Systemic risk and insurance

Pierre-Emmanuel Darpeix

WORKING PAPER N° 2015 – 39

Systemic risk and insurance

Pierre-Emmanuel Darpeix

JEL Codes: G22, G28, G32, G38, L51
Keywords: Insurance, Systemic risk, International regulation

Systemic risk and insurance

This version: May 19th 2014

Pierre-Emmanuel Darpeix

Paris School of Economics
Campus Jourdan – 48, boulevard Jourdan – 75014 Paris.

Summary:

The literature generally agrees that the traditional insurance sector is not a source of systemic risk, and insurers are often considered to be shock absorbers rather than shock amplifiers. Yet, the evolution of the industry both in terms of structure (concentration of the reinsurers, increased linkages with banks, especially through bancassurance conglomerates) and in terms of techniques (securitization, monolines, derivatives) increased the systemic relevance of the insurers.

Résumé:

La littérature admet généralement que le secteur traditionnel de l'assurance n'est pas une source de risque systémique: les assureurs sont plutôt considérés comme des absorbeurs de chocs plutôt que comme des amplificateurs. Cependant, l'évolution du secteur, que ce soit en termes de structure (concentration des réassureurs, liens accrus avec les banques, et tout particulièrement par le biais de conglomérats de bancassurance) ou en termes de techniques (titrisation, *monolines*, dérivés) invite à étudier le potentiel systémique des assureurs.

Keywords: Insurance, Systemic risk, International regulation

JEL Classification: G22, G28, G32, G38, L51.

List of acronyms:

ACPR	French Supervisor (*Autorité de contrôle prudentiel et de résolution*)
CDS	Credit Default Swap
CoVar	Co-Value-at-Risk index (for systemic risk)
DIP	Distress Insurance Premium (measure of systemic risk)
EIOPA	European Insurance and Occupational Pensions Authority
FGAP	French Life-insurance guarantee scheme (*fonds de garantie des assurances de personnes*)
FSB	Financial Stability Board
GIC	Guaranteed Insurance Contract
G-SIB	Global Systemically Important Bank
G-SII	Global Systemically Important Insurers
IAIS	International Association of Insurance Supervisors
ILS	Insurance Linked Security
ILW	Industry Loss Warranties
MBS	Mortgage-Backed Security
MES	Marginal Expected Shortfall
NTNI	Non-Traditional/Non-Insurance activities
ORSA	Own Risk and Solvency Assessment
PC	Property-Casualty insurance (non-life)
SES	Systemic Expected Shortfall
SIFI	Systemically Important Financial Institution
SRISK	Systemic Risk index
S1	Solvency 1 prudential regime
S2	Solvency 2 prudential regime

Introduction:

The issue at stake here is to assess whether the insurance sector should be considered a source of systemic risk and identify its potential vulnerabilities to impairments in the financial sector. We review writings from the academia, the supervisory authorities, and the industry, and come to the conclusion that traditional insurers represent a smaller risk to the system than the banking sector, chiefly because of the specificities of their business model (inverted cycle, asset-liability matching) and the hierarchical structure of the industry. The life segment, sharing common features with the banking sector's saving products is more at risk than the property-casualty (PC) segment, but remains low risk, although much concern has arisen over the past years about life-insurers' ability to cope with a prolonged low yield environment.
This said, the recent developments in the financial sector, both in terms of structure (concentration, conglomerates) and in terms of products (credit derivatives, securitization) increase the linkages within the group of insurers, as well as between insurers and the rest of the financial world.
Strikingly, the content of the extent literature on systemic risk in insurance is rather descriptive and policy oriented: quantitative analysis is more the exception than the rule.

The paper is organized as follows: In section 1 we provide a discussion on the standard definition of systemic risk and a description of the factors that are retained by the supervisors to assess the potential for systemic risk origination as well as systemic risk vulnerability; we also review some of the newly developed metrics provided by the academia. Section 2 assesses the systemic relevance of insurers against that of banks. We compare the two sectors in terms of industry organization and business models. Section 3 shows that the interconnections between insurance and the rest of the financial sector are significant, and getting even more so. Section 4 focuses on particularly risky business lines pertaining to the Non-Traditional/Non-Insurance category of newly developed activities. The special case of reinsurance is addressed in section 5, and open research questions in the last section.

I. Some definitions and assessments methods:

1) Definition(s)

The supervisors – e.g. the Financial Stability Board (FSB), the International Association of Insurance Supervisors (IAIS) or the European Insurance and Occupational Pensions Authority (EIOPA) – define systemic risk as **"the risk of disruption to the flow of financial services that is *(i)* caused by an impairment of all or parts of the financial system; and *(ii)* has the potential to have serious negative consequences for the real economy."**[1]

In most of the literature, systemic risk relates to the failure of a significant portion of financial institutions, with a large negative impact on the real economy.[2]
This large scale failure can either be triggered by a macroeconomic shock affecting simultaneously many institutions exposed in the same way, or it can propagate, through a network of financial interdependencies, from the initial impairment of a few institutions. The concept of systemic risk can thus be understood either as a structural vulnerability of the financial institutions to a given set of exogenous factors (system-wide shock), or as a consequence of spillover and contagion effects endogenous to the financial system (limited shock with subsequent contagion).

Some authors, like Harrington (2009), restrict the understanding of systemic risk to *"interdependency transmitted contagion"* (p.802). For instance, the Committee on Capital markets Regulation (2009) defines the systemic risk as *"the risk of collapse of an entire system or entire market, exacerbated by links and interdependencies, where the failure of a single entity or cluster of entities can cause a cascading failure"*, p.ES-3).

Another interesting qualification of the definition of systemic risk can be found in Billio *et al* (2012): "*any set of circumstances that threatens the stability of or public confidence in the financial system"* (p.537). Indeed, the authors recognize the self-fulfilling propensity of events affecting the financial sector.

Eventually, the geographical understanding of the concept of "system" is not always very clear as an institution could well be considered systemically relevant for a national economy without it being significant globally. Several authors in the literature addressed the issue of systemic risk at the national level.[3]

2) Primary factors:

To try to identify the different sources of impairments, the FSB indicated three main criteria at the entity level, namely *size*, *interconnectedness* and *substitutability*[4] to which the IAIS added a *timing criterion*[5] to account for the inverted production cycle that characterizes insurers.

[1] FSB (2009), p.5 ; IAIS (2009), p.1 ; See also EIOPA (2014a), p.55
[2] Eling and Pankoke (2014), p.33
[3] e.g. Minderhood (2003) for the Netherlands ; Cummins and Weiss (2012) for the US ; Frey *et al* (2013) for France.
[4] FSB (2009), p.9
[5] IAIS (2009), p.5

