
	Kazakhstan	-1.08	-1.04	4.75***	-18.04***	-18.08***	0.09
	Korea	0.75	0.66	5.95***	-16.81***	-16.84***	0.26***
	Malaysia	0.19	0.20	3.64***	-19.46***	-19.47***	0.17**
	Singapore	0.50	0.43	3.08***	-17.04***	-17.09***	0.14*
	Austria	-0.22	-0.23	7.17***	-17.83***	-17.85***	0.06
	Belgium	-0.32	-0.32	6.83***	-22.09***	-22.02***	0.05
	Denmark	-0.48	-0.48	7.01***	-18.91***	-18.91***	0.07
	France	-0.13	-0.14	3.72***	-17.72***	-17.72***	0.02
	Germany	-0.07	-0.09	4.95***	-15.09***	-15.07***	0.03
	Greece	-1.40	-1.39	5.94***	-18.67***	-18.67***	0.03
	Ireland	-0.61	-0.62	5.82***	-19.83***	-19.82***	0.08
	Italy	-0.39	-0.38	6.07***	-17.25***	-17.25***	0.06
	Netherlands	-0.68	-0.68	7.26***	-19.07***	-19.07***	0.07
	Portugal	-0.04	-0.06	2.56***	-15.25***	-15.20***	0.04
	Spain	-0.19	-0.19	4.46***	-14.80***	-14.83***	0.06
	Sweden	-0.26	-0.25	7.85***	-18.00***	-18.01***	0.07
	Switzerland	0.23	0.18	6.07***	-15.58***	-15.52***	0.07
	UK	-0.15	-0.17	4.94***	-13.95***	-13.85***	0.04
	Bahrain	-1.37	-1.47	7.19***	-20.62***	-20.67***	0.09
	Qatar	-0.95	-0.93	7.10***	-18.13***	-18.12***	0.14*
	UAE	-1.70*	-1.49	6.29***	-14.51***	-14.48***	0.32***
	Russia	-0.73	-0.68	5.03***	-15.28***	-15.25***	0.21**
Period 4	US	-0.31	-0.30	4.34***	-15.55***	-15.52***	0.03
	Australia	-0.81	-0.80	2.73***	-18.00***	-18.00***	0.04
	China	-0.02	-0.01	4.86***	-18.13***	-18.13***	0.04
	Hong Kong	-0.40	-0.39	2.12***	-17.04***	-17.02***	0.03
	India	-0.67	-0.60	4.66***	-15.25***	-15.27***	0.07
	Japan	-0.49	-0.45	5.01***	-15.96***	-15.98***	0.10
	Kazakhstan	0.84	0.77	1.69***	-16.50***	-16.49***	0.02

Period	Bank CDS spread	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
	Korea	-0.26	-0.24	2.74***	-13.64***	-13.66***	0.07
	Malaysia	-0.16	-0.16	2.38***	-19.83***	-19.85***	0.04
	Singapore	-0.61	-0.58	4.38***	-16.11***	-16.08***	0.09
	Austria	0.03	0.01	3.54***	-16.64***	-16.65***	0.02
	Belgium	-0.68	-0.63	2.08***	-15.29***	-15.27***	0.09
	Denmark	-0.70	-0.75	4.41***	-20.10***	-20.19***	0.09
	France	-0.69	-0.65	3.02***	-16.37***	-16.37***	0.03
	Germany	-0.50	-0.48	2.66***	-15.89***	-15.86***	0.04
	Greece	-1.80*	-1.68*	3.94***	-15.91***	-15.89***	0.04
	Ireland	-1.69*	-1.66*	1.70***	-19.39***	-19.37***	0.09
	Italy	-0.89	-0.84	2.21***	-16.21***	-16.20***	0.04
	Netherlands	-0.52	-0.50	3.89***	-17.14***	-17.14***	0.02
	Portugal	-2.70***	-2.31**	3.03***	-14.25***	-14.30***	0.09
	Spain	-1.09	-1.01	2.73***	-15.69***	-15.70***	0.04
	Sweden	0.22	0.26	2.38***	-21.25***	-21.34***	0.04
	Switzerland	-0.35	-0.34	3.87***	-16.52***	-16.53***	0.06
	UK	-0.53	-0.52	2.69***	-17.70***	-17.70***	0.03
	Bahrain	-0.04	-0.05	5.22***	-17.15***	-17.17***	0.06
	Qatar	0.23	0.25	2.50***	-19.33***	-19.36***	0.03
	UAE	0.66	0.60	0.92***	-16.80***	-16.82***	0.04
	Russia	1.13	0.92	1.64***	-12.84***	-12.87***	0.03

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix K: Cointegration test for country sovereign and bank CDS spreads

Period	Variable 1 *Sovereign* CDS	Variable 2 *Bank* CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	US	US	43.91***	2.91	41.00***	2.91	-5.72***
	Australia	Australia	51.24***	9.88**	41.36***	9.88**	-6.56***
	China	China	23.51**	1.87	21.65***	1.87	-4.34***
	Hong Kong	Hong Kong	34.55***	3.93	30.62***	3.93	-5.40***
	India	India	69.64***	24.09***	45.55***	24.09***	-6.61***
	Japan	Japan	84.04***	29.52***	54.51***	29.52***	-5.59***
	Kazakhstan	Kazakhstan	35.43***	5.36	30.07***	5.36	-3.61**
	Korea	Korea	60.45***	5.10	55.35***	5.10	-5.21***
	Malaysia	Malaysia	59.18***	1.23	57.94***	1.23	-7.61***
	Singapore	Singapore	59.14***	1.91	57.23***	1.91	-7.80***
	Austria	Austria	228.52***	72.33***	156.19***	72.33***	-8.85***
	Belgium	Belgium	146.07***	7.32	138.75***	7.32	-12.94***
	Denmark	Denmark	31.25***	4.85	26.41***	4.85	-5.21***
	France	France	85.53***	10.94**	74.59***	10.94**	-9.05***
	Germany	Germany	40.36***	6.72	33.64***	6.72	-5.93***
	Greece	Greece	31.21***	1.57	29.64***	1.57	-1.46
	Ireland	Ireland	44.67***	14.94***	29.74***	14.94***	-5.52***
	Italy	Italy	10.60	1.86	8.74	1.86	-2.59
	Netherlands	Netherlands	46.51***	11.62**	34.89***	11.62**	-6.02***
	Portugal	Portugal	42.68***	5.09	37.59***	5.09	-2.67
	Spain	Spain	57.18***	11.49**	45.68***	11.49**	-6.89***
	Sweden	Sweden	45.12***	5.84	39.28***	5.84	-6.17***
	Switzerland	Switzerland	53.69***	4.52	49.17***	4.52	-7.21***
	UK	UK	47.26***	2.84	44.42***	2.84	-6.85***
	Bahrain	Bahrain	44.21***	4.54	39.67***	4.54	-6.46***
	Qatar	Qatar	22.21**	2.02	20.19***	2.02	-4.17***
	UAE	UAE	52.52***	4.93	47.59***	4.93	-7.12***
	Russia	Russia	33.92***	4.87	29.05***	4.87	-4.48***
Period 2	US	US	47.80***	3.10	44.70***	3.10	-5.13***
	Australia	Australia	32.85***	3.73	29.12***	3.73	-3.32*
	China	China	49.39***	4.09	45.30***	4.09	-5.62***
	Hong Kong	Hong Kong	16.99	4.50	12.48	4.50	-2.32
	India	India	19.11*	3.04	16.07**	3.04	-3.94***
	Japan	Japan	23.12**	2.40	20.73***	2.40	-4.60***
	Kazakhstan	Kazakhstan	24.91**	4.37	20.54***	4.37	-4.41***
	Korea	Korea	25.30***	3.72	21.58***	3.72	-4.43***
	Malaysia	Malaysia	14.77	3.43	11.34	3.43	-3.09*
	Singapore	Singapore	13.12	3.83	9.29	3.83	-1.83
	Austria	Austria	103.85***	9.28**	94.57***	9.28**	-8.11***
	Belgium	Belgium	17.10	4.79	12.31	4.79	-1.87
	Denmark	Denmark	25.31***	1.90	23.41***	1.90	-4.82***
	France	France	41.06***	4.91	36.15***	4.91	-6.11***
	Germany	Germany	40.93***	5.24	35.69***	5.24	-5.84***
	Greece	Greece	21.81**	6.53	15.28*	6.53	-0.25
	Ireland	Ireland	41.61***	8.07*	33.54***	8.07*	-5.75***
	Italy	Italy	15.16	3.91	11.24	3.91	-1.42
	Netherlands	Netherlands	45.95***	1.79	44.16***	1.79	-6.79***
	Portugal	Portugal	16.76	5.22	11.54	5.22	-2.56

