Is the Insurance Industry Systemically Risky?

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I. Introduction

As a result of the financial crisis, the Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act and it was signed into law by President Obama on July 21, 2010. The Dodd-Frank Act did not create a new direct regulator of insurance but did impose on non-bank holding companies, possibly insurance entities, a major new and unknown form of regulation for those deemed "Systemically Important Financial Institutions" (SIFI) (sometimes denoted "Too Big To Fail" (TBTF)) or, presumably any entity which regulators believe represents a "contingent liability" for the federal government, in the event of severe stress or failure.

In light of the financial crisis, and the somewhat benign changes to insurance regulation contained in the Dodd-Frank Act (regulation of SIFIs aside), how should a modern insurance regulatory structure be designed to deal with systemic risk?

The economic theory of regulation is very clear. Regulate where there is a market failure. It is apparent that a major market failure in the financial crisis of 2007-2009 was the emergence of systemic risk. More concretely, systemic risk emerged when aggregate capitalization of the financial sector became low. The intuition for why this is a problem is straightforward. When a financial firm's capital is low, it is difficult for that firm to perform financial services; and when capital is low in the aggregate, it is not possible for other financial firms to step into the breach. This breakdown in financial intermediation is the reason severe consequences occurred in the broader economy.

When financial firms therefore ran aground during the crisis period, they contributed to the aggregate shortfall, leading to consequences beyond the firm itself. The firm has no incentive to manage the systemic risk and the negative externality associated with such risks implies that private markets cannot efficiently solve the problem, so government intervention is required. In other words, regulators now need to focus *not just* on the own losses of a financial institution, but also on the cost that their failure would impose on the system.

The question is whether this applies to the insurance sector. Some academics and others have argued with good reason that there are fundamental differences between the insurance and banking sectors (e.g., see Cummins and Weiss (2013), Harrington (2009, 2010, 2013) and Tyler and Hoenig (2009)).[ii] The argument basically rests on the fact that "traditional" insurers do not

write and retain large and concentrated amounts of nontraditional insurance or similar risk management products with exposure to macroeconomic variables. That is, traditional insurance usually protects policyholders against risks that they deem significant but that are at least reasonably idiosyncratic and thus diversifiable from the insurers' perspective.[iii] Moreover, insurance companies have much longer-term and less liquid liabilities which make them less susceptible to runs on their liabilities of the sort that plague financial firms during typical financial crises.

It does not follow, however, that systemic risk cannot emerge in what is typically defined as the insurance sector. One of the main reasons is that researchers misunderstand the meaning of systemic risk. As describe above, the emergence of systemic risk is that financial firms will no longer be able to provide intermediation, causing knock-on effects to households and businesses.

The purpose of this chapter is to explain why the insurance sector may be a source for systemic risk. In brief, we argue that the insurance industry is no longer traditional in the above sense and instead (i) offers products with non-diversifiable risk, (ii) is more prone to "runs", (iii) insures against macro-wide events and (iv) has expanded its role in financial markets. This can lead to the insurance sector performing particularly poorly in systemic states, that is, when other parts of the financial sector are struggling. We provide evidence using publicly available data on equities and credit default swaps. As an important source for products to the economy (i.e., insurance) and a source for financing (i.e., corporate bonds and commercial mortgages), disintermediation of the insurance sector can have dire consequences. Indeed, the recent decision by the Financial Stability Oversight Council (FSOC) to name AIG and Prudential (and potentially MetLife) as SIFIs was related to this point.

The chapter is organized as follows. Section II describes the arguments for and against systemic risk regulation of the insurance sector. Given the Dodd-Frank Act's required regulation of insurance companies that are designated SIFIs, there is perhaps no greater controversy in insurance regulation. In section III, we provide an empirical analysis of the systemic risk of insurance companies based on a specific systemic risk measure. While sections II and III address specific issues related to systemic risk, in section IV, we analyze this question with respect to regulation at the federal versus state level.

II. Are Insurance Companies Systemically Risky?

Our argument is that systemic risk emerges when aggregate capitalization of the financial sector is low. In the recent crisis, full-blown systemic risk emerged only when, in the early Fall of 08, the GSEs, Lehman, AIG, Merrill Lynch, Washington Mutual, Wachovia, and Citigroup, among others, effectively failed. The result – as we have seen painfully in several crises over past forty years around the world - was loss of intermediation to households and corporations. It is this breakdown in financial intermediation that severe consequences occurred in the broader economy.

For insurance companies, disintermediation can take several forms. For example, the willingness of insurance companies to supply insurance products may suffer, leading to higher prices and an overall loss of economic welfare. There is growing evidence that capital constrained financial firms, including insurance companies, may reduce the supply of capital in the face of losses. For

example, in the catastrophe insurance area, Froot (2001) and Froot and O'Connell (1999) find that insurance premiums not only appear high relative to expected losses in these markets, but increase dramatically after a catastrophe.[iv] Interestingly, this increase spills-over to insurance markets not affected by the catastrophe. Garmaise and Moskowitz (2009) find that the supply of credit for catastrophe susceptible properties in California fell after the earthquakes in the 1990s.[v] It is an open question whether these supply shocks extend beyond the catastrophe insurance area.

In addition, as an important player in the financing of credit-linked activities, insurance companies are an essential part of the economic system. Almost all financial firms have in common the characteristic that they are holders of long-term assets. Through the flow of funds within the economic system, these firms provide financing to real economy firms. These firms are in effect all financial intermediaries, such as banks holding retail, commercial and mortgage loans, insurance companies holding corporate bonds, money market funds buying commercial paper, mutual funds and hedge funds holding equity and other securities, structured investment vehicles pooling loans into asset-backed securities, and so forth. In addition, some financial firms provide additional functions to real economy participants such as payment and clearing, liquidity, insurance against catastrophic risks, etc… The important point is that all firms are potentially important. As we make clear below, the key factor in their systemic risk determination is whether the firm contributes to the aggregate capital shortfall.