When conducting the identification of globally systemically important insurers though, the IAIS did not include the timing criterion (although they keep on recognizing the specificity of the insurance sector with respect to the timeframe of the potential outflows) but added *global activity* and *non-traditional insurance* to the list of criteria.[6] Once again, the proposed criteria should, according to the regulator, be used to identify systemically important financial institutions and not business activities. These criteria led to the identification of 9 insurance companies and 28 banks as globally systematically important financial institutions (SIFIs) in 2012-2013.[7] In November 2014, the FSB issued a note indicating that the list remained unchanged. The IAIS methodology is expected to be updated by November 2015, and the list to be amended.[8]

a) <u>Size:</u>

Size is the first criterion that comes to mind when one tries to identify the determinants of systemic risk. “Too big to fail” means that a firm’s collapse would imply such an enormous cost for the economy at large that the government is forced to rescue it. Yet many argue that this criterion is too crude to actually reflect the potential for systemic risk. Indeed, if it is clear that a large institution’s default is more likely to perturb the system than a small firm, it is also true that small and large companies do not have the same probability of default in the first place. This *caveat* is particularly relevant for insurance companies as their *raison d’être* is the pooling of risk across time, geography, and business lines: larger insurers enjoy diversification benefits which may increase their resilience to shocks.[9] Additionally, as noted by Adrian and Brunnermeier (2011), “many small institutions can be ‘systemic as part of a herd’.” (p.21) Indeed, should many firms be exposed in a similar fashion to the very same risk, with identical incentives (may they be prudential, fiscal, competitive), a slight transformation in the global economic conditions is likely to induce a simultaneous parallel shift of all undertakings, with potentially dire consequences.

b) <u>Interconnectedness:</u>

As was mentioned earlier, the impairment of a large part of the system can be due to the simultaneous collapse of several independent institutions exposed to a similar risk, or to the propagation of a distress from an initial individual collapse. This propagation can only happen through a network of interconnections.
Contagion can take several forms[10]:

- Asset price contagion with the cascade of ‘fire sales’
- Counterparty contagion (either through bankruptcies or credit ratings downgrades)
- Reputational contagion (where investors suspect that other firms may either be subject to the same exogenous distress that caused the initial collapse, or be exposed to the initial collapse: suspicion of connectedness can be a form of connectedness)
- Irrationality (general withdrawal of funds irrespective of individual firms’ actual risk exposure).

[6] IAIS (2013), p.12 ; See also EIOPA (2014a), p.56 and 58 for the precise weighting of the different indicators used to define SIFIs.
[7] See FSB (2012), p.3 for the list of global systematically important banks (G-SIBs)
and FSB (2013), p.4 for the list of global systematically important insurers (G-SIIs)
[8] See FSB (2014), p.2 for the 2014 list of G-SIIs
[9] IAIS (2011), p.9 ;
see also Geneva Association (2010): “*It is not size as such that presents danger but **undiversified size***”, p.25
[10] Harrington (2009), p.802 ; Eling and Pankoke (2014), p.8

Aside from proper contagion, we would like to point out that connectedness can also stem from the use of similar models, the reliance on similar indicators, with the consequence that a exogenous shock on one particular parameter induces many firms to react the same way. Prudential regulation could be considered a particular form of exogenous interconnectedness between supervised firms.

c) Substitutability:

This last common criterion for banks and insurers refers to the ability of competitors to take over the operations of a failed undertaking. Substitutability could be reduced should the defaulting institution be too large for its business to be absorbed by the competitors, or should the products commercialized be too complex or too specific. In order to be relevant for systemic risk, lack of substitutability must concern a service of critical importance (e.g. the payment and settlement systems, the liquidity provision ...).[11]

In general, the insurance activities are deemed pretty substitutable as the sector is rather competitive. Yet the disappearance of a whole segment of the insurance industry could have significant long run effects both socially and economically: insurance fosters several economic activities that would probably not take place without proper coverage (e.g. some areas of medical specialization).

The degree of actual substitutability can be very dependent on the approval policy undertaken by the national supervisory authority.

d) Factors specific to the insurance sector:

The previous three primary factors were common to both the banking and the insurance sectors. The following two are specific to the identification of globally systemically important insurers (G-SII).

With the “*global activity*” factor, IAIS tries to measure the connection of a particular institution to the international markets. It can also help assess the degree to which a firm diversifies its “exposure” to regulatory frameworks and its opportunities for regulatory arbitrages. The “*non-traditional insurance and non-insurance*” factor aims at capturing the exposure to particularly risky operations. This factor will be addressed in more detail in IV.[12]

e) General comments:

Cummins and Weiss (2012) argue that what matters the most is not each criterion taken individually, but rather the interaction between these factors: “a large firm may not pose a systemic problem if it is not interconnected or if its products do not lack substitutes” (p.9)

To determine the globally systemically important insurers (G-SII), IAIS constructed an index that weights differently the five factors. While “interconnectedness” and “non-traditional insurance and non-insurance activities” account respectively for 40% and 45% of the index, the other three account for 5% each.[13] The weights are the result of international negotiations, and can appear quite arbitrary. Again, an update of the IAIS methodology is expected by November 2015.

As was noted earlier, the FSB criteria were designed to be applied at the entity level. Other branches of the literature focus on business lines rather than on institutions to

[11] Cummins and Weiss (2012), p.11
[12] EIOPA (2014a), p.58
[13] EIOPA (2014a), p.58

identify systemic risk.[14] This could indeed avoid regulatory arbitrage (e.g. risky activities could migrate to partner non-SIFI-labelled institutions) and market distortions (the likelihood of bailout would be larger for SIFIs than for other institutions).

The time criterion, introduced by the IAIS in 2009, is particularly relevant as a slow pace of contagion can give leeway for the regulator to intervene. With respect to this particular criterion, insurance activities (especially PC and health) are very different from banks as their business model implies that claim settlement can take several months, contrary to margin calls for instance. When an insurer fails, it generally goes into a run-off process that can last for several years, while the collapse of a bank can happen almost overnight. This factor was very useful to compare the systemic relevance of banks and insurances, yet, surprisingly, it disappeared from the constitution of the G-SII index by IAIS in 2013.

3) Contributing factors:

To evaluate the resilience/vulnerability of financial institutions to an initial impairment, and therefore the potential for contagion, the FSB proposes three additional criteria, namely *leverage, liquidity risk and maturity mismatch,* and *complexity*.[15]

a) Leverage:

In the words of Cummins and Weiss (2012), "*leverage is an indicator of vulnerability to financial shocks and also of interconnectedness. i.e., the likelihood that an institution will propagate distress in the system by magnifying financial shocks.*" (p.13). Indeed, the more leveraged a position is, the more likely it is to go bankrupt in case of an adverse price movement due to the higher margin requirements. What is true for individual positions is also true for entire portfolios and firms: in periods of stress, highly levered firms are particularly vulnerable to loss spirals.

b) Liquidity risk and maturity mismatch:

Brunnnermeier and Pederson (2009) distinguish between two types of liquidity: market liquidity (which relates to the tradability of an asset), and funding liquidity (corresponding to the ability of a trader to fund its operations).
Vulnerability to systemic risk can arise when a shock hits a company with a large exposure to illiquid assets. This indeed reduces the managerial leeway to cope with the shock, and could induce forced sales of asset for a depressed price. Note that the liquidity of a given asset is not exogenous and can be reduced in times of crisis. (cf. Gorton (2008), p.77 on rating-triggered fire sales).
Funding liquidity relates to the ease with which investors and traders can raise money from the markets. For instance, the risk stems from a firm's inability to fund its margin call, and the consecutive liquidation of its position (funding liquidity could also be induced by massive surrender, or by the inability to roll over short term funding). [16]
Maturity mismatch occurs when the assets and liabilities of the balance sheet differ in terms of duration or in terms of cash flows.