Period	Variable 1 *Sovereign* CDS	Variable 2 *Bank* CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
	Spain	Spain	27.29***	5.57	21.72***	5.57	-4.19***
	Sweden	Sweden	23.57**	3.71	19.86**	3.71	-4.48***
	Switzerland	Switzerland	59.60***	5.50	54.10***	5.50	-7.54***
	UK	UK	51.84***	6.37	45.46***	6.37	-6.93***
	Bahrain	Bahrain	68.96***	7.76*	61.21***	7.76*	-8.07***
	Qatar	Qatar	33.15***	5.05	28.10***	5.05	-2.73
	UAE	UAE	71.66***	7.66*	64.01***	7.66*	-8.23***
	Russia	Russia	24.41**	2.26	22.15***	2.26	-4.43***
Period 3	US	US	6.79	2.23	4.56	2.23	-1.75
	Australia	Australia	11.89	1.79	10.10	1.79	-2.28
	China	China	14.50	0.57	13.93*	0.57	-3.49**
	Hong Kong	Hong Kong	16.65	1.18	15.47*	1.18	-3.92**
	India	India	14.17	0.56	13.61	0.56	-3.66**
	Japan	Japan	10.10	2.66	7.44	2.66	-1.61
	Kazakhstan	Kazakhstan	28.17***	2.16	26.01***	2.16	-1.36
	Korea	Korea	15.86	0.58	15.28*	0.58	-3.90**
	Malaysia	Malaysia	17.09	0.62	16.46**	0.62	-4.02***
	Singapore	Singapore	20.99**	4.33	16.66**	4.33	-3.38**
	Austria	Austria	13.78	1.62	12.16	1.62	-1.68
	Belgium	Belgium	10.29	3.46	6.84	3.46	-1.75
	Denmark	Denmark	10.38	4.51	5.88	4.51	-1.89
	France	France	14.65	5.51	9.14	5.51	-1.90
	Germany	Germany	14.42	4.65	9.77	4.65	-1.98
	Greece	Greece	9.16	1.31	7.85	1.31	-1.71
	Ireland	Ireland	25.01**	6.30	18.71**	6.30	-2.39
	Italy	Italy	12.06	5.17	6.89	5.17	-2.19
	Netherlands	Netherlands	26.02***	4.29	21.73***	4.29	-2.91
	Portugal	Portugal	14.49	3.08	11.40	3.08	-1.70
	Spain	Spain	10.72	2.09	8.63	2.09	-1.44
	Sweden	Sweden	12.11	1.20	10.90	1.20	-1.49
	Switzerland	Switzerland	10.30	1.38	8.91	1.38	-1.76
	UK	UK	17.14	4.55	12.59	4.55	-2.26
	Bahrain	Bahrain	26.03***	1.92	24.11***	1.92	-2.77
	Qatar	Qatar	34.91***	3.75	31.16***	3.75	-3.73**
	UAE	UAE	29.22***	8.87*	20.35***	8.87*	-3.97***
	Russia	Russia	18.12*	3.40	14.72*	3.40	-3.63**
Period 4	US	US	15.84	3.90	11.93	3.90	-2.54
	Australia	Australia	30.59***	6.89	23.70***	6.89	-3.38**
	China	China	13.93	4.38	9.55	4.38	-2.82
	Hong Kong	Hong Kong	16.92	5.96	10.95	5.96	-2.73
	India	India	30.62***	5.73	24.88***	5.73	-4.67***
	Japan	Japan	3.08	0.89	2.19	0.89	-1.14
	Kazakhstan	Kazakhstan	11.30	3.82	7.49	3.82	-2.15
	Korea	Korea	65.64***	6.84	58.80***	6.84	-5.60***
	Malaysia	Malaysia	23.22**	4.55	18.67**	4.55	-4.13***
	Singapore	Singapore	19.39*	7.23	12.15	7.23	-1.25
	Austria	Austria	23.90**	5.44	18.46**	5.44	-3.22*
	Belgium	Belgium	25.19***	6.64	18.55**	6.64	-2.54
	Denmark	Denmark	8.88	1.44	7.45	1.44	-2.70

Period	Variable 1 *Sovereign* CDS	Variable 2 *Bank* CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
	France	France	23.86**	9.08*	14.78*	9.08*	-3.45**
	Germany	Germany	13.64	5.73	7.91	5.73	-2.38
	Greece	Greece	41.15***	4.36	36.79***	4.36	-4.14***
	Ireland	Ireland	28.26***	2.73	25.53***	2.73	-3.16*
	Italy	Italy	18.41*	6.85	11.56	6.85	-2.13
	Netherlands	Netherlands	20.43**	4.59	15.84*	4.59	-3.29*
	Portugal	Portugal	35.71***	5.04	30.67***	5.04	-2.27
	Spain	Spain	27.27***	5.08	22.19***	5.08	-3.12*
	Sweden	Sweden	16.21	4.69	11.52	4.69	-3.01
	Switzerland	Switzerland	15.66	4.56	11.10	4.56	-2.61
	UK	UK	16.86	5.47	11.39	5.47	-2.04
	Bahrain	Bahrain	9.24	0.80	8.44	0.80	-1.99
	Qatar	Qatar	21.05**	6.10	14.96*	6.10	-3.72**
	UAE	UAE	30.78***	2.81	27.97***	2.81	-4.50***
	Russia	Russia	20.11*	5.37	14.74*	5.37	-2.84

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix L: Unit-root test for regional corporate CDS spreads