Life insurance companies are one of the largest investors in the U.S. capital markets and therefore an important source of funding for the U.S. economy. (See, for example, in this volume, Cummins and Weiss (2013) and Paulson et. Al.). For example, the American Council of Life Insurers (ACLI) estimates that, at the end of 2010, life insurers held almost $5 trillion in total assets, with them being the largest single investor in U.S. corporate bonds (17%) and a significant player in the commercial mortgage market (9.5%). If these firms are in distress and can no longer play their role as financiers for corporate America, then this is precisely the concern about systemic risk. In particular, if AA- and AAA-rated firms find it punitively expensive to issue corporate bonds, then they would draw down on their bank lines of credit as a form of last-resort financing, triggering massive liabilities for their relationship banks. While the healthier banks with adequate capital and deposit base might be able to meet the sudden drawdowns of credit lines, moderately risky banks could experience distress, and the already weakened ones run aground as they scramble for liquidity to avoid shortfall between loan demand and their available funding.

Even leaving aside such a transmission of risk from the insurance sector to the banking sector via the "flow-of-funds nexus" between corporate bonds and lines of credit, it is clear that at a minimum the corporate bond market, which is not that liquid to start with, would experience further pressure on its liquidity. There is substantive evidence, for example, that the liquidity of the corporate bond market dropped after the onset of the crisis (e.g., see Dick-Nielsen, Feldhutter and Lando (2012)).[vi] In Chapter 6 of this book, Paulson, Pletis, Rosen, McMenamin and Mohey-Dean (2013) describe the liquidity of the insurance industry's asset holdings.[vii] In particular, they analyze stress scenarios in which the insurance industry would have to liquidate some of its assets. They find that, relative to runnable liabilities, these firms would have to dip fairly deep into their holdings of corporate bonds and other less liquid securities (i.e., nonagency and nongovernment securities).

Manconi, Massa and Yasuda (2012)[viii] document that in the second half of 2007, bond mutual funds and insurance firms contributed to the illiquidity of the corporate debt market as losses on the holdings of securitized bonds and commercial mortgage-backed securities (CMBS, which insurers hold more than securitized bonds, in contrast to bond mutual funds) transmitted in the form of asset sales or reduced purchases in other holdings, notably of lower-rated securitized and corporate bonds. The authors also document that the sales during the crisis were associated with widening yields in contrast to the reverse association in the pre-crisis period. While bond mutual funds contributed more to this illiquidity due to their shorter horizons of investment, insurance firms did so due to the capital requirements they face, especially if they were close to their risk-based capital threshold.

Indeed, the authors conclude that "*insurance companies did not act as strategic liquidity providers at the onset of the crisis and that at best, there is only weak evidence that their trades partially offset the net sales of corporate bonds by mutual funds.*" Interestingly, this brings to fore the role of risk-based capital requirements for insurance firms. Stanton and Wallace (2010)[ix] attribute the pre-crisis rise in holdings of CMBS on balance-sheets of regulated financial firms to a "regulatory arbitrage" of risk weights, including by insurance companies. Since the crisis, insurance companies have indeed become dominant purchasers of securitized and tranched collateral loan and bond obligation (CLO, CBO) products, due to the reduced interest from the banking sector which has come under tighter scrutiny of regulation and prudential norms. In other words, insurance sector is now an increasingly important player not just in the corporate bond market but also in the securitized bond markets.

It is an open question what role financial disintermediation on the part of distressed insurers played in the credit crunch in the corporate bond market in the Fall of 2008. More research examining this issue directly would be highly informative and important for understanding the transmission of insurance sector distress to the real economy. Nevertheless, the impact of insurance sector's unwillingness to intermediate in the corporate bond market is now well-documented, even when it is outside of a common shock to the economy. For instance, Ellul, Jotikasthira and Lundbland (2010)[x] investigate fire sales of downgraded corporate bonds induced by regulatory constraints on insurance companies. Using transaction data from 2001-2005, they find that insurance companies more constrained by regulation are more likely to sell downgraded bonds and that these bonds exhibit significant price declines and subsequent reversals, effects that are stronger during periods when insurance companies as a group are relatively more distressed and whether other potential buyers' capital is relatively scarce. It would be natural to conclude that such fire-sale effects would be only stronger if insurance sector was distressed coincidentally with a wave of downgrades in the economy, and especially so, in a time when banking sector was experiencing severe distress too – an outcome we would call as "systemic risk" as it would imply limited capacity to re-intermediate funding in the economy.

Above, we discussed two ways insurance companies might disintermediate in the face of losses. To this point, in declaring AIG to be a SIFI, FSOC argued that AIG poses a threat to financial stability through three related channels: "(1) the exposures of creditors, counterparties, investors, and other market participants to AIG; (2) the liquidation of assets by AIG, which could trigger a fall in asset prices and thereby could significantly disrupt trading or funding in key markets or cause significant losses or funding problems for other firms with similar holdings; and (3) the inability or unwillingness of AIG to provide a critical function or service relied upon by market

participants and for which there are no ready substitutes."[xi] The specifics of each of these channels is described by FSOC in their document and maps closely to our discussion. Note that in deciding that AIG is a SIFI, FSOC looks at the nature, scope, size, scale and interconnectedness of AIG's activities, their leverage, their reliance on short-term funding, and whether AIG is a source of credit for the economy, amongst other things.