[14] See Geneva Association (2010)*: "Our aim is not to argue that the criteria are wrong, or that they do not apply to insurers, only that they need to be applied to **activities** and not to **institutions**"*, p.24
see also Eling and Pankoke (2014), p.10
[15] FSB (2009), p.13 – Cummins and Weiss (2013) suggest adding "government policy and regulation" to those three contributing factors (p.12)
[16] See also Brunnermeier (2009), pp.91-92

c) <u>Complexity:</u>

The definition of the last contributing factor is given by FSB (2009): *"A complex institution is an institution or financial group that (a) operates diverse types of activities through numerous legal entities (e.g., simultaneously operating banking, insurance and securities subsidiaries); (b) operates across borders with centrally managed capital and liquidity (as opposed to simpler networks of national subsidiaries); and/or (c) has exposures to new and complex products and markets that have not been sufficiently tested"* (p.13). This factor thus encompasses institutional, regulatory, and technical complexity. It is to be noted that complexity is often related to lack of transparency, which is even more of a concern than complexity itself.[17] Indeed, opacity can trigger contagion, as nobody really knows the exposure of the different firms (counterparty, credit, liquidity, reputational risks).

4) Measures of systemic risk:

The identification criteria selected by the FSB are rather qualitative. They are keys for understanding the particular situation of a given firm, but they are definitely subject to interpretation, and as noted earlier, the interaction between the criteria is almost as relevant as the criteria themselves.

Over the past five years, the academia tried to come up with synthetic measures of systemic risk using market data in order to provide a benchmark and enable comparisons between financial industries and between firms. In this part, we describe some of the most used metrics[18]. Note that these measures were primarily tailored for the banking sector, and might not reflect the specificities of the insurance industry.

Acharya *et al* (2010) developed a measure of systemic risk to assess the contribution of individual firms to the vulnerability of the financial sector. The Systemic expected shortfall (**SES**) of a company corresponds to its own expected loss conditional upon the financial sector's overall poor performance. In the words of the authors, it measures "its propensity to be undercapitalized when the system as a whole is undercapitalized" (p.1). They classify the financial corporations into four sub-sectors (depository institutions, security and commodity brokers, insurance companies, and miscellaneous non-depository institutions including real estate firms), and find that the insurance industry as a whole is the least systematically risky of the four sub-sectors. Yet they indicate that some insurance companies (especially those providing credit guarantees for structured products) got scores that were comparable to systematically risky banks[19].

The seminal paper by Acharya *et al* paved the way to the elaboration of the **SRISK** index by Brownlees and Engle (2011). This index measures the portion of the total expected system capital shortfall in a crisis that is due to a given firm (cf. p.8). It is a function of leverage and MES (marginal expected shortfall[20]) In the words of the authors, it evaluates "the expected equity loss of a firm when the overall market declines beyond a given threshold over a given time horizon" (p.2). When calculating

[17] See Cummings and Weiss (2012), p.15

[18] For a detailed survey of the systemic risk measures, see for instance de Bandt *et al* (2013)

[19] Acharya *et al* (2010), p.21

[20] In Acharya *et al* (2010), MES is defined as the average net equity return of a firm during the 5% worst days for the market in a year (cf. pp.4, 15, 17). Yet, Brownlees and Engle (2011) define it as "the expected equity loss of a firm when the overall market declines beyond a given threshold over a given time horizon" (p.2). More specifically, in their paper, they consider a 2% market drop over one day, and 40% drop over six months (p.3). As such, Brownlees and Engle's MES is probably conceptually closer to Acharya *et al*'s SES than to their own MES.

the SRISK for the European financial sector over the period 2000-2012, Engle, Jondeau and Rockinger (2012) found that banks were representing 80% of systemic risk, insurances 18%, and the contribution of financial services and real estate firms was negligible (p.20).

Chen *et al* (2013) constructed a risk-neutral forward-looking systemic risk metric using CDS spreads and high frequency intra-day stock prices. Their indicator has two components: the probability of default of each entity and the default correlation. They show that there exist a strong bidirectional Granger-causality between the banking and insurance sector, yet when correcting for heteroskedasticity, they note that the influence of insurers on banks fades away while banks keep on having a persistent predictive power. The asymmetry of the connection is confirmed by stress testing.

Using quantile regression, Adrian and Brunnermeier (2011) calculated the 1%-value-at-risk (VaR) of the whole financial sector conditional on a particular institution being in trouble, which they labelled **CoVaR**. They additionally computed the ΔCoVaR as the difference between the CoVaR when the institution is in distress and its CoVaR in normal times. According to this metric, driving factors for systemic risk include size, leverage and maturity mismatch (p.20). Although they do not comment on that, the result of their regression of CoVaR on explanatory variables seems to indicate that insurers are less systemically relevant (p.39)

The Distressed insurance premium (**DIP**) developed by Huang *et al* (2009, 2011) measures the insurance premium that protects against the distressed losses of a hypothetical portfolio consisting in the total liability of the banking sector in the coming 12 weeks. “Technically, it is calculated as the risk-neutral expectation of portfolio credit losses that equal or exceed a minimum share of the sector’s total liabilities.” (2011, p.7) This measure is computed using Monte Carlo simulations and daily data on CDS spreads (for the probability of default) and equity prices (to calculate the co-movements of equity returns). It differs from the SES in that the sector distress is measured as an absolute threshold instead of being measured as a quantile. Their decomposition of the DIP among the different banks in the sector shows that the marginal contributions are mainly driven by the bank size, and then by correlation and probability of default.(2011, p.21) This particular measure has not yet been applied to insurers.

Eling and Pankoke (2014) consider that by definition, the systemic risk measures applied to the insurance sector (except ΔCoVaR) are more indicators of vulnerability to impairments of the financial sector than measures of actual contributions to systemic risk (p.21). It is clear indeed that the ΔCoVaR is the only one to assess the impact of the failure of a particular firm onto the system. The other measures evaluate the loss suffered by the firm when the system is in trouble. It should probably be possible to construct an indicator that would take into account all three aspects of systemic risk: origination, propagation and vulnerability.

II. ***Systemic risk in banking and insurance differ:***

Almost every piece of the surveyed literature analyzes systemic risk in insurance with respect to systemic risk in banking. It is true that systemic risk was identified first and foremost in the banking industry, and the FSB criteria were probably developed having this particular sector in mind. In line with this observation, we start our review with a brief comparison between banks and insurers.

1) Banks

The bank and insurance sectors differ fundamentally in terms of both their business model and their organization/structure.

In terms of business model, banks are involved in maturity transformation and money creation: they collect deposits from the real economy, which are often callable at will, and distribute longer term credit to economic agents (with monetary creation through the fractional reserve mechanism). By doing so, they are transforming short term liabilities into longer term assets, and generally, the greater the duration gap, the larger the profits, which means that they have an incentive to increase the maturity mismatch.[21]

In terms of structure, banks are largely interconnected in the very short run through the interbank market. They lend and borrow overnight funds from one another in order to comply with the technical and regulatory liquidity requirements.[22]

One can easily see that the banking system is heavily relying on trust: indeed, banks need to be confident that their depositors will not come all at the same time to withdraw their funds (which would lead to a liquidity crisis as only a fraction of their deposits is kept, and the rest has been loaned), and to be confident that they will always find another bank to extend them overnight credit if needed. Trust can easily be lost though, which translates into bank runs and freezes of the interbank market (remember the definition of systemic risk by Billio *et al* (2013) and its emphasis on "public confidence in the financial sector"). Insurance, on the other hand, also need to fulfill their commitments, but rather in the longer run.