America

Period	Industry CDS spreads	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	0.14	0.13	5.68***	-18.46***	-18.46***	0.08
	Basic materials	1.11	1.23	3.26***	-24.24***	-23.99***	0.07
	Chemicals, healthcare and pharma	0.85	0.77	3.06***	-20.18***	-20.16***	0.03
	Commerce and consumer	2.20	2.01	2.63***	-19.57***	-19.57***	0.04
	Construction and logistics	1.16	1.33	1.44***	-24.33***	-24.67***	0.02
	Energy and utilities	2.44	2.18	3.87***	-24.83***	-24.84***	0.04
	Financial services (excl. banking)	2.37	2.14	7.60***	-20.53***	-20.49***	0.12*
	Industrial	-0.47	-0.37	1.50***	-25.04***	-26.13***	0.00
	Telecommunication, media and tech.	1.05	0.96	3.79***	-18.48***	-18.50***	0.11
	Overall	0.57	0.63	6.88***	-24.87***	-25.75***	0.01
Period 2	Automotive	-1.51	-1.58	1.14***	-19.97***	-19.97***	0.03
	Basic materials	-2.60***	-2.42**	2.57***	-16.33***	-16.32***	0.09
	Chemicals, healthcare and pharma	-1.97**	-1.73*	2.15***	-15.07***	-15.12***	0.12*
	Commerce and consumer	-2.09**	-1.76*	2.25***	-15.45***	-15.49***	0.10
	Construction and logistics	-2.30**	-2.08**	2.48***	-16.41***	-16.43***	0.07
	Energy and utilities	-2.22**	-1.93*	2.56***	-16.28***	-16.29***	0.11
	Financial services (excl. banking)	-3.01***	-2.39**	2.94***	-13.30***	-13.31***	0.13*
	Industrial	-0.44	-0.38	3.66***	-29.55***	-31.08***	0.01
	Telecommunication, media and tech.	-2.37**	-2.02**	2.42***	-14.64***	-14.63***	0.15**
	Overall	-1.72*	-1.70*	1.53***	-21.94***	-21.87***	0.05
Period 3	Automotive	0.55	0.55	6.68***	-18.63***	-18.63***	0.15**
	Basic materials	-0.07	-0.10	7.53***	-11.95***	-11.88***	0.54***
	Chemicals, healthcare and pharma	-0.05	-0.07	6.02***	-13.26***	-13.25***	0.30***
	Commerce and consumer	0.20	0.14	5.23***	-14.38***	-14.38***	0.29***
	Construction and logistics	0.71	0.55	6.06***	-14.57***	-14.58***	0.18**
	Energy and utilities	-0.01	-0.04	5.59***	-13.26***	-13.29***	0.24***
	Financial services (excl. banking)	-0.29	-0.29	6.24***	-15.06***	-15.01***	0.11
	Industrial	0.47	0.36	6.92***	-16.59***	-16.59***	0.19**
	Telecommunication, media and tech.	0.43	0.31	4.94***	-13.30***	-13.27***	0.25***
	Overall	0.38	0.34	6.68***	-13.82***	-13.76***	0.23***
Period 4	Automotive	1.52	1.33	3.56***	-15.06***	-15.05***	0.08
	Basic materials	0.12	0.08	6.37***	-14.70***	-14.71***	0.06
	Chemicals, healthcare and pharma	-0.04	-0.04	5.41***	-14.66***	-14.68***	0.09
	Commerce and consumer	-0.26	-0.24	2.21***	-15.00***	-14.94***	0.05
	Construction and logistics	-0.59	-0.55	4.70***	-17.45***	-17.46***	0.11
	Energy and utilities	-0.04	-0.05	6.37***	-15.07***	-15.09***	0.17**
	Financial services (excl. banking)	0.44	0.35	6.15***	-13.80***	-13.79***	0.09
	Industrial	-0.19	-0.17	4.58***	-16.03***	-16.00***	0.04
	Telecommunication, media and tech.	-0.12	-0.12	4.38***	-14.43***	-14.43***	0.12*
	Overall	0.53	0.42	5.70***	-13.65***	-13.63***	0.08

Asia-Pacific

Period	Industry CDS spreads	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	-0.03	0.01	6.00***	-25.01***	-26.39***	0.01
	Basic materials	0.07	0.10	7.69***	-20.78***	-21.04***	0.04
	Chemicals, healthcare and pharma	0.01	0.13	1.37***	-20.72***	-21.30***	0.01
	Commerce and consumer	-0.21	-0.22	1.52***	-21.91***	-22.72***	0.01
	Construction and logistics	-0.05	0.02	2.40***	-25.50***	-30.67***	0.01
	Energy and utilities	0.27	0.43	3.03***	-19.46***	-20.31***	0.01
	Financial services (excl. banking)	0.42	0.42	1.06***	-19.24***	-19.24***	0.01
	Industrial	0.33	0.38	6.04***	-22.00***	-22.21***	0.08
	Telecommunication, media and tech.	0.00	0.03	5.57***	-21.80***	-22.25***	0.01
	Overall	0.19	0.24	5.28***	-20.17***	-20.78***	0.01
Period 2	Automotive	-1.44	-1.47	2.59***	-24.90***	-24.92***	0.06
	Basic materials	-1.94*	-1.80*	2.78***	-16.16***	-16.15***	0.19**
	Chemicals, healthcare and pharma	-1.20	-1.46	1.18***	-25.75***	-26.04***	0.02
	Commerce and consumer	-1.18	-1.04	3.97***	-18.06***	-18.07***	0.14*
	Construction and logistics	-2.78***	-2.42**	3.36***	-15.56***	-15.60***	0.29***
	Energy and utilities	-2.13**	-1.92*	3.23***	-19.92***	-19.93***	0.11
	Financial services (excl. banking)	-1.92*	-1.89*	4.85***	-19.37***	-19.37***	0.03
	Industrial	-2.21**	-1.79*	1.62***	-13.49***	-13.55***	0.22***
	Telecommunication, media and tech.	-1.63*	-1.34	2.27***	-15.69***	-15.83***	0.24***
	Overall	-2.39**	-1.92*	2.56***	-15.68***	-15.75***	0.25***
Period 3	Automotive	-0.76	-0.66	7.00***	-14.56***	-14.60***	0.31***
	Basic materials	0.34	0.29	6.42***	-15.58***	-15.63***	0.55***
	Chemicals, healthcare and pharma	0.04	0.03	6.42***	-17.75***	-17.80***	0.27***
	Commerce and consumer	-0.68	-0.64	7.58***	-16.01***	-16.08***	0.45***
	Construction and logistics	-0.39	-0.38	6.80***	-18.38***	-18.40***	0.24***
	Energy and utilities	0.54	0.43	6.53***	-17.10***	-17.12***	0.32***
	Financial services (excl. banking)	-0.20	-0.20	6.36***	-20.25***	-20.23***	0.09
	Industrial	-0.39	-0.39	6.28***	-15.45***	-15.53***	0.54***
	Telecommunication, media and tech.	-0.29	-0.27	7.25***	-14.24***	-14.26***	0.38***
	Overall	-0.35	-0.30	7.12***	-12.04***	-12.00***	0.67***
Period 4	Automotive	0.29	0.24	2.38***	-15.13***	-15.12***	0.10
	Basic materials	-0.57	-0.54	2.14***	-16.39***	-16.39***	0.05
	Chemicals, healthcare and pharma	0.67	0.65	0.81***	-15.93***	-15.92***	0.08
	Commerce and consumer	0.70	0.75	2.54***	-19.42***	-19.42***	0.06
	Construction and logistics	0.95	0.87	5.03***	-16.65***	-16.67***	0.06
	Energy and utilities	-1.23	-1.09	1.00***	-15.75***	-15.76***	0.04
	Financial services (excl. banking)	-0.53	-0.55	5.56***	-20.31***	-20.32***	0.09
	Industrial	0.22	0.21	1.89***	-16.77***	-16.77***	0.07
	Telecommunication, media and tech.	0.48	0.38	2.28***	-13.18***	-13.16***	0.08
	Overall	0.21	0.16	1.70***	-13.26***	-13.23***	0.10