In this chapter, we have a somewhat different take on how much a firm contributes to systemic risk. To a first approximation, we argue that a systemic financial crisis occurs if and only if there is a capital shortfall of the aggregate sector. Of course, the source for an aggregate capital shortfall can take many forms. To coincide with FSOC's description of AIG, we illustrate this point in the context of AIG.

First, financial firms could all be highly leveraged and face aggregate market exposure. A large shock to the economy could therefore cause large aggregate losses and a capital shortfall. With respect to the financial crisis of 2007-2009, many financial firms had broad exposure to nonprime residential real estate either through loans or asset-backed security (ABS) holdings.

For example, a major factor in AIG's collapse was the $40.5 billion loss on AIG Capital Markets (AIG CM, a division of its "Financial Services Business"), out of the total loss of over $100 billion (see page 116 of the 10K). Much of these losses were due to AIG CM's selling of $527 billion worth of credit default swap (CDS) protection on super senior ABS (page 122, AIG quarterly filings, February 2008). In addition, AIG's Life Insurance and Retirement Services segment had serious losses in 2008, of $37.5 billion, almost as much as AIG Financial Services' loss of $40.8 billion. These losses came from their failed securities lending businesses, aggressive variable annuity death benefit provisions and investment losses on their over $500 billion asset portfolio ($489.6 billion at 12/31/2008). Securities lending is typically not considered a very risky business as the collateral is invested in safe short-term assets. Other life insurance companies, such as MetLife, also run similar businesses. In AIG's case, however, state filings show that roughly two-thirds of its cash collateral was invested in mortgage-backed securities very similar to the AAA-rated tranches they were insuring in their financial products group.

Second, the financial sector, possibly starting from a weak point, could suffer a capital shortfall if a highly interconnected firm fails and losses reverberate throughout the sector. From our standpoint, the relevant issue is not only that the highly interconnected firm is systemically risky, but that its counterparties are as well by being exposed to that firm.

In AIG's case, the degree of interconnectedness to the financial system was a great contributor to systemic risk. Through its Capital Markets unit, AIG had $1.6 trillion in notional derivatives exposures, linking itself to over 1,500 corporations, governments and institutional investors. The problem with OTC derivatives markets, like the ones AIG participated in, is that bilateral collateral and margin requirements in OTC trading do not take into account the counterparty risk externality that each trade imposes on the rest of the system, allowing systemically important exposures to be built up without sufficient capital to mitigate the risks. To get an idea of the magnitude of the losses and the depth of the counterparties, Acharya, Biggs, Le, Richardson and Ryan (2010) document the ten largest payments of AIG to its various counterparties from

September 16, 2008 to December 31, 2008 as a result of government aid.[xii] The payments are broken down into (i) collateral postings under credit default swap contracts, (ii) the outright purchase of collateralized debt obligations that AIG had written CDS contracts on via Maiden Lane III, and (iii) guaranteed investment agreements held by municipalities. They show that, without government support, the losses across the financial community from these three sources alone during the 3-month period would have been staggering, reaching a total of $61.6 billion. The resulting market and funding liquidity conditions of these and other firms would have likely led to even greater aggregate capital shortfalls, exacerbating the financial crisis.[xiii]

Third, the financial sector, again possibly starting from a weak point, could suffer a capital shortfall if a large financial firm fails and liquidation of illiquid assets leads to fire sales which pose funding problems for other financial firms which in turn lead to greater liquidations and more funding problems, et cetera. The result is a financial sector death spiral. In our view, the relevant point is not only that this large firm with concentrated holdings is systemically risky, but also other financial firms are as well as long as these firms are exposed to similar risks.

With respect to AIG, its holdings of $1.6 trillion in derivatives would have led to an unwind of positions that could have created a death-like spiral. An additional question is whether AIG's failure at the parent level could lead to fire sales on its vast holdings of assets beyond the derivative products mentioned above. Going into the crisis, AIG was the fifth largest institutional asset manager worldwide. If one were to include all of AIG's investments, AIG was the largest investor in corporate bonds in the U.S., and the second largest holder of U.S. municipal bonds through its commercial insurance (AIG CI) business worth $50 billion. Any significant forced sale of these bond portfolios would have put substantive stress on the respective financial markets. Since the assets of AIG's insurance companies were legally separated from AIG CM, however, it is not clear that a failure at the parent level would indeed have caused a fire sale of its asset holdings elsewhere in the organization. In case of default, the AIG parent company had guaranteed the contracts at AIG CM which effectively meant the counterparties had a claim on the underlying businesses owned by AIG though not ahead of the policyholders. It is quite possible that the businesses would have continued as normal. Finally, as mentioned above, there were significant losses from AIG's investments in the cash collateral derived from its securities lending business in which it lent out securities held in its life insurance and retirement service businesses. These losses were mostly attributable to AA- and AAA-tranches of non-prime mortgage-backed securities. Acharya, Cooley, Richardson and Walter (2010) show that many financial firms were exposed to the exact same tail risk associated with these securities.[xiv]

Fourth, the financial sector, again possibly starting from a weak point, could suffer a capital shortfall if there is a run on a financial firm that runs into trouble and is funded via short-term liabilities. Given the uncertainty about other likewise financial institutions, an aggregate capital shortfall could result because these other likewise institutions might suffer similar runs on their liabilities. The end result is a run on the financial sector. As above, from our standpoint, the relevant matter is not only that the failing firm is systemically risky, but likewise financial firms are as well given that they are also subject to runs even if "solvent".