2) Insurers

The traditional insurers' business model is totally different: in exchange for the payment of an upfront premium, the undertakings accept to compensate the policyholder for the loss he would undergo should a given risk materialize (non-life and health insurance): the business model is characterized by what is known as the inverted production cycle.[23] The premiums are acquired and not redeemable to the policyholder. The payment of a claim depends on the occurrence of a particular event, which means that cash outflows are not subject to behavioral trends and are thus more predictable.[24] Insurers "endeavor to exploit the benefits of diversification over time, geographies and between different lines of business. While diversification

[21] See Baluch *et al* (2011): "*The banking sector is more susceptible to systemic risk due to lower capital to asset ratios, lower levels of cash reserves and the highly structured and illiquid instruments traded by banks."* (p.139) ; see also Thimann (2014), p.9

[22] Thimann (2014), p.9

[23] IAIS (2011), p.6

[24] Cummins and Weiss (2012): *"Thus, insurers are primarily funded through long-term sources that cannot be withdrawn on demand by policyholders. For banks, on the other hand, 82.5% of liabilities represent deposits, most of which are short-term and withdrawable on demand, such that banks have higher liquidity risk and maturity mismatch risk than insurers."* (p.19)

reduces the overall risk, the law of large numbers makes variations in the pattern of actual losses more predictable".[25] Using probability distributions, the insurer can thus estimate the likelihood and timeframe of the payouts (which he uses to calculate the premium in the first place), and will try to match the duration of its liabilities with that of its assets[26]. Additionally, even when a claim is filed, the settlement process can be rather long, which leaves time for the insurer to plan the necessary funding.[27] In 2009, the IAIS had considered a "time criterion" in its assessment of systemic risk for insurance. This was particularly relevant as a slow pace of contagion can give leeway for the regulator to intervene. With respect to this particular criterion, insurance activities (especially PC and health) are very different from banks as their business model implies that claim settlement can take several months, contrary to margin calls for instance. When an insurer fails, it generally goes into a run-off process that can last for several years, while the collapse of a bank can happen almost overnight. Yet, surprisingly, this factor disappeared from the constitution of the G-SII index by IAIS in 2013.
The main risk facing an insurer is an unforeseen change in one or more parameters of the model, which could lead to a mispricing of the premium relative to the potential claims (technical risk).[28] Last, the PC sector is rather competitive, with the consequence that the services provided are rather substitutable. For all these reasons, PC insurance is not considered systemically risky.[29]

Life insurance products are deemed to be slightly more systemically relevant for two main reasons.
On the one hand, the investment strategies pursued by the insurers are more risky: Indeed, in the words of Baluch *et al* (2011), "*Life insurance products are based on the duration of human life and promise to pay fixed sums, set at inception of the contract, such payments not being so subject to the random occurrence of an unknown event. Therefore, life insurers invest in bonds and funds to achieve a rate of return requisite with their future obligations. These forms of investment carry a higher degree of market risk than non-life investments, which makes life insurers more susceptible to systemic risk during periods of market downturn*". (p.143) Other authors stress the fact that life insurers have a higher leverage (lower equity basis), are less diversified and are more invested in MBSs.[30]
On the other hand, the premiums collected on those contracts a more callable than for other types of insurance. Yet the early withdrawal of funds is usually penalized, either contractually through lapse fees or fiscally[31]. Additionally, the State guarantee funds provide a strong protection to life insurance policyholders.[32] As a consequence,

[25] IAIS (2011), p.25
[26] IAIS (2011) emphasizes the role of Liability-driven investment either through cash-flow matching or duration matching (p.23); See also Geneva association (2010), p.36 ; Cummins and Weiss (2011), p.18
[27] IAIS (2011): *"it took seven quarters for the settlement of the reinsurance claims attributed to the loss of hurricane Katrina (2005) to reach 60% and 11 quarters for the settlement of the losses of the World Trade Center (2001) to reach the same threshold. And it too approximately another three quarters for Katrina-related payouts to reach 80%, while WTC claims took a total of 24 quarters to reach 80% of the ultimate payouts."* (p.6-7); See also: Geneva association (2010): "*Insurance claims operate much more slowly than the margin call, collateral and depositor claims on banks*" (p.28) and further: "*The failure of a bank and the consequent closure of the wholesale funding markets could trigger the collapse of the banking system very quickly. By contrast, the wind-up of an insurer is likely to be a more orderly process*" (p.29)
[28] IAIS (2011) : *"two major impairment factors both for life and non-life insurers are deficient loss provisioning and inadequate pricing – the most important causes in both segments – and rapid growth, which in many cases was coupled with deficiencies in risk management as well as in sound and balanced governance"* (p.9). Hence the importance of a precise and reliable actuarial model of technical provisions to meet claims and unexpired risk.
[29] Eling and Pankoke (2014), pp.17-18
[30] Cummins and Weiss (2012) p.20 ; Grace (2011), p.11 Geneva Association (2010), p.15 ; Harrington (2009), p.804
[31] See for instance Geneva Association (2012)
[32] Cummins and Weiss (2012), p.20. In France, following the insolvency of Europavie in 1997, the legislator voted the creation of a life-insurance guarantee scheme: the *Fonds de Garantie des Assurances de Personnes* (FGAP). Although the fund is managed under private law by the industry, it is the French supervisory authority (ACPR) that determines when the money should be released to compensate for the insolvency of a particular undertaking. See Oxera (2007), pp.199-205

the IAIS (2011) indicates that "the historical evidence of insurance runs is limited" (p.7, 16). Cummins and Weiss (2012) argue that, should a run happen, it would only affect weak life-insurers and not propagate to the whole sector (p.20). Last, simulations seem to show that life insurers have enough liquidity to cope with a run.[33] In the end, Eling and Pankoke (2014) conclude that the life sector has a low vulnerability to systemic risk, at least for the part of insurance business where the policyholder bears the investment risk (no guaranteed payout). Fixed guarantees however seem to remain a concern for the supervisors (cf. e.g. the low yield module of the 2014 EIOPA Stress tests or the low yield environment add-on to the 2015 French preparatory exercise to the ORSA)[34], and Gollier (2015) even goes on to say that "in the event of a macroeconomic disaster, the rate guarantee would bankrupt most insurers" (p.134).

The structure of the insurance market is much less horizontal than the bank sector. Insurance companies do not lend large amounts to one another[35]. However, they transfer a fraction of the risk they accepted to reinsurers and the reinsurance industry is fairly concentrated. Through this vertical connection, it thus appears that primary insurers might not be as insulated as they look. The role of reinsurance in systemic risk is treated separately, in part V.

In short, banks and insurance differ on two main aspects[36]:

- Insurers have a much lower liquidity risk and maturity mismatch (except in the low probability case of massive surrender),
- The insurance sector is much less directly intraconnected (which doesn't mean that it is not connected to the rest of the financial sector),
- Due to the timing of its operations, the unwinding of an insurer is more likely to be an orderly process.[37]

For these reasons, the traditional insurance sector is not considered a source of systemic risk.

Let's mention that although the FSB assessment is operated at the undertaking level, another strand of the literature focuses on business lines rather than on institutions to identify systemic risk.[38] This approach could help avoid regulatory arbitrage (e.g. risky activities could migrate to partner non-SIFI-labelled institutions) and market distortions (the likelihood of bailout would be larger for SIFIs than for other institutions), but would require stricter ring-fencing of activities.