Europe

Period	Industry CDS spreads	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	2.47	2.25	1.65***	-17.12***	-17.15***	0.05
	Basic materials	0.94	1.01	5.62***	-20.78***	-20.83***	0.03
	Chemicals, healthcare and pharma	0.90	0.83	4.93***	-21.45***	-21.43***	0.09
	Commerce and consumer	1.36	1.21	1.43***	-21.31***	-21.23***	0.08
	Construction and logistics	0.06	0.11	1.03***	-26.80***	-27.44***	0.01
	Energy and utilities	0.91	0.89	2.32***	-25.03***	-25.30***	0.05
	Financial services (excl. banking)	1.86	2.05	2.93***	-21.33***	-21.35***	0.03
	Industrial	1.85	1.74	2.79***	-19.54***	-19.54***	0.05
	Telecommunication, media and tech.	0.35	0.34	3.02***	-18.82***	-18.83***	0.04
	Overall	2.55	2.31	1.67***	-19.55***	-19.55***	0.04
Period 2	Automotive	-1.52	-1.35	1.95***	-15.21***	-15.18***	0.12*
	Basic materials	-2.31**	-2.08**	2.36***	-15.96***	-15.96***	0.14*
	Chemicals, healthcare and pharma	-1.68*	-1.50	3.38***	-15.27***	-15.29***	0.15**
	Commerce and consumer	-1.61	-1.44	1.93***	-15.29***	-15.29***	0.10
	Construction and logistics	-1.56	-1.41	2.37***	-16.21***	-16.21***	0.08
	Energy and utilities	-1.78*	-1.52	4.49***	-14.10***	-14.08***	0.19**
	Financial services (excl. banking)	-2.30**	-2.10**	3.96***	-15.81***	-15.75***	0.11
	Industrial	-2.27**	-1.99**	2.32***	-15.03***	-15.02***	0.15**
	Telecommunication, media and tech.	-1.33	-1.24	2.35***	-16.65***	-16.65***	0.13*
	Overall	-2.06**	-1.82*	3.10***	-14.72***	-14.64***	0.13*
Period 3	Automotive	-0.18	-0.19	6.73***	-15.01***	-14.99***	0.10
	Basic materials	0.41	0.28	6.50***	-13.07***	-13.07***	0.32***
	Chemicals, healthcare and pharma	0.26	0.20	6.13***	-14.21***	-14.18***	0.21**
	Commerce and consumer	0.31	0.24	5.12***	-13.83***	-13.76***	0.15**
	Construction and logistics	0.06	0.04	6.64***	-15.54***	-15.51***	0.08
	Energy and utilities	-0.24	-0.23	6.26***	-14.44***	-14.42***	0.22***
	Financial services (excl. banking)	-0.19	-0.19	8.03***	-15.10***	-15.08***	0.12*
	Industrial	0.20	0.13	6.22***	-13.65***	-13.63***	0.27***
	Telecommunication, media and tech.	0.43	0.38	5.02***	-15.46***	-15.36***	0.10
	Overall	-0.06	-0.08	7.70***	-14.33***	-14.29***	0.15**
Period 4	Automotive	-0.07	-0.07	4.66***	-17.57***	-17.58***	0.06
	Basic materials	-0.11	-0.12	5.96***	-15.93***	-15.92***	0.04
	Chemicals, healthcare and pharma	-0.30	-0.29	6.16***	-16.67***	-16.69***	0.07
	Commerce and consumer	-0.50	-0.48	4.63***	-17.29***	-17.29***	0.05
	Construction and logistics	-0.61	-0.58	6.78***	-17.10***	-17.10***	0.05
	Energy and utilities	-0.81	-0.75	6.13***	-15.60***	-15.60***	0.07
	Financial services (excl. banking)	-0.44	-0.41	2.50***	-16.31***	-16.34***	0.04
	Industrial	-0.07	-0.08	4.92***	-16.79***	-16.80***	0.10
	Telecommunication, media and tech.	-0.74	-0.70	5.67***	-16.57***	-16.56***	0.03
	Overall	-0.46	-0.43	4.30***	-16.31***	-16.33***	0.04

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix M: Cointegration test for regional bank and corporate CDS spreads

America

Period	Variable 1 Regional bank CDS	Variable 2 Non-bank corp. CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank CDS	Automotive	13.03	3.42	9.61	3.42	-2.33
		Basic materials	14.84	4.82	10.03	4.82	-1.20
		Chemicals, healthcare and pharma	13.79	3.06	10.72	3.06	-2.15
		Commerce and consumer	13.04	5.33	7.71	5.33	-0.36
		Construction and logistics	17.19	3.10	14.09*	3.10	-2.66
		Energy and utilities	23.70**	7.41	16.28**	7.41	-0.71
		Financial services (excl. banking)	24.06**	5.33	18.73**	5.33	-1.00
		Industrial	64.58***	3.12	61.46***	3.12	-2.69
		Telecommunication, media and tech.	15.68	5.73	9.95	5.73	-1.38
		Overall	13.37	5.09	8.28	5.09	-1.86
Period 2	Regional bank CDS	Automotive	10.22	2.97	7.25	2.97	-1.96
		Basic materials	13.64	2.74	10.91	2.74	-2.05
		Chemicals, healthcare and pharma	17.87	2.56	15.31*	2.56	-2.28
		Commerce and consumer	10.03	3.41	6.62	3.41	-2.07
		Construction and logistics	13.16	3.63	9.53	3.63	-2.36
		Energy and utilities	26.60***	2.61	23.99***	2.61	-2.85
		Financial services (excl. banking)	24.23**	2.22	22.01***	2.22	-2.46
		Industrial	47.04***	3.79	43.25***	3.79	-3.28*
		Telecommunication, media and tech.	13.44	2.21	11.23	2.21	-1.73
		Overall	19.51*	2.75	16.76**	2.75	-2.90
Period 3	Regional bank CDS	Automotive	8.84	0.60	8.24	0.60	-2.76
		Basic materials	19.66*	0.30	19.35**	0.30	-2.38
		Chemicals, healthcare and pharma	7.78	0.60	7.18	0.60	-1.96
		Commerce and consumer	3.95	0.26	3.69	0.26	-1.87
		Construction and logistics	6.42	0.48	5.94	0.48	-2.26
		Energy and utilities	8.96	0.62	8.34	0.62	-2.08
		Financial services (excl. banking)	37.38***	3.07	34.31***	3.07	-2.97
		Industrial	9.52	0.29	9.23	0.29	-2.41
		Telecommunication, media and tech.	4.45	0.36	4.09	0.36	-2.02
		Overall	8.07	0.29	7.78	0.29	-2.62
Period 4	Regional bank CDS	Automotive	19.00*	2.56	16.44**	2.56	-3.32*
		Basic materials	29.53***	1.98	27.55***	1.98	-4.38***
		Chemicals, healthcare and pharma	12.47	1.89	10.58	1.89	-3.09*
		Commerce and consumer	18.00*	6.74	11.26	6.74	-2.58
		Construction and logistics	14.78	5.09	9.69	5.09	-3.03
		Energy and utilities	40.41***	1.99	38.42***	1.99	-4.14***
		Financial services (excl. banking)	42.20***	1.20	41.00***	1.20	-4.32***
		Industrial	16.90	4.14	12.76	4.14	-3.41**
		Telecommunication, media and tech.	12.45	2.19	10.26	2.19	-3.07*
		Overall	31.64***	0.98	30.67***	0.98	-3.99***