Even if AIG were not failing at the individual insurance company level, it is possible that its failure at the parent level, and weaknesses described above at the insurance company level, could

cause a classic "run on the bank." Since AIG has more than 81 million life insurance policies worldwide with a face value of $1.9 trillion, a large-scale run could have wide-scale effects. For example, in one scenario, policyholders would cash in their policies, forcing AIG to raise cash, primarily through asset sales, leading to the type of spillover risk described above. The only protection AIG would have in this case is the surrender charges or cancellation penalties, or untapped value of the policies. In another scenario, the sudden jump in uninsured would put temporary pressure at least on the ability of other life insurance companies to meet the insurance demands of these potential new customers. Of course, the largest concern of a "bank" run is that it leads to a system-wide run on the sector. System-wide runs are catastrophic as they lead to a freezing of the market these institutions operate in, and cause severe externalities towards related individuals and businesses. Given the importance of the life insurance sector to the overall economy, a system run would be very damaging. It remains an open question whether a run on some of AIG's insurance businesses would lead to a run on other insurance companies. To many analysts, AIG was a unique company, so its troubles may be seen as specific to its circumstances – the failure of AIG CM and the collateral investments of its securities lending business – and not a more endemic characteristic of life insurance companies such as investment-oriented life insurance policies with minimum guarantees.

What should be clear from the above examples is that systemic risk is really a statement about co-dependence. While the approach to regulation may be different in all of these cases, the bottom line is that firms which contribute to an aggregate capital shortfall are systemically risky. Above, we argued why the insurance sector is an important part of the economy-wide financial intermediation process. It follows that significant capital shortfalls of the insurance sector would contribute to systemic risk. We used the case of AIG to illustrate how an insurance company can potentially impact the aggregate shortfall of the financial sector. In the next section, we apply this intuition to a particular methodology for estimating and measuring systemic risk. That said, it is certainly reasonable to argue that AIG is a special case and that, for the most part, insurance companies do not add significantly to aggregate capital shortfalls and are not systemic. From this perspective, it is useful to compare traditional insurers with banks, and they differ in two important respects.

First, the underwriting risks of traditional insurers' claim liabilities usually are better diversified than are the credit risks of banks' loan assets, which typically are exposed to the macroeconomy, geographical regions, industries, or lines-of-business. When this is the case, traditional insurers need to hold relatively smaller amounts of capital relative to the face amount of insurance in order to maintain an adequate solvency cushion against adverse claim outcomes.

Second, traditional insurers typically experience illiquidity only when they make poor business decisions rather than as an inevitable result of their business model.[xv] In contrast, banks' illiquidity risk arises from their business model of investing in less liquid assets than liabilities. Traditional insurers though tend to write insurance policies that (i) require premiums to be received before claims are paid with fairly high policy renewal rates, (ii) naturally link the insurers' assets and liabilities because, when policyholders cancel their insurance policies, the insurer both refunds any unused premiums and eliminates any related claim liabilities, and (iii), even for investment-oriented life ones with accumulated policy values, policyholders that cash

out those policies early are often subject to surrender charges or have the investment values of the policies paid out over prolonged periods (e.g., as annuities).

Because of these distinct features, most traditional insurers weathered the financial crisis considerably better than did most banks and other financial institutions. It is therefore difficult to make a case that traditional insurance firms, even large ones, cause systemic risk. For example, Park and Xie (2011) analyze systemic risk amongst interconnected P/C insures around rating downgrades.[xvi] While they do find evidence of spillover effects, the probability that these effects could lead to a system-wide impact is seen as small.

The argument that the insurance sector poses systemic risk, however, relies on the view that the insurance industry is no longer traditional in the above sense and instead (i) offers products with non-diversifiable risk, (ii) is more prone to "runs", (iii) insures against macro-wide events and (iv) has expanded its role in financial markets.

First, the product offerings of insurance companies may contain aggregate, non-diversifiable risk. For example, some large life insurers, notably AIG, Hartford Financial Services Group (HSFG), and Lincoln National, aggressively wrote investment-oriented life insurance policies with minimum guarantees and other contract features that exposed them to equity and other investment markets. These policies expose the insurers to potentially large losses when markets decline. Moreover, the investment decisions of insurance companies may also include aggregate market exposures. If these risks materialize, and the risks by nature are more likely to do so during a financial and economic crisis, then insurance companies collectively will suffer investment losses. Some recent examples in the literature include Brewer, Carson, Elyasiani, Mansur and Scott (2007) which examines the interest rate sensitivity of life insurers' holdings, and Baranoff and Sager (2009) that investigates life insurer's exposures to mortgage-backed securities.[xvii] Both of these papers show sensitivity to market-wide exposures.

To some degree, it is an empirical question whether insurance companies face aggregate exposures. Due to marked-to-market losses in their asset holdings or product offerings (like guaranteed investment contracts) becoming underwater, all tied to common macroeconomic events, the equity and subordinated bonds' value of insurance companies will, and did so in the financial crisis of 2007-2009, come under pressure. For example, the credit default swap (CDS) spreads – the cost of buying protection against default of senior, subordinated bonds – of MetLife, Hartford, and Lincoln National, amongst others, all rose well above 500 basis points in the fall of 2008 after Lehman's collapse.

Second, insurance products and markets have shifted in major ways. There has been a rapid rise in annuities - particularly variable annuities, some with imprudent macroeconomic guarantees. Most annuities are now purchased as withdrawable investment accounts (albeit with cash-out penalties) and represent almost 75% of all premiums. The standard assumption that the liabilities of distressed insurance companies cannot be run on no longer holds.