[33] Baranoff *et al* (2013) according to Eling and Pankoke (2014)

[34] EIOPA (2014b) and ACPR (2015)

[35] IAIS (2012): *"The insurance market is characterized by an essentially hierarchical structure, with weak interconnectivity along vertical lines (ie. between cedants and reinsurers), and event weaker, or no connectivity al all, across primary insurers."* p.14

[36] Geneva Association (2010): Insurance companies are deemed less vulnerable to systemic risk because *"insurers do not rely on wholesale market funding for liquidity. They fund themselves through premiums, with long-term capital to support risk-taking position"*. (p.20) ;

cf. also Grace (2010): *"Holding the special case of AIG aside, it is important to understand that traditional insurers are unlike banks in their interconnectedness and product risks."* (p.7)

[37] Geneva Association (2010), p.29

[38] See Geneva Association (2010): *"Our aim is not to argue that the criteria are wrong, or that they do not apply to insurers, only that they need to be applied to **activities** and not to **institutions**"*, p.24

see also Eling and Pankoke (2014), p.10

III. Yet they are connected (more and more so)

If the traditional insurance sector is deemed less systemically relevant when analyzed independently, one need to keep in mind that they are not insulated from the rest of the financial world: to start with, insurers are major institutional investors, and they have a large exposure to the financial sector. For instance, IAIS (2011) indicates that, in 2010, the investment portfolio of European insurers entailed 26% of Financial Sector corporate bonds and 3% Financial Sector equity. (p.24)

Additionally, recent research put emphasis on the increased connections in the financial industry during the 2000s. For instance, Baluch *et al* (2011) point out to a higher correlation between the bank and insurance equity in recent years (2004-2009).[39] Using principal component analysis and Granger-causality networks applied to monthly returns, Billio *et al* (2012) come to a similar conclusion with respect to the increased interconnectedness between hedge funds, banks, broker/dealers, and insurance companies. Going further, they analyze the direction of the relationships and find that the core of interconnectedness lies in both banks and insurers: in their own words, "the returns of banks and insurers seem to have more significant impact on the returns of hedge funds and brokers/dealers than vice versa." (p.536), and later: "Over the recent period, our empirical results suggest that the banking and insurance sectors may be even more important sources of connectedness than other parts. (p.555). This last result is somewhat challenged by Chen *et al* (2013) who showed that the strong bidirectional Granger causality they had found between banks and insurers was becoming asymmetric, from banks to insurers, when controlling for heteroskedasticity. The result obtained with systemic risk metrics also go in the same direction (e.g. Acharya *et al* (2010) point out to the fact that although some insurers scored high in terms of systemic risk, the insurance sector as a whole was "the least systemically risky" (p.21)).

The increased correlation between banks and insurers could stem from two (not mutually exclusive) sources:

- On the one hand, the last decade saw the rapid development of *bancassurance* and other multiple-activities financial conglomerates, which institutionally links the business models in a way that is not always transparent.[40] Here we get back the complexity and opacity issue that was raised by the FSB, and the potential leakages between lines of business for regulatory arbitrage purposes (as in communicating vessels). Considering the French financial sector, Hauton and Héam (2014) conclude that conglomerates *"have a pivotal role to gather and distribute financial assets but not to gather and distribute riskiness"* (p.25). According to the authors, this central role is mainly due to their size. There is actually an ongoing debate about the desirability of ring-fencing accounts in a financial conglomerate: Some argue that there should be strict ring-fencing in order to avoid healthy, regulated insurance subsidiaries to pay for the unregulated quasi-banking activities of another subsidy (as was the case with AIG Financial Products

[39] Baluch *et al* (2011): *"It is clear from our analysis that the insurance and banking sectors have become increasingly connected over the last decade. Insurers (particularly life insurers) have extensively participated in the capital markets for additional profitability and risk transfer. This has left insurers exposed to systemic contagion via banks. Insurers have also become significant players in the credit protection market, leaving banks exposed to counterparty risk with potential systemic impact."* p.151

[40] Baluch *et al* (2011) asserts: "*Unsurprisingly, "bancassurers"—integrated financial services providers and insurers that have close affiliations with banks—have been among the major insurance market victims*." p.148. This statement is qualified by the industry as Geneva association (2010) states "*Conglomerates with banks that had strong liquidity positions and low involvement in structured products came out of the crisis relatively unharmed (BNP Paribas, HSBC, Crédit Agricole)*" (p.16)

division)[41]. Others warn that the collapse of a subsidiary might threaten the survival of the holding (and the other subsidiaries) if not prevented. The limited fungibility of capital or liquidity within a group could thus induce unnecessary failures.[42]

- On the other hand, the non-traditional/non-insurance activities (quasi-banking) that developed recently might make insurers behave more like banks and other financial institutions.[43] These NTNI activities and their implication for systemic risk are analyzed in the next section.

[41] Geneva Association (2010), p.17; Harrington (2009)
[42] See for instance Radice (2010), p.32
[43] Baluch *et al* (2011) write that the increased interconnectedness “does suggest that the insurance industry’s pursuit of capital investment as a value driver to compensate for underwriting results has resulted in its being exposed to market risk, which can be defined as “potential losses owing to detrimental changes in market prices and/or other financial variables influenced by prices”.” (p.139)

IV. *Non-core activities and their impact for systemic risk:*

We now turn to what is referred to as *"Non-traditional/non-insurance" (NTNI)* or "*non-core"* activities in the literature[44]. Following IAIS (2012), Eling and Pankoke (2014) define a traditional activity as being linked to risks that are mostly idiosyncratic, not correlated with each other, and not influenced by economic business cycles (p.15). They decompose the NTNI activities into two groups, namely the non-traditional insurance underwriting and the non-traditional insurance funding and investing activities. We will follow this structure here.

1) Non-traditional underwriting

The guaranteed annuities life insurance contracts and the credit protection instruments (credit insurance, credit guarantees, and derivatives) fall in the non-traditional insurance underwriting category.

a) *Life insurance:*

Guaranteed annuities contract might be prone to massive surrender. In case the market rates are above the contractual rate, insurers may indeed be tempted to shop around for higher yield investments. On the other hand, one can imagine that concerns about the ability of an insurer to serve the guaranteed returns when market rates are low over a long period can foster lapses (cf. the current low yield environment). The cancellation fees and fiscal incentives are often considered a protection against such events, but surrenders are still possible.

Other life insurance products of systemic relevance include separate accounts and group annuities[45]. Group annuities are insurance contracts negotiated by a corporation for its employees. In general, given the size of the contractor, its financial literacy and thus its bargaining power, these contracts entail better guarantees, and the enforcement thereof is more closely managed.

Separate accounts are funds that an insurer manages separately from its general assets. They include all "non-euro funds", that is unit-linked assets, segregated funds, retirement accounts, specific euro funds. According to Cummins and Weiss (2013), they can be used to offer "annuity products embedded with options, guaranteed investment products (GICs), and other banking type contracts" (p.21)

Both products entail a large part of optionality and interconnectedness risk: "life insurers are often dealing with large corporate clients who control large blocks of assets, and such products are susceptible to withdrawals and other interruptions of cash flows during a crisis" (p.12).

b) *Credit protection:*

Concerning credit protection, one should make a strong distinction between credit insurance on the one hand, and credit guarantees and derivatives on the other. Indeed, the industry argues that credit and trade insurance cannot be considered a source of systemic risk given the substantial reserves it implies and the fact that the cash outflows are conditional upon an actual default. Credit insurance is primarily a

[44] In order to compute the "non-traditional insurance and non-insurance activities" component of its G-SII index, IAIS uses individual indicators on non-policy holder liabilities and non-insurance revenues, derivatives trading, short term funding, financial guarantees, minimum guarantee on variable insurance products, intra-group commitments, and liability liquidity. (cf. EIOPA (2014a), p.58)

[45] Cummins and Weiss (2013), p.17. Note however that, contrary to Eling and Pankoke (2014), the authors consider group annuities and separate accounts as core life insurance activity (cf. p.29)

bilateral contract subject to exogenous risk factors and with only little potential contagion. Additionally, although the market is very concentrated (85% of the market share for the four largest providers in 2005), it is extremely small compared to the non-life industry as a whole (the premiums collected amounted to .5%).[46] Last, Caja *et al* (2015) document the credit insurers' ability "to limit or cancel the offered guarantees at any time, depending on the change in the credit quality of the insured firm, thus eventually on the evolutions of the business cycle and the macroeconomic environment" (p.2).