Asia-Pacific

Period	Variable 1 Regional bank CDS	Variable 2 Non-bank corp. CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank CDS	Automotive	42.27***	10.91**	31.35***	10.91**	-5.51***
		Basic materials	46.94***	4.22	42.71***	4.22	-6.62***
		Chemicals, healthcare and pharma	88.23***	21.57***	66.67***	21.57***	-6.59***
		Commerce and consumer	42.82***	13.09***	29.73***	13.09***	-5.21***
		Construction and logistics	82.80***	18.39***	64.41***	18.39***	-7.23***
		Energy and utilities	100.06***	11.43**	88.62***	11.43**	-9.79***
		Financial services (excl. banking)	47.38***	5.38	42.00***	5.38	-6.64***
		Industrial	33.61***	2.96	30.65***	2.96	-5.62***
		Telecommunication, media and tech.	32.56***	7.40	25.16***	7.40	-5.03***
		Overall	36.25***	7.12	29.14***	7.12	-5.45***
Period 2	Regional bank CDS	Automotive	35.58***	3.33	32.25***	3.33	-2.84
		Basic materials	12.85	5.16	7.69	5.16	-2.28
		Chemicals, healthcare and pharma	35.15***	5.16	29.99***	5.16	-4.53***
		Commerce and consumer	24.41**	7.04	17.37**	7.04	-1.91
		Construction and logistics	25.36***	3.97	21.39***	3.97	-1.77
		Energy and utilities	15.23	3.35	11.88	3.35	-1.92
		Financial services (excl. banking)	20.68**	2.65	18.03**	2.65	-1.65
		Industrial	23.68**	3.05	20.63***	3.05	-2.13
		Telecommunication, media and tech.	23.59**	4.48	19.12**	4.48	-1.71
		Overall	27.49***	4.47	23.02***	4.47	-1.61
Period 3	Regional bank CDS	Automotive	37.53***	7.09	30.44***	7.09	-1.02
		Basic materials	31.30***	2.13	29.16***	2.13	-2.01
		Chemicals, healthcare and pharma	6.95	0.78	6.17	0.78	-1.50
		Commerce and consumer	31.98***	5.13	26.85***	5.13	-1.01
		Construction and logistics	20.52**	2.36	18.16**	2.36	-1.37
		Energy and utilities	22.68**	1.24	21.43***	1.24	-2.41
		Financial services (excl. banking)	33.72***	2.10	31.62***	2.10	-2.23
		Industrial	15.49	0.76	14.73*	0.76	-2.13
		Telecommunication, media and tech.	35.65***	4.94	30.71***	4.94	-1.23
		Overall	57.07***	5.94	51.14***	5.94	-1.22
Period 4	Regional bank CDS	Automotive	8.61	2.18	6.43	2.18	-2.24
		Basic materials	16.12	4.79	11.33	4.79	-2.75
		Chemicals, healthcare and pharma	70.98***	4.23	66.75***	4.23	-6.26***
		Commerce and consumer	15.47	3.73	11.75	3.73	-2.12
		Construction and logistics	20.08*	4.05	16.03**	4.05	-2.06
		Energy and utilities	15.37	5.28	10.09	5.28	-2.16
		Financial services (excl. banking)	10.33	3.14	7.19	3.14	-1.78
		Industrial	23.72**	5.31	18.41**	5.31	-3.54**
		Telecommunication, media and tech.	14.14	2.96	11.17	2.96	-2.42
		Overall	25.34***	4.82	20.51***	4.82	-3.08*

Europe

Period	Variable 1 Regional bank CDS	Variable 2 Non-bank corp. CDS	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank CDS	Automotive	27.95***	6.08	21.87***	6.08	-4.61***
		Basic materials	14.42	1.42	13.00	1.42	-3.59**
		Chemicals, healthcare and pharma	17.78	1.30	16.49**	1.30	-3.89**
		Commerce and consumer	25.88***	2.89	22.99***	2.89	-4.70***
		Construction and logistics	31.42***	3.17	28.25***	3.17	-2.47
		Energy and utilities	17.51	1.42	16.09**	1.42	-3.99***
		Financial services (excl. banking)	63.31***	4.35	58.96***	4.35	-7.71***
		Industrial	22.63**	3.50	19.13**	3.50	-4.27***
		Telecommunication, media and tech.	11.65	1.01	10.64	1.01	-2.96
		Overall	43.31***	5.71	37.60***	5.71	-5.88***
Period 2	Regional bank CDS	Automotive	13.01	4.72	8.29	4.72	-2.34
		Basic materials	11.89	5.11	6.78	5.11	-1.99
		Chemicals, healthcare and pharma	12.47	3.52	8.95	3.52	-2.55
		Commerce and consumer	11.18	3.59	7.59	3.59	-2.26
		Construction and logistics	11.94	3.97	7.97	3.97	-1.78
		Energy and utilities	15.83	6.10	9.73	6.10	-2.92
		Financial services (excl. banking)	25.01**	6.64	18.37**	6.64	-4.17***
		Industrial	13.76	6.15	7.61	6.15	-2.38
		Telecommunication, media and tech.	11.96	3.99	7.97	3.99	-2.23
		Overall	15.77	6.11	9.66	6.11	-2.92
Period 3	Regional bank CDS	Automotive	5.73	1.04	4.69	1.04	-2.14
		Basic materials	6.03	0.33	5.71	0.33	-2.31
		Chemicals, healthcare and pharma	7.04	0.52	6.52	0.52	-2.20
		Commerce and consumer	5.43	0.46	4.97	0.46	-1.97
		Construction and logistics	6.19	1.33	4.86	1.33	-2.12
		Energy and utilities	5.57	0.82	4.75	0.82	-2.02
		Financial services (excl. banking)	30.01***	1.86	28.16***	1.86	-2.83
		Industrial	5.10	0.25	4.85	0.25	-2.12
		Telecommunication, media and tech.	6.41	0.91	5.50	0.91	-2.08
		Overall	14.16	0.83	13.33	0.83	-2.52
Period 4	Regional bank CDS	Automotive	11.95	1.22	10.74	1.22	-1.98
		Basic materials	8.77	0.99	7.79	0.99	-1.75
		Chemicals, healthcare and pharma	10.72	1.04	9.68	1.04	-1.79
		Commerce and consumer	13.62	2.29	11.33	2.29	-1.45
		Construction and logistics	11.92	3.83	8.09	3.83	-1.75
		Energy and utilities	9.19	2.92	6.28	2.92	-1.60
		Financial services (excl. banking)	17.04	7.11	9.93	7.11	-2.61
		Industrial	9.13	0.96	8.17	0.96	-1.88
		Telecommunication, media and tech.	8.74	2.01	6.73	2.01	-1.39
		Overall	12.71	2.10	10.61	2.10	-1.21

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix N: Unit-root test for regional bank equity prices

Period	Regional bank equity prices	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	America	0.22	0.22	1.52***	-19.99***	-19.99***	0.10
	Asia-Pacific	0.19	0.19	1.85***	-29.02***	-29.02***	0.01
	Europe	0.78	0.78	1.45***	-22.18***	-22.18***	0.01
	Middle East & Russia	0.12	0.12	3.77***	-21.56***	-21.56***	0.02
Period 2	America	-1.86*	-1.86*	2.87***	-15.49***	-15.49***	0.08
	Asia-Pacific	-2.54**	-2.54**	2.37***	-13.52***	-13.52***	0.17**
	Europe	-2.28**	-2.28**	4.30***	-15.50***	-15.50***	0.09
	Middle East & Russia	-1.14	-1.14	4.92***	-21.31***	-21.31***	0.07
Period 3	America	0.10	0.10	5.70***	-15.12***	-15.12***	0.03
	Asia-Pacific	0.11	0.11	5.09***	-14.24***	-14.24***	0.25***
	Europe	-0.17	-0.17	5.96***	-15.09***	-15.09***	0.04
	Middle East & Russia	-0.94	-0.94	5.25***	-14.60***	-14.60***	0.28***
Period 4	America	-0.31	-0.31	4.34***	-15.58***	-15.58***	0.03
	Asia-Pacific	-0.55	-0.55	2.03***	-14.68***	-14.68***	0.09
	Europe	-0.85	-0.85	2.46***	-16.23***	-16.23***	0.04
	Middle East & Russia	1.09	1.09	1.56***	-15.38***	-15.38***	0.04

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix O: Unit-root test for regional corporate equity prices