In this volume, Paulson, Pletis, Rosen, McMenamin and Mohey-Dean (2013) provide a detailed analysis of this issue.[xviii] They provide evidence that approximately 50% of liabilities are in a moderate- to high-liquid category, allowing for some type of withdrawal. Projected onto stress scenarios, they estimate that 43% (31%) of the life insurance industry's liabilities are subject to withdrawals in an extreme (moderate) stress environment. In light of the possibility that life insurance premiums are no longer as sticky, one can look at evidence from the P/C industry (which are generally short-term contracts) to see that an insurer's distress can impact its ability to

intermediate. (See, for example, Cummins and Lewis (2003) and Eppermanis and Harrington (2006).)[xix]

Third, over the last few decades, some insurers have deviated from the traditional insurance business model by providing "insurance" or similar financial products protecting against macroeconomic events and other non-diversifiable risks. For example, in the years leading up to the financial crisis, the monoline insurers and American International Group (AIG) wrote financial guarantees on structured financial products tied to subprime mortgages.[xx] If these non-traditional insurers become distressed, as they did during the most recent financial crisis, then their losses can be passed on to their counterparties, thus causing possible contagion throughout the financial sector at large.

Fourth, more broadly, the line between insurance companies and other financial services companies has become blurred over time. For example, some insurance companies, in particular AIG, ran large securities lending businesses. Securities lending is simply a form of "shadow banking", that is, lightly regulated and subject to significant liquidity and run risks when underlying security or counterparty risks materialize. Another example is detailed in Koijen and Mogo (2013) and is reminiscent of the special purpose vehicles of large complex banks during the financial crisis.[xxi] Koijen and Mogo (2013) show that some of the larger life insurance companies are now using reinsurance to move liabilities from operating companies that sell policies to less regulated (i.e., less capitalized) "shadow insurers" in regulation-friendly U.S. states (e.g., South Carolina and Vermont) and offshore locales (e.g., Bermuda and the Cayman Islands). Since the liabilities stay within the insurer's holding company, there is not the usual risk transfer between the insurer and reinsurer. They show that this type of regulatory arbitrage has grown from $10 billion to $363 billion over the past decade, and, when accounted for, expected losses are almost $16 billion higher in the industry.

In another sign of blurring of the insurance industry's functional form, annuities are now the product of choice within the insurance sector, and can be considered investment products with certain features not unlike those offered by asset management companies. In surveys of these changes, Brown (2008) and Cummins and Weiss (2009) both provide descriptions of the convergence of financial services across different parts of the financial sector.[xxii] Of course, if different types of financial companies are offering similar products, then this suggests that regulation should be by function and not form, and also contradicts the often-stated claim that insurance companies are fundamentally different.

If systemic risk can indeed emerge from the insurance sector, what is the likelihood that insurance companies will fail *en masse* during a financial crisis period? Systemic risk should be broadly conceived as the potential failure of a significant part of the financial sector – one large institution or many smaller ones – leading to reductions in the availability of credit and/or critical risk management products such as insurance, thereby adversely affecting the real economy. And, because of the interconnectedness of the modern financial sector, for the purposes of systemic risk regulation, one must view the financial sector also broadly as composed of not just commercial bank taking deposits and making loans, but also investment banks, money market funds, mutual funds, insurers, and potentially, even hedge funds and private equity funds.

In terms of measuring systemic risk of the insurance sector, however, there is not uniformity in the academic literature. For example, Billio, Getmansky, Lo, and Pelizzon (2012) find that,

through a battery of tests, hedge funds, banks, broker-dealers and insurance companies have become more inter-connected over the last decade, giving support to the above thesis.[xxiii] In contrast, Chen, Cummins, Viswanathan and Weis (2012) find that, while there is some bidirectional evidence of systemic risk between banks and insurers, the majority of this risk derives from banks.[xxiv] Similarly, Grace (2010) argues, and provides some evidence around potentially systemic events during the recent financial crisis, that the insurance industry is less impacted.[xxv]

All of this evidence, in favor and against, however, falls into the potential trap of measuring systemic risk incorrectly. Instead, the relevant issue is whether an insurer, and when aggregated, the insurance sector, contributes to an aggregate capital shortfall of the financial sector and whether financial disintermediation results from this shortfall.[xxvi] In Chapter 7 of this book, Cummins and Weiss (2013) relate particular insurance characteristics to such a measure, and find that systemic risk measured this way is more likely to show up in noncore activities of the insurance sector. In contrast, in Chapter 8 of this book, Harrington (2013) questions the efficacy of some of these methods applied to the insurance sector. In Section III below, we provide an analysis of systemic risk based on aggregate capital shortfall.

III. Systemic Risk Evidence

Why is measuring systemic risk so important?

The current problem with financial regulation is that the regulation seeks to limit each institution's risk in isolation. Unless the external costs of systemic risk are internalized by each financial institution, however, these institutions will have the incentive to take risks that are not borne just by the institution but instead by society as a whole. In other words, individually, firms may take actions to prevent their own collapse, but not necessarily the collapse of the system. It is in this sense that the financial institution's risk is a negative externality on the system.

Formal economic theory can be a useful guide to help measure systemic risk. Specifically, in (i) a model of a financial system in which each firm has limited liability and maximizes shareholder value, (ii) the regulator provides some form of a safety net (i.e., guarantees for some creditors such as deposit or too-big-to-fail insurance), and (iii) the economy faces systemic risk (i.e., system-wide costs) in a financial crisis when the financial sector's equity capitalization falls below some fraction of its total assets and that these costs are proportional to the magnitude of this shortfall, the costs of each financial firm are equal to the sum of two components:[xxvii]

> Costs to society of the financial firm = Expected losses of the firm's guaranteed debt upon default + Expected systemic costs in a crisis per dollar of capital shortfall × Expected capital shortfall of the firm if there is a crisis

Under reasonable assumptions, one can show that the systemic risk of a firm is equal to the

Expected real social costs in a crisis per dollar of capital shortage
× *Expected capital shortfall of the firm in a crisis*

The first term above reflects the product of the large bailout costs and real economy welfare losses associated with financial crises times the probability of such crises. The second term deals with the relative contribution of each financial firm to systemic risk though the firm's expected losses in a crisis.