On the contrary, credit guarantees by the monoliners as well as CDS underwriting are considered systemic risk factors. By definition, those products link the insurance sector with the remaining of the financial sector, and thus increase interconnectedness. Moreover, they are very sensitive to overnight market downturns, as well as to credit rating downgrades (liquidity risk)[47]. Not only are the credit guarantees subject to contagion as they are spread thorough the market, but they are also at risk of hoarding effects, as different credit guarantees will react in a similar way to similar indicators (ratings) in case of a large economic downturn. There is a large consensus in the literature concerning the contribution of CDS to systemic risk, or at least to the vulnerability to systemic risk.[48]

2) Non-traditional funding and investing

On the funding and investing side, we find:

- the securitization of upfront payments and future profits, which according to the IAIS exposes the investor to interest rate risk (implied guarantees, insurance risks, market risk), but is not yet big enough to be considered systemically relevant[49]. We lack information on the development of these new funding strategies, and it is particularly important to monitor them carefully.
- the excessive reliance on short term financing, which increases the risk of fire sale (cf. securities lending, credit rating utilization and issuance of commercial paper).[50] The recourse to these short term strategies probably takes origin in the search for yield associated with the low interest rate of the past decade. By definition, these instruments increase liquidity risk and maturity mismatch, and can thus contribute to increasing systemic risk.

[46] Geneva Association (2010), p.58
[47] Drake and Neale (2011)
[48] Eling and Pankoke (2014), p.23, Baluch *et al* (2011), pp.144-148 ; Cummins and Weiss (2011), p.40; IAIS (2011), p.12; Geneva Association (2010), p.18
[49] IAIS (2012), p.27
[50] Geneva Association (2010), p.55 ; Harrington (2009), p.790

V. *Reinsurance*

As we already mentioned, the insurance sector is hierarchical[51], meaning that insurers do not have many relationships between themselves, but do have ongoing business with the same few reinsurers. The insurers might therefore not be as insulated as they seemed at first sight.

The *reinsurance market* has indeed become particularly concentrated and interconnected over the past 20 years. Cummins and Weiss (2002) note that the market share of the top ten reinsurers went up to 52% in 1998 from 35% in 1991 (p.22), and Park and Xie (2012) report that this share reached 79% in 2009, with 60% for the first five undertakings (p.4 and 8). Several authors point out at the fact that the collapse (or downgrade) of a particular reinsurer could have an impact not only on the primary insurers who ceded the risk in the first place, but also on the other reinsurers through the retrocession spiral. Indeed, Park and Xie (2012) show that the downgrade of a reinsurer both increases the likelihood of downgrading for the counterparty primary insurers and negatively impacts their stock prices. However, the mainstream view is that the vertical structure of the sector limits intra-insurance contagion as well as spillovers to the rest of the financial sector. Indeed, the scenario analyses conducted by Park and Xie (2012) for the US, Van Lelyveld *et al* (2011) for the Netherlands, and Frey *et al* (2013) for France conclude that even the collapse of several international reinsurance companies would not translate into many primary insurers defaults. For instance, Park and Xie (2012) document that even if one of the top three global reinsurers were to default on 100% of their recoverable, this would only lead to a downgrade for about 2% of American insurers, and to insolvency for 1%[52]. Frey *et al* (2013) run two stress tests: the first with the idiosyncratic collapse of a reinsurer (zero recovery rate), and the second assuming that primary insurers would have to cope with a large-scale catastrophe without the help of reinsurers. In the first case, they show that even a simultaneous default of all reinsurers would not imply any insolvency of the French primary insurers (provided that the off balance sheets guarantees of the reinsurers are effective). In the second case, the catastrophe would not affect life insurers, but would lead to insolvency for 14% of non-life insurers. However, it is to be noted that the analysis is conducted on solo entities, and does not take into account potential support by the group holding. A stress test by the Group of 30 (2006) concludes that even a failure of 20% of the reinsurance capacity would be unlikely to neither induce widespread insolvencies among primary insurers nor affect significantly the real economy. (pp.31-39)

The industry and the supervisor do not consider traditional reinsurance to be systematically relevant. To reach this conclusion, they point out to several factors:

- The small size of the market. Indeed, in 2010, the market capitalization of the top 10 global reinsurers taken together was equivalent to that of the two largest insurers and to less than half that of the single largest bank. In terms of total assets, the top ten reinsurers were equivalent to the largest insurer and to a third of the largest bank.[53] Additionally, IAIS (2012) indicates that only 5% of the global volume of primary insurers' premiums is ceded to reinsurers, and only 0.6% to retrocessionaires (p.26) [54]

[51] IAIS (2012), p.10
[52] Park and Xie (2012), p.28
[53] IAIS (2011), p.21
[54] A clearer breakup of the insurance and reinsurance global activity by business is given for year 2008 in Geneva Association (2010), pp.25 and 52. For life, the reinsurance premiums represent 2.4% of the primary premiums, and the retrocessions 55% of the ceded premiums (that is 1.3% of the primary premiums). For non-life activities, the reinsurance premiums amount to 5.6% of primary premiums, and retrocessions to 28% of ceded premiums, that is 1.6% of primary premiums).

- The diversification of primary insurers' exposure to the reinsurers, which makes them less sensitive to a particular entity's failure. Note however that Park and Xie (2012) calculated the Herfindahl index of the US insurers' reinsurance portfolios, and came up with a mean index of more than 0.6 which leads them to conclude that they are not diversified enough.[55]
- The low probability of default of reinsurers (historically, and with regards to credit ratings) linked with their liability structure, their low leverage, and the slow claim settlement process. Indeed, IAIS (2011) records 29 reinsurers' failure between 1980 and 2011, for a total cumulated loss of 0.43% of the ceded premiums in this period. IAIS also reports an overall industry's solvency ratio of 250% in 2010, and comments that in order to go under a 100% ratio the economy at large would need to suffer a total loss equivalent to the cost of all great world-wide catastrophes between 1950 and 2010 (p.28). This result should be qualified though as the numbers were calculated using the S1 framework.
- Last, even more than for primary insurers, the temporal aspect of reinsurers' cash outflows is particularly important in determining their systemic relevance. Indeed, claim settlement can be a very long process, and the run-offs can last for decades. Primary insurers do not apparently rely on quick access to recoverable.