America

Period	Industry equity prices	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	-0.78	-0.77	4.66***	-18.31***	-18.30***	0.05
	Basic materials	0.41	0.40	4.16***	-18.04***	-18.02***	0.05
	Chemicals, healthcare and pharma	0.08	0.08	3.75***	-19.29***	-19.30***	0.07
	Commerce and consumer	0.27	0.30	4.76***	-21.14***	-21.27***	0.04
	Construction and logistics	-0.03	-0.03	2.52***	-18.76***	-18.76***	0.10
	Energy and utilities	-0.15	-0.16	2.19***	-20.27***	-20.39***	0.04
	Financial services (excl. banking)	0.56	0.61	4.61***	-20.71***	-20.76***	0.07
	Industrial	0.23	0.24	2.64***	-19.67***	-19.69***	0.05
	Telecommunication, media and tech.	0.66	0.73	6.00***	-21.16***	-21.27***	0.07
	Overall	0.30	0.34	5.13***	-21.27***	-21.42***	0.05
Period 2	Automotive	-1.04	-1.09	1.90***	-20.93***	-20.89***	0.04
	Basic materials	0.74	0.76	2.12***	-20.37***	-20.35***	0.04
	Chemicals, healthcare and pharma	-1.37	-1.47	6.30***	-20.58***	-20.59***	0.05
	Commerce and consumer	-0.85	-0.95	1.79***	-22.19***	-22.23***	0.02
	Construction and logistics	-0.74	-0.78	3.13***	-20.51***	-20.50***	0.03
	Energy and utilities	-0.16	-0.17	2.14***	-23.12***	-23.11***	0.03
	Financial services (excl. banking)	-1.36	-1.43	4.28***	-21.08***	-21.06***	0.05
	Industrial	-0.76	-0.84	6.34***	-22.04***	-22.08***	0.02
	Telecommunication, media and tech.	-0.96	-1.06	3.99***	-21.96***	-21.92***	0.07
	Overall	-1.04	-1.17	4.40***	-22.31***	-22.29***	0.04
Period 3	Automotive	0.84	0.80	4.42***	-18.29***	-18.33***	0.09
	Basic materials	-0.47	-0.49	5.78***	-19.07***	-19.08***	0.09
	Chemicals, healthcare and pharma	0.13	0.18	7.05***	-22.23***	-22.48***	0.02
	Commerce and consumer	0.04	0.06	6.36***	-22.50***	-22.81***	0.02
	Construction and logistics	-0.01	0.01	7.10***	-21.35***	-21.46***	0.03
	Energy and utilities	-0.22	-0.26	4.57***	-23.69***	-24.34***	0.01
	Financial services (excl. banking)	-0.39	-0.41	6.95***	-20.50***	-20.53***	0.04
	Industrial	-0.62	-0.67	7.55***	-20.94***	-20.94***	0.04
	Telecommunication, media and tech.	0.07	0.11	5.70***	-22.72***	-23.06***	0.02
	Overall	-0.22	-0.24	7.14***	-21.15***	-21.24***	0.03
Period 4	Automotive	1.00	0.98	1.94***	-18.53***	-18.53***	0.07
	Basic materials	0.98	0.92	3.56***	-17.75***	-17.76***	0.06
	Chemicals, healthcare and pharma	0.80	0.84	2.58***	-19.08***	-19.10***	0.04
	Commerce and consumer	0.85	0.88	2.70***	-19.32***	-19.33***	0.06
	Construction and logistics	1.05	1.06	2.44***	-18.65***	-18.65***	0.04
	Energy and utilities	1.18	1.26	4.32***	-20.04***	-20.06***	0.04
	Financial services (excl. banking)	0.83	0.91	2.65***	-19.71***	-19.73***	0.06
	Industrial	1.35	1.33	2.54***	-17.65***	-17.65***	0.10
	Telecommunication, media and tech.	0.59	0.61	1.91***	-19.61***	-19.61***	0.03
	Overall	1.04	1.09	1.98***	-19.26***	-19.26***	0.06

Asia-Pacific

Period	Industry equity prices	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	0.68	0.69	2.74***	-18.55***	-18.55***	0.05
	Basic materials	1.02	1.11	3.01***	-20.20***	-20.25***	0.04
	Chemicals, healthcare and pharma	1.04	1.07	2.92***	-19.21***	-19.21***	0.09
	Commerce and consumer	0.81	0.84	2.80***	-19.87***	-19.87***	0.08
	Construction and logistics	-0.05	-0.05	3.42***	-18.25***	-18.23***	0.10
	Energy and utilities	1.46	1.55	3.40***	-20.72***	-20.71***	0.07
	Financial services (excl. banking)	1.64	1.79	3.16***	-19.65***	-19.67***	0.02
	Industrial	0.35	0.36	3.10***	-19.25***	-19.25***	0.09
	Telecommunication, media and tech.	0.56	0.58	3.20***	-19.20***	-19.20***	0.07
	Overall	0.97	1.01	3.31***	-19.56***	-19.56***	0.07
Period 2	Automotive	-1.46	-1.56	1.37***	-21.45***	-21.43***	0.02
	Basic materials	0.45	0.47	3.27***	-19.52***	-19.53***	0.03
	Chemicals, healthcare and pharma	-1.01	-1.13	2.48***	-20.93***	-21.07***	0.05
	Commerce and consumer	-0.67	-0.76	4.84***	-21.93***	-22.11***	0.03
	Construction and logistics	-1.99**	-1.95**	4.76***	-18.73***	-18.73***	0.02
	Energy and utilities	-0.15	-0.15	7.60***	-20.05***	-20.04***	0.04
	Financial services (excl. banking)	-0.90	-0.90	5.23***	-18.92***	-18.92***	0.03
	Industrial	-0.29	-0.31	3.01***	-21.24***	-21.35***	0.03
	Telecommunication, media and tech.	-0.51	-0.54	3.84***	-21.33***	-21.36***	0.02
	Overall	-0.59	-0.64	4.47***	-21.82***	-21.90***	0.02
Period 3	Automotive	0.08	0.11	4.09***	-21.71***	-21.85***	0.04
	Basic materials	-0.19	-0.20	6.12***	-19.15***	-19.16***	0.07
	Chemicals, healthcare and pharma	-0.42	-0.42	3.28***	-18.47***	-18.46***	0.04
	Commerce and consumer	-0.23	-0.26	6.21***	-22.10***	-22.26***	0.04
	Construction and logistics	-0.12	-0.12	2.60***	-19.26***	-19.26***	0.04
	Energy and utilities	-0.38	-0.38	3.22***	-19.67***	-19.68***	0.02
	Financial services (excl. banking)	0.20	0.21	7.22***	-20.88***	-20.84***	0.03
	Industrial	-0.23	-0.23	5.50***	-19.25***	-19.25***	0.07
	Telecommunication, media and tech.	-0.43	-0.46	5.80***	-21.42***	-21.49***	0.04
	Overall	-0.26	-0.27	5.90***	-20.65***	-20.70***	0.05
Period 4	Automotive	0.11	0.13	2.28***	-19.52***	-19.66***	0.05
	Basic materials	0.36	0.36	2.97***	-18.56***	-18.56***	0.05
	Chemicals, healthcare and pharma	0.67	0.70	1.35***	-18.78***	-18.80***	0.04
	Commerce and consumer	0.80	0.85	2.07***	-18.42***	-18.45***	0.06
	Construction and logistics	0.45	0.53	3.87***	-21.12***	-21.31***	0.05
	Energy and utilities	0.56	0.59	4.00***	-18.27***	-18.28***	0.03
	Financial services (excl. banking)	-0.35	-0.35	3.82***	-18.19***	-18.19***	0.02
	Industrial	0.82	0.85	3.49***	-18.27***	-18.27***	0.07
	Telecommunication, media and tech.	0.19	0.21	1.67***	-19.38***	-19.48***	0.05
	Overall	0.51	0.54	1.81***	-19.06***	-19.13***	0.05