The advantage of the above "formula" for a firm's systemic risk is that it is precise in nature. To measure a financial firm's contribution to systemic risk involves measuring the firm's expected capital shortfall in a crisis. This immediately provides the regulator with a quantifiable measure of the relative importance of a firm's contribution to overall systemic risk. The measure also captures in one fell swoop many of the characteristics considered important for systemic risk such as size, leverage, concentration and interconnectedness, all of which serve to increase the expected capital shortfall in a crisis. But the measure also provides an important addition, most notably the co-movement of the financial firm's assets with the aggregate financial sector in a crisis. The other major advantage of this measure is that it makes it possible to understand systemic risk not just in terms of an individual financial firm but in the broader context of financial subsectors. For example, since the measure is additive, it is just one step to compare the systemic risk of say the regional banking sector versus the life insurance sector.

Can we quantify and measure the systemic risk of financial institutions? In this section, we argue that significant progress can be made even by relying exclusively on market information. The basis behind these calculations are provided in Acharya, Pedersen, Philippon and Richardson (2010) and Brownlees and Engle (2010).[xxviii] A detailed analysis is given at NYU Stern's Systemic Risk website, http://vlab.stern.nyu.edu/welcome/risk. Indeed, the results below are extracted from this site.

In brief, the procedure is to calculate the losses in market value of equity of a financial firm in a crisis, defined as the marginal expected shortfall (MES) associated with a market decline of at least c:

$$MES_{i,t} = E_{t-1}\left(-R_{i,t} \mid R_{m,t} < c\right) \tag{1}$$

The MES can be estimated in a variety of ways using either a structural model (e.g., an asymmetric GARCH and dynamic conditional correlation model as in Brownlees and Engle (2010)) or a tail distribution model (e.g., see Acharya, Pedersen, Philippon and Richardson (2010)), amongst other methodologies. The key point is to estimate what a firm's losses will be in the aggregate crisis state, hence, building into the framework the idea of co-dependence. The estimate of these losses allow us to calculate the expected capital shortfall of each firm if there is a crisis. This is a simple calculation based on the leverage of the firm.

$$\mathrm{SRISK} = \min\left(0, \mathrm{E} - \mathrm{k}\left(\mathrm{E} + \mathrm{D}\right)\right) \tag{2}$$

where E is the market value of equity in crisis, D is the book value of debt and k is a prudential capital requirement which is taken to be 8% in accordance with current regulatory standards. The expected value of equity is simply

$$E = (1 - MES)E_0 \tag{3}$$

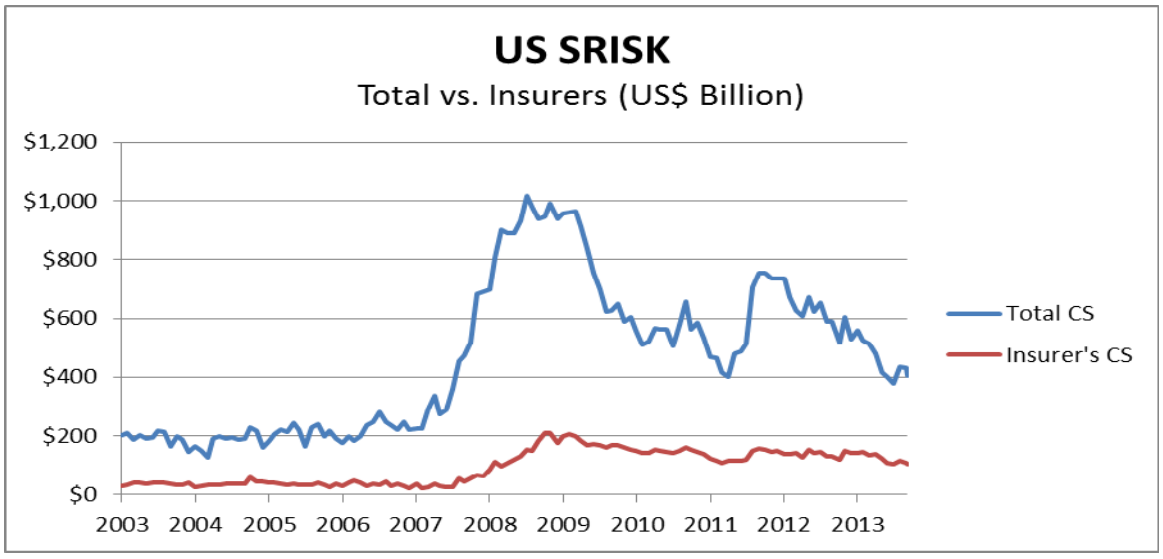
where E_0 is today's market value of equity. The contribution to systemic risk then is simply

$$SRISK\%_{i,t} = \frac{SRISK_{i,t}}{\sum_{i=1}^{N} SRISK_{i,t}} \quad (4)$$

A few observations on the procedure are in order. First, note that there is an implicit assumption that the capital ratio at which firms disintermediate, i.e., *k*, is the same for all firms, bank or no bank. It has been suggested that this may not be appropriate for insurance companies (e.g., see chapter 8 of this book, Harrington (2013)). While this is true, it is not clear which direction *k* should go in for insurance companies. Indeed, there is evidence to suggest a ratio of *k=8%* is conservative for some insurance companies.[xxix] That is, "in equilibrium", these companies tend to be less levered than their bank counterparts. This is especially true for property casualty insurance companies as their market value of equity covers a higher fraction of total assets. Thus, if an insurance company were to fall to a ratio as low 8%, this level would be far from normal. Second, the theory outlined in Acharya, Pedersen, Philippon and Richardson (2010) would apply a negative SRISK to safe, well-capitalized financial firms. In a crisis, these firms would be natural buyers of struggling financial firms and therefore reduce aggregate systemic risk. The current analysis at NYU Stern's Systemic Risk website ignores this element and could impact some of the results analyzed below. Third, and perhaps most important, a dollar of capital shortfall for any firm is treated the same in its contribution to aggregate capital shortfall. This issue was discussed in detail in Section II, and in particular with respect to a comparison between the insurance sector and the banking industry. While the discussion pointed to insurance companies being systemic, whether their capital shortfalls are equal to those of other financial institutions is an open and reasonable question.