This said, there is a general consensus on the potential systemic risk associated with some non-traditional reinsurance activities, especially the Industry loss warranties and the CDSs.
"Industry loss warranties (ILW) are a specific reinsurance or derivative contracts that tie any claim payments to a predefined catastrophic loss level incurred by the whole industry (the industry loss trigger) or a subset thereof rather than an individual company's aggregate losses from a catastrophic event." (IAIS (2012), p.28). According to the supervisor, ILW are usually not collateralized and are characterized by the absence of insurable interest. They share common features with financial derivatives and are a source of credit risk as well as of basis risk.
We already mentioned that CDSs had a substantial potential for systemic risk. Swiss Re (2003) stresses that the link they create with the banking sector is a source of vulnerability. It is to be noted however that their contribution to the market significantly declined since 2003, to represent less than 0.02% of the supply in 2010.[56]

Other non-traditional reinsurance activities, such as Cat-bonds and finite reinsurance, are deemed less relevant for systemic risk assessment. Catastrophe bonds, which are a particular case of insurance-linked securities, allow the reinsurer to transfer large peak risks to the financial markets. Cat-bonds appear not to be correlated to financial markets returns, and are thus a good instrument for diversification purposes.[57] It is also to be noted that the market for cat-bonds is very small, which limits its impact on systemic risk.[58]

As for finite reinsurance, it is broadly defined by IAIS (2006) as the "*entire spectrum of reinsurance arrangements that transfer limited risk relative to aggregate premiums*

[55] Park and Xie (2012), p.12. They mention though that the index decreased slightly between 2002 and 2009, from 0.657 to 0.639.
[56] IAIS (2012), p.30
[57] Cummins and Weiss (2009), p.532
[58] IAIS (2011, 2012)

that could be charged under the contract"[59] (p.5). These financial reinsurance contracts were designed initially to smooth the variations of insurance income over the years. They have come under the supervisor's scrutiny as they were sometimes used to reduce the prudential requirements without operating a real risk transfer, thus sharing common features with credit intermediation. Currently, the regulator requires that there be a "significant amount of risk transfer" and considers that, as the contracts "do not entail leverage and do not extend beyond the two contracting parties", they do not represent a source of systemic risk. [60]

Last, the industry acknowledges that the opacity of reinsurance networks might lead to reinsurance spirals, and warns that certain contracts with rating triggers (which allow a counterparty to cancel it in case of a downgrade) can be a source of risk.[61] One possible channel of contagion stems from the loss of private information gathered on small insurance companies by a large reinsurer that goes bankrupt. Following the collapse of such a large reinsurer, some small insurance companies with very specific activities might not be able to find a proper reinsurance at reasonable price, with possible spillovers.

[59] Cf. also Group of 30 (2006), p.69
[60] IAIS (2012), p.26
[61] Group of 30 (2006), p.38

VI. Conclusion and further research

This review of literature showed that the insurance sector in general had less systemic relevance than the banking industry. The business model and the structure of the sector tend to make it a risk absorber rather than a risk contributor. However some recent developments in the financial industry (concentration of the reinsurers, bancassurance conglomerates, credit guarantees, securitization…) might lead to an increased vulnerability to contagion or even to systemic risk origination.

As we mentioned earlier and as could be seen in this review, most of the literature on systemic risk in insurance took the form of a qualitative assessment based on FSB criteria or on default track records (case studies). Quantitative metrics of systemic risk contributions were only recently developed (and they are not necessarily tailored to the specificities of the insurance industry). The literature is still in the process of comparing the adequacy and relative predictive power of these measures, but they have already been used a couple of times to identify likely determinants of systemic relevance (on the one hand, Cummins and Weiss (2013) use SRISK to show that separate accounts and group annuities increase the systemic risk of the life-entities that propose them; on the other hand, Weiß and Mühlnickel (2013) use MES and ΔCoVaR to show that size, and reliance on investment income and non-policyholder liabilities were good predictors of systemic vulnerability). More work on this line could be very useful (quantify the systemic relevance of other business lines, of financial instruments, of conglomerates[62], and of reinsurers for example). Concerning the indicators, another issue of paramount importance is to find a way to disentangle more clearly the likelihood that a particular institution be a source of systemic risk from the resilience or vulnerability to systemic shocks. In short, would an institution be likely an originator, a propagator, or a mere victim of systemic risk? The metrics developed so far tend to measure the latter rather than the former.

The contribution of supervision to systemic risk has still not been investigated thoroughly: in particular, the impact of the labelling of SIFI on the firm's behavior (i.e. the bailout guarantees and what they imply in terms of increased moral hazard and market distortion[63]); the possibility of regulatory arbitrage; and the procyclicity of the measures for instance are still open research questions.[64] Additionally the cost of regulation for the sector (in terms of productivity, efficiency, innovation…) as well as for the taxpayer (guarantees) has not been properly assessed as of today, nor its significance with respect to the potential cost of an unregulated system. Such a cost benefit analysis could lead to a more parsimonious regulatory framework or to ring-fencing for instance.

It would be very interesting to investigate the indirect connection that exists between the financial institutions merely because they focus on similar indicators and rely on similar models to shape their course of action (S1 or S2 frameworks, ratings…). Such a hoarding effect would probably not be captured by the systemic metrics, and nevertheless the impact on the economy could be tremendously important, given the major role of insurers on the investment side (think for instance about the downgrade of a Tier1 asset, and the potential massive disinvestment that could follow; think also

[62] Cf. the current ongoing research by Hauton and Héam (2014)
[63] See for example Harrington (2009), p.805
[64] See for instance Billio et al (2012): *"because they are more highly regulated, banks and insurers are more sensitive to value-at-risk changes through their capital requirements; hence, their behavior may generate endogenous feedback loops with perverse externalities and spillover effects to other financial institutions."* (p.536);

about the hesitations concerning the valuation of sovereign bonds in solvency requirements)[65].

It is often said that the insurance sector does not qualify for the “lack of substitutability” criterion for systemic relevance given its highly competitive nature. We would like to point out that this argument applies to firms, but not necessarily to lines of business. Some particular insurance and reinsurance activities could very well disappear because of legal evolutions, and not be replaced by any substitute, with large social consequences (cf. medical practices insurances).

The issue of massive surrender, although deemed low probability, should certainly be examined carefully. For example, a scenario of raising interest rates after a long period of stagnation at low levels could very well lead to high lapse rates for traditional insurers, with policyholders turning to newly chartered life insurance companies not bound by their low yield assets and able to offer higher returns.[66]

Last, the analysis of systemic relevance could also be extended to other major players of the financial markets, such as pension funds. The “real life” impact of the collapse of such an institution could be dramatic. We could not find many documents on this particular issue.

[65] On the impact of valuation standards in insurance on financial stability, see for instance Trainar (2008)

[66] See also the problems faced by the Japanese insurance industry in the context of low interest rates: Bernard and La Motte (2014)

References:

Acharya, Viral V., Lasse H. Pedersen, Thomas Philippon and Matthew Richardson (2010) 'Measuring Systemic Risk'. *Working Paper, New York University* (May) 46p.

Adrian, Tobias and Markus K. Brunnermeier (2011) 'CoVaR' *Federal Reserve Bank of New York Staff Reports* n°348 (Sept.2008 revised Sept.2011) 43p.

Autorité de contrôle prudentiel et de résolution (2015) '*Notice technique décrivant les scénarios d'environnement de taux bas dans le cadre de la remise préparatoire 2015 de l'ORSA*' (July 22nd) [accessed online at https://acpr.banque-france.fr/fileadmin/user_upload/acp/Solvabilite-2/20150720-Notice_technique-environnement-taux-bas-rev.pdf]

Baluch, Faisal, Stanley Mutenga and Chris Parsons (2011) 'Insurance, systemic risk, and the financial crisis', *The Geneva papers* 36: 126-163.

de Bandt, Olivier, Jean-Cyprien Héam, Claire Labonne and Santiago Tavolaro (2013) 'Measuring systemic risk in a post crisis world' *Débats économiques et financiers de l'Autorité de Contrôle Prudentiel*, (June) n°6

Baranoff, E. G., Haefli, D. and Sager, T. W. (2013) 'Surrenders in the life insurance industry: A systemic risk of runs?' working paper, presented at ARIA 2013 Annual Meeting, Washington, DC.