Europe

Period	Industry equity prices	Log Values			Log Differences		
		ADF	PP	KPSS	ADF	PP	KPSS
Period 1	Automotive	1.59	1.61	4.00***	-18.93***	-18.93***	0.06
	Basic materials	1.49	1.54	2.27***	-19.97***	-19.96***	0.03
	Chemicals, healthcare and pharma	1.10	1.11	2.03***	-19.45***	-19.45***	0.03
	Commerce and consumer	2.21	2.27	4.10***	-19.76***	-19.75***	0.05
	Construction and logistics	1.20	1.17	3.95***	-19.28***	-19.29***	0.07
	Energy and utilities	0.79	0.79	2.43***	-18.98***	-18.98***	0.06
	Financial services (excl. banking)	1.43	1.51	3.58***	-20.50***	-20.50***	0.08
	Industrial	1.35	1.39	3.99***	-20.37***	-20.35***	0.12
	Telecommunication, media and tech.	0.45	0.45	7.36***	-18.59***	-18.59***	0.06
	Overall	1.51	1.61	3.95***	-20.66***	-20.66***	0.07
Period 2	Automotive	0.53	0.51	4.90***	-19.56***	-19.56***	0.05
	Basic materials	-0.21	-0.22	2.51***	-21.28***	-21.25***	0.03
	Chemicals, healthcare and pharma	-0.20	-0.20	2.92***	-20.61***	-20.57***	0.07
	Commerce and consumer	-0.84	-0.88	2.49***	-20.89***	-20.87***	0.03
	Construction and logistics	-1.55	-1.49	3.11***	-18.90***	-18.93***	0.07
	Energy and utilities	-0.30	-0.30	5.01***	-20.59***	-20.55***	0.05
	Financial services (excl. banking)	-1.37	-1.41	2.87***	-20.36***	-20.34***	0.02
	Industrial	-0.13	-0.13	4.73***	-21.39***	-21.32***	0.03
	Telecommunication, media and tech.	-0.74	-0.79	7.72***	-21.22***	-21.22***	0.04
	Overall	-1.01	-1.05	3.77***	-21.04***	-21.00***	0.03
Period 3	Automotive	-0.50	-0.51	2.29***	-17.92***	-17.90***	0.06
	Basic materials	-0.43	-0.43	7.06***	-18.27***	-18.26***	0.05
	Chemicals, healthcare and pharma	-0.04	-0.03	7.94***	-20.07***	-20.11***	0.02
	Commerce and consumer	0.07	0.08	7.35***	-19.02***	-19.05***	0.04
	Construction and logistics	0.19	0.19	4.97***	-18.09***	-18.06***	0.03
	Energy and utilities	-0.44	-0.48	7.01***	-20.03***	-20.15***	0.02
	Financial services (excl. banking)	-0.38	-0.38	6.81***	-18.52***	-18.51***	0.05
	Industrial	-0.46	-0.46	5.89***	-18.45***	-18.44***	0.05
	Telecommunication, media and tech.	-0.14	-0.15	7.60***	-20.42***	-20.58***	0.02
	Overall	-0.39	-0.41	6.91***	-18.87***	-18.87***	0.05
Period 4	Automotive	1.58	1.50	2.71***	-16.09***	-16.02***	0.08
	Basic materials	0.52	0.51	4.09***	-17.55***	-17.53***	0.03
	Chemicals, healthcare and pharma	0.96	0.95	2.69***	-18.19***	-18.19***	0.03
	Commerce and consumer	0.57	0.60	2.81***	-18.78***	-18.79***	0.03
	Construction and logistics	0.06	0.06	4.32***	-17.44***	-17.42***	0.02
	Energy and utilities	-0.28	-0.27	6.34***	-17.41***	-17.40***	0.05
	Financial services (excl. banking)	0.35	0.34	3.95***	-17.61***	-17.60***	0.02
	Industrial	1.03	1.02	3.90***	-16.98***	-16.94***	0.02
	Telecommunication, media and tech.	0.22	0.23	1.76***	-18.90***	-18.92***	0.04
	Overall	0.56	0.56	4.06***	-17.54***	-17.53***	0.03

Notes: The table shows the test-statistics from applying the ADF, PP and KPSS unit root tests. ADF and PP examines the null hypothesis of a unit root. By contrast, the KPSS test examines the null hypothesis of stationarity. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.

Appendix P: Cointegration test for regional bank and corporate equity prices

America

Period	Variable 1 Regional bank equity	Variable 2 Non-bank corp. equity	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank equity	Automotive	14.30	2.99	11.31	2.99	-1.56
		Basic materials	8.64	2.92	5.71	2.92	-1.65
		Chemicals, healthcare and pharma	6.50	3.06	3.44	3.06	-1.74
		Commerce and consumer	10.01	3.10	6.91	3.10	-2.10
		Construction and logistics	7.11	2.89	4.22	2.89	-1.78
		Energy and utilities	23.47**	2.96	20.50***	2.96	-3.44**
		Financial services (excl. banking)	9.66	2.77	6.90	2.77	-1.61
		Industrial	10.84	3.08	7.77	3.08	-1.87
		Telecommunication, media and tech.	8.63	2.71	5.92	2.71	-2.09
		Overall	9.22	3.28	5.93	3.28	-1.96
Period 2	Regional bank equity	Automotive	12.89	3.79	9.10	3.79	-2.51
		Basic materials	21.78**	4.55	17.23**	4.55	-1.43
		Chemicals, healthcare and pharma	11.16	4.43	6.73	4.43	-1.72
		Commerce and consumer	16.42	3.87	12.55	3.87	-3.31*
		Construction and logistics	10.50	3.97	6.53	3.97	-2.09
		Energy and utilities	26.01***	6.07	19.94**	6.07	-2.32
		Financial services (excl. banking)	9.99	3.83	6.16	3.83	-2.20
		Industrial	9.62	4.23	5.39	4.23	-1.91
		Telecommunication, media and tech.	14.14	4.73	9.40	4.73	-2.31
		Overall	12.40	4.63	7.77	4.63	-2.24
Period 3	Regional bank equity	Automotive	10.74	1.66	9.08	1.66	-2.80
		Basic materials	10.64	2.43	8.20	2.43	-1.63
		Chemicals, healthcare and pharma	12.38	2.58	9.81	2.58	-2.30
		Commerce and consumer	13.27	3.29	9.98	3.29	-1.61
		Construction and logistics	7.74	2.13	5.61	2.13	-1.89
		Energy and utilities	17.59	2.51	15.08*	2.51	-1.33
		Financial services (excl. banking)	7.44	2.18	5.26	2.18	-1.38
		Industrial	8.07	2.80	5.28	2.80	-1.28
		Telecommunication, media and tech.	13.02	2.45	10.57	2.45	-2.15
		Overall	8.64	2.60	6.04	2.60	-1.59
Period 4	Regional bank equity	Automotive	16.86	4.40	12.47	4.40	-3.02
		Basic materials	14.74	3.68	11.06	3.68	-3.23*
		Chemicals, healthcare and pharma	18.64*	5.33	13.31	5.33	-3.11*
		Commerce and consumer	18.12*	7.09	11.04	7.09	-2.81
		Construction and logistics	16.95	5.13	11.81	5.13	-2.88
		Energy and utilities	14.69	2.74	11.96	2.74	-3.25*
		Financial services (excl. banking)	20.59**	7.39	13.20	7.39	-2.84
		Industrial	23.39**	3.55	19.84**	3.55	-3.22*
		Telecommunication, media and tech.	13.65	4.73	8.92	4.73	-2.89
		Overall	18.42*	4.87	13.55	4.87	-3.01