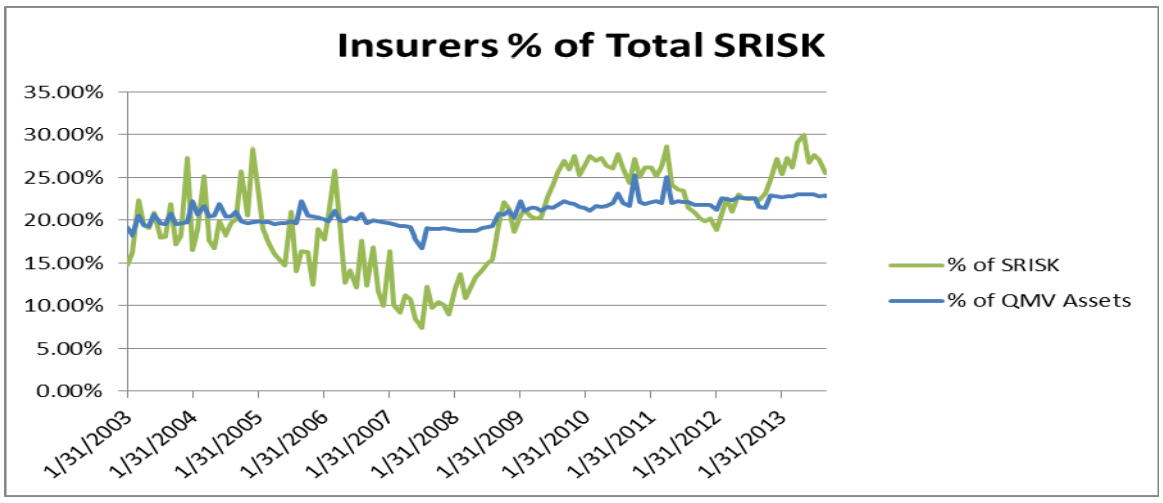
Figure 1 below describes the SRISK (i.e., the total estimated aggregate capital shortfall during a crisis) of the financial sector and the insurance subsector over the years 2003-2013. Up until the occurrence of the financial crisis, the estimate of the financial sector and insurance sector respectively hovered around $200 billion and $40 billion. As the crisis took roots in the summer of 2007 and peaked in the Fall of 2008 (with the failure of Lehman), SRISK increased to around a $1 trillion and $200 billion for the insurance sector. Interestingly, as the financial sector worked through the financial crisis, with various peaks and valleys, SRISK of the financial sector in 2013 has gone down to around $400 billion whereas the insurance subsector has also declined, albeit less on a percentage basis, to approximately $100 billion. The relative improvement of the rest of the financial system compared to the insurance sector can be attributed to reductions in market leverage relative to the insurance sector.

Figure 1: Total Systemic Risk of US Financial Sector and Insurance subsector



This point is highlighted in Figure 2. Figure 2 describes the insurance subsector's percentage of the US financial sector's total quasi market value of assets and the sector's SRISK (i.e., total systemic risk).[xxx] Prior to the crisis, the insurance sector moved around 20% in terms of both percentage shares. In other words, the insurance sector's SRISK was commensurate with its share of total assets. Starting in 2005 and going through the financial crisis, its share was less, reaching a low of 10% in terms of systemic risk. This is not surprising since the financial crisis was very much a banking crisis even putting aside the fact that insurance companies had broken into nontraditional businesses. By the Spring of 2009, however, insurance had become on a relative basis in terms of its total assets, a more systemically risky financial subsector. Whether it was due to regulation or to conscious behavior, the banking sector became better capitalized and less risky. Figures 1 and 2 show that this reduction in systemic risk is less true of the insurance subsector. In fact, the percentage contribution to overall systemic risk is generally between 25% and 30% in contrast to the insurance sector's 22%-23% share of overall assets.

Figure 2: Insurance Subsector Percentage of US Financial Sector's Assets and Systemic Risk