Bernard, Romain and Laure La Motte (2014) 'Défaillances dans le secteur de l'assurance vie au Japon dans les décennies 1990 et 2000' *Analyses et Synthèses de l'ACPR* (May), n°30, 27p.

Billio, Monica, Mila Getmansky, Andrew W. Lo and Loriana Pelizzon (2012) 'Econometric measures of connectedness and systemic risk in the finance and insurance sectors'. *Journal of Financial Economics* 104: 535-559

Brownlees, Christian T. and Robert Engle (2011) 'Volatility, correlation and tails for systemic risk measurement' *Working paper - Stern School of Business, NYU (June), 37p.*

Brunnermeier, Markus K. (2009) 'Deciphering the liquidity and credit crunch 2007-2008', *Journal of Economic Perspectives* 23(1): 77-100.

Brunnermeier, Markus K. and Lasse Heje Pedersen (2009) 'Market liquidity and funding liquidity', *The Review of Financial Studies* 22(6): 2201-2238.

Caja, Anisa, Quentin Guibert and Frédéric Planchet (2015) 'Influence of Economic Factors on the Credit Rating Transitions and Defaults of Credit Insurance Business', *ISFA working papers* (July 20th), 48p.

Chen, Hua, J. David Cummins, Krupa S. Viswanathan and Mary A. Weiss (2013), 'Systemic Risk and the Interconnectedness Between Banks and Insurers: An Econometric Analysis. *Journal of Risk and Insurance*. doi: 10.1111/j.1539-6975.2012.01503.x, 45p.

Cummins, David J. and Mary A. Weiss (2002) ‘The global market for reinsurance: consolidation, capacity and efficiency’. *Working paper,* (April 2nd), 63p.

Cummins, David J. and Mary A. Weiss (2009) ‘Convergence of insurance and financial markets: hybrid and securitized risk-transfer solutions’, *Journal of Risk and Insurance* 76(3): 493-545.

Cummins, David J. and Mary A. Weiss (2012) ‘Systemic Risk and the U.S. Insurance Sector’. *Working paper, Temple University* (October 15th), 66p.

Eling, Martin and David Pankoke (2014) ‘Systemic risk in the insurance sector – what do we know?’ *Working papers on risk management and insurance*, University of St.Gallen Institute of Insurance Economics (January), 51p.

Engle, Robert, Éric Jondeau and Michael Rockinger (2012) ‘Systemic risk in Europe’ *Working paper* (December), 46p.

European Insurance and Occupational Pensions Authority (2014a) ‘Financial Stability Report’ EIOPA-FS-14-044 (May 14th), 65p.

European Insurance and Occupational Pensions Authority (2014b) ‘EIOPA Insurance stress test 2014’ EIOPA-BOS-14-203 (November 28th), 244p. [accessed online at https://eiopa.europa.eu/Publications/Surveys/Stress%20Test%20Report%202014.pdf]

Financial Stability Board (2009) ‘Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations’, Report to G20 Finance Ministers and Governors (October), 27p.

Financial Stability Board (2012) ‘Update of Group of Global Systemically Important Banks (G-SIBs)’ (November 1st), 4p.

Financial Stability Board (2013) ‘Global Systemically Important Insurers (G-SIIs) and the Policy Measures that Will Apply to Them’ (July 18th), 5p.

Financial Stability Board (2014) ‘2014 update of list of global systemically important insurers (G-SIIs)’ (Nov 6th), 2p

Frey, Laure, Santiago Tavolaro and Sandrine Viol (2013) ‘Reinsurance counterparty risk for French insurers’ *Débats économiques et financiers de l’ACPR* (April), n°4, 30p.

Geneva Association (2010) ‘Systemic Risk in Insurance – An Analysis of Insurance and Financial Stability’, Special report of the Geneva Association Systemic Risk Working Group (March), 118p.

Geneva Association (2012) ‘Surrenders in the life insurance industry and their impact on liquidity’. (edited by Daniel Haefeli and Wilhelm Ruprecht). Geneva, Switzerland: The Geneva Association (August), 60p.

Gollier, Christian (2015) ‘Long-term savings: the case of life insurance in France’, *Financial Stability Review,* 19 (April): 129-136

Gorton, Gary B. (2008) ‘The panic of 2007’ *NBER Working paper*, (September), n°14358, 91p.

Grace, Martin F. (2010) ‘The insurance industry and systemic risk: evidence and discussion’ *Policy Brief*, Networks Financial Institute at Indiana State University (April), 40p.

Group of 30 (2006) ‘Reinsurance and international financial markets’, (Washington DC : Group of 30), 115p.

Harrington, Scott E. (2009) ‘The financial crisis, systemic risk, and the future of insurance regulation’, *Journal of Risk and Insurance* 76(4): 785–819.

Hauton, Gaël and Jean-Cyprien Héam (2014) ‘How to measure interconnectedness between banks, insurers and financial conglomerates’ (May), 36p.

Huang, Xin, Hao Zhou, and Haibin Zhu (2009) ‘A Framework for Assessing the Systemic Risk of Major Financial Institutions’ *Journal of Banking and Finance*, 33(11) 2036-2049.

Huang, Xin, Hao Zhou, and Haibin Zhu (2011). ‘Systemic risk contribution’. Working paper, *Federal Reserve Board - Finance and Economics Discussion Series* 2011-08. 39p.

International Association of Insurance Supervisors (2009) ‘Systemic Risk and the Insurance Sector’ (October 25th), 6p.

International Association of Insurance Supervisors (2011) *Insurance and Financial Stability* (November), 47p.

International Association of Insurance Supervisors (2012) *Reinsurance and Financial Stability* (July 19th), 52p.

International Association of Insurance Supervisors (2013) ‘Global Systemically Important Insurers: Initial Assessment Methodology’ (July 18th), 25p.

van Lelyveld, Iman, Franka Liedorp and Manuel Kampman (2011) ‘An empirical assessment of reinsurance risk’, *Journal of Financial Stability* 7: 191-203

Minderhoud, Koen (2003) ‘Systemic risk in the Dutch financial sector’ *Working paper of the Monetary and Economic Policy Department,* De Nederlandsche Bank, MEB Serie n° 2003-17 (December) 24p.

Oxera Consulting Ltd. (2007) ‘Insurance guarantee schemes in the EU – Comparative analysis of existing schemes, analysis of problems and evaluation of options – Final report prepared for European Commission DG Internal Markets and Services’ (November), 295p.

Park, Sojung Carol and Xiaoying Xie (2012) ‘Reinsurance and systemic risk: the impact of reinsurer downgrading on property-casualty insurers’ 39p.

Thimann, Christian (2014) 'How insurers differ from banks: a primer on systemic regulation' Mimeo, (May 15th), 22p.

Trainar, Philippe (2008) 'Valorisation dans l'assurance et crise financière' *Revue de la stabilité financière de la Banque de France* (Octobre), n°12:111-123

Weiß, Gregor N.F. and Janina Mühlnickel (2013) 'Why do some insurers become systemically relevant?' *SFB823 Discussion Paper* n°26/2013 (June 29th), 54p.