Asia-Pacific

Period	Variable 1 Regional bank equity	Variable 2 Non-bank corp. equity	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank equity	Automotive	40.75***	2.89	37.87***	2.89	-6.25***
		Basic materials	41.92***	1.70	40.22***	1.70	-6.51***
		Chemicals, healthcare and pharma	32.83***	3.66	29.16***	3.66	-5.50***
		Commerce and consumer	31.79***	6.62	25.16***	6.62	-5.08***
		Construction and logistics	30.40***	2.51	27.89***	2.51	-5.27***
		Energy and utilities	47.35***	2.54	44.81***	2.54	-6.89***
		Financial services (excl. banking)	58.44***	3.00	55.44***	3.00	-7.69***
		Industrial	29.29***	3.76	25.53***	3.76	-5.08***
		Telecommunication, media and tech.	31.14***	5.94	25.21***	5.94	-5.06***
		Overall	35.58***	3.30	32.28***	3.30	-5.79***
Period 2	Regional bank equity	Automotive	27.11***	1.98	25.14***	1.98	-2.79
		Basic materials	23.63**	5.29	18.34**	5.29	-1.13
		Chemicals, healthcare and pharma	24.49**	3.78	20.72***	3.78	-2.91
		Commerce and consumer	33.70***	4.58	29.12***	4.58	-2.37
		Construction and logistics	16.55	3.05	13.50	3.05	-1.51
		Energy and utilities	24.71**	6.14	18.57**	6.14	-1.39
		Financial services (excl. banking)	13.48	5.41	8.07	5.41	-2.32
		Industrial	25.38***	3.67	21.72***	3.67	-1.45
		Telecommunication, media and tech.	30.26***	3.92	26.35***	3.92	-2.27
		Overall	32.01***	4.13	27.89***	4.13	-2.14
Period 3	Regional bank equity	Automotive	14.78	0.62	14.16*	0.62	-2.38
		Basic materials	14.24	1.15	13.09	1.15	-1.94
		Chemicals, healthcare and pharma	22.80**	0.64	22.17***	0.64	-1.59
		Commerce and consumer	25.10***	1.36	23.74***	1.36	-1.58
		Construction and logistics	14.82	0.39	14.43*	0.39	-1.43
		Energy and utilities	11.63	0.36	11.27	0.36	-1.42
		Financial services (excl. banking)	14.80	1.99	12.82	1.99	-1.48
		Industrial	19.96*	0.96	19.00**	0.96	-2.28
		Telecommunication, media and tech.	18.40*	1.01	17.39**	1.01	-1.23
		Overall	18.21*	1.17	17.05**	1.17	-1.72
Period 4	Regional bank equity	Automotive	22.60**	10.47**	12.13	10.47**	-2.00
		Basic materials	8.92	3.92	4.99	3.92	-1.99
		Chemicals, healthcare and pharma	20.64**	8.77*	11.87	8.77*	-1.97
		Commerce and consumer	13.63	4.46	9.17	4.46	-1.97
		Construction and logistics	14.79	6.63	8.16	6.63	-1.97
		Energy and utilities	15.95	4.68	11.26	4.68	-2.09
		Financial services (excl. banking)	14.40	4.01	10.40	4.01	-2.00
		Industrial	11.82	3.33	8.49	3.33	-2.00
		Telecommunication, media and tech.	22.20**	9.86**	12.34	9.86**	-1.97
		Overall	15.69	6.66	9.03	6.66	-2.00

Europe

Period	Variable 1 Regional bank equity	Variable 2 Non-bank corp. equity	Johansen Trace Stat. r=0	Johansen Trace Stat. r=1	Johansen Max Eigenvalue r=0	Johansen Max Eigenvalue r=1	Engle-Granger-Test
Period 1	Regional bank equity	Automotive	20.12*	4.03	16.10**	4.03	-4.05***
		Basic materials	32.19***	3.21	28.98***	3.21	-5.10***
		Chemicals, healthcare and pharma	32.95***	3.17	29.78***	3.17	-5.07***
		Commerce and consumer	40.09***	5.61	34.48***	5.61	-5.90***
		Construction and logistics	12.96	2.41	10.55	2.41	-3.20*
		Energy and utilities	24.87**	2.11	22.76***	2.11	-4.49***
		Financial services (excl. banking)	19.42*	3.80	15.62*	3.80	-3.85**
		Industrial	11.81	3.21	8.60	3.21	-2.83
		Telecommunication, media and tech.	11.24	1.08	10.16	1.08	-2.74
		Overall	20.71**	3.41	17.30**	3.41	-4.11***
Period 2	Regional bank equity	Automotive	15.20	4.03	11.17	4.03	-1.43
		Basic materials	20.19*	7.59*	12.59	7.59*	-2.49
		Chemicals, healthcare and pharma	18.10*	6.68	11.42	6.68	-3.12*
		Commerce and consumer	12.43	3.35	9.08	3.35	-2.65
		Construction and logistics	9.63	2.98	6.64	2.98	-1.43
		Energy and utilities	17.09	6.98	10.11	6.98	-2.35
		Financial services (excl. banking)	10.62	3.63	6.99	3.63	-2.21
		Industrial	16.96	7.28	9.67	7.28	-2.32
		Telecommunication, media and tech.	11.86	3.59	8.27	3.59	-1.96
		Overall	11.34	4.36	6.98	4.36	-2.37
Period 3	Regional bank equity	Automotive	27.54***	3.74	23.81***	3.74	-2.42
		Basic materials	10.88	3.53	7.35	3.53	-2.18
		Chemicals, healthcare and pharma	13.40	3.25	10.15	3.25	-2.45
		Commerce and consumer	9.57	2.07	7.50	2.07	-2.65
		Construction and logistics	7.56	1.36	6.20	1.36	-2.33
		Energy and utilities	14.82	3.94	10.88	3.94	-2.10
		Financial services (excl. banking)	8.38	3.56	4.82	3.56	-1.91
		Industrial	10.37	3.51	6.86	3.51	-2.00
		Telecommunication, media and tech.	13.44	3.89	9.55	3.89	-2.48
		Overall	9.40	3.37	6.03	3.37	-1.94
Period 4	Regional bank equity	Automotive	12.19	4.13	8.06	4.13	-2.65
		Basic materials	10.21	2.73	7.48	2.73	-2.61
		Chemicals, healthcare and pharma	10.83	2.02	8.81	2.02	-2.54
		Commerce and consumer	14.96	3.89	11.07	3.89	-2.85
		Construction and logistics	11.41	3.76	7.66	3.76	-1.86
		Energy and utilities	8.10	1.46	6.64	1.46	-1.58
		Financial services (excl. banking)	9.75	2.87	6.89	2.87	-2.30
		Industrial	11.12	4.55	6.57	4.55	-2.55
		Telecommunication, media and tech.	10.96	3.60	7.35	3.60	-2.34
		Overall	10.14	2.69	7.45	2.69	-2.52

Notes: The table shows the test-statistics from applying the Johansen Trace and Max Eigenvalue tests and the Engle-Granger cointegration tests. *r* denotes the null hypothesis with respect to the available cointegrating vectors, e.g., *r=0* denotes that the null hypothesis of *zero* cointegrating vectors. *, **, *** denotes significance at the 10%, 5% and 1% significance level, respectively. Period 1 ranges from October 1st, 2005 to February 28th, 2007, Period 2 ranges from March 1st, 2007 to July 31st, 2008, Period 3 ranges from August 1st, 2008 to December 31st, 2009, Period 4 ranges from January 1st, 2010 to April 30th, 2011.