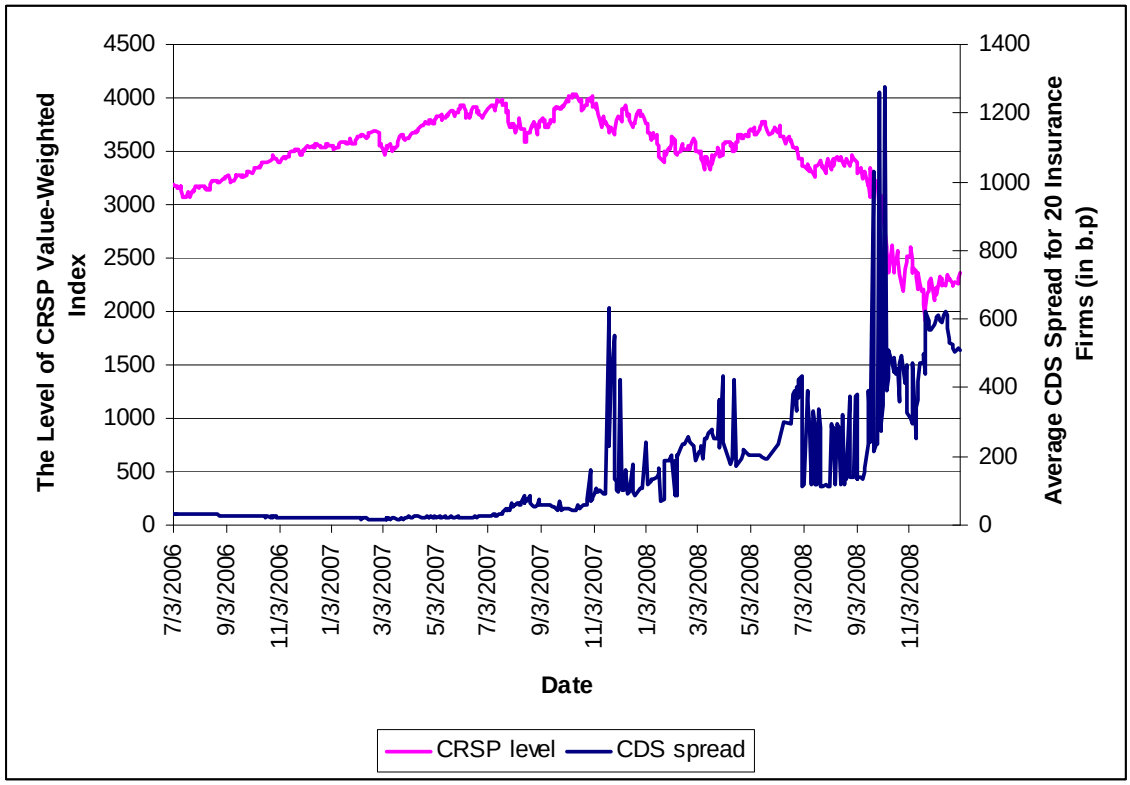


The above analysis uses historical equity market data to back out systemic risk estimates of individual financial companies and then aggregates up these estimates to the overall financial sector and the insurance subsector. We extend this analysis below in two ways: (i) by focusing on a particular snapshot of the insurance sector, namely June 2007, just prior to the emergence of the financial crisis, and (ii) by measuring systemic risk using credit default swaps (CDS) data.

Insurance firms experienced significant stress during the financial crisis of 2007-2009. Figure 3 shows the time series of daily levels of the CRSP value weighted index and the daily average levels of CDS spreads for 20 insurance firms whose spread data is available from Bloomberg.[xxxi] Noticeably, the stock market declined gradually from the onset of the crisis in the middle of 2007, only to take a big plunge in the summer of 2008. Meanwhile, insurance firms showed serious signs of stress from as early as Q4:2007, when their CDS spreads remarkably widened from around 20 basis points to over 600 basis points. These spreads remained considerably high throughout the crisis, peaking at around 1300 basis points right before the trough of the stock market.

Figure 3. CDS Spread vs. CRSP Index Level

The graph depicts a plot of the daily average CDS spread for 20 insurance firms included in the sample, and CRSP index level over the July 06-December 08 period.



An important question is thus posed: how can we measure ex ante which insurance firms are relatively more systemic than others and thus will undergo greater stress during a systemic crisis? We show that information from the credit default swaps market can offer a good answer to this question. In particular, we find that a measure of systemic risk computed from CDS spreads, namely CDS Marginal Expected Shortfall (CDS MES), can successfully predict the performance of insurance firms during the 2007-2009 financial crisis.

The idea of using Marginal Expected Shortfall (MES) based on stock market data as a measure of firm specific systemic risk is employed and discussed above. Given that information from CDS data is informative about the level of stress experienced by insurance firms over the crisis, we employ a similarly defined measure of MES computed from CDS spread data. Acharya, Pedersen, Philippon, and Richardson (2010) argue that this measure can approximate expected systemic risk contribution given that the change in CDS spreads attaches smaller weight to safer firms.[xxxii]

As a proxy for the market of insurance firms, we initially consider the 102 US financial firms with at least $5 billion in market capitalization (as of June 2007). Data on CDS spreads are available from Bloomberg for 40 of these firms, 20 of which are insurance firms which are the focus of this section. To compute CDS MES for each insurance firm, we take the 5% worst days over the one year pre-crisis period (from 30th June 2006 to 1st July 2007) for an equally weighted portfolio of CDS returns on the 40 financial firms, then calculate CDS MES for each individual firm as the average daily logarithmic returns on CDS spreads over these days.[xxxiii] The CDS MES obtained is our measure of systemic risk for each of the 20 insurance firms examined. Table 1 provides the ranking for these 20 firms based on their CDS MES. These rankings can be viewed as systemic risk on a per dollar basis. At the top of the list is Genworth Financial Inc. whose systemic risk measure is as high as 16.40%. AMBAC Financial Group Inc, MBIA Inc, and AIG are next. Of course, because AIG has considerably more assets than either MBIA or AMBAC ($1.0333 trillion versus $43 and $21 billion, respectively), AIG's overall systemic risk iss magnitudes higher. On the other hand, AETNA Inc; CIGNA Corp, and Marsh & McLennan Cos. Inc. are the least systematically risky firms, with CDS MESs being negative.

Table 1 CDS MES ranking of 20 insurance firms

This table contains the list of 20 US insurance firms with a market cap in excess of $5 bln as of June 2007. The firms are listed in descending order according to their CDS Marginal Expected Shortfall at the 5% level (MES), calculated over the July 2006 to June 2007 period. Realized SES is the return on CDS spread during the crisis.

Name of company	Ticker	Assets ($ blns)	CDS MES ranking	Realized CDS SES (July 07-June 08)	Realized CDS SES (July 07-Dec 08)	CDS MES
GENWORTH FINANCIAL INC	GNW	111.94	1	145.38%	403.03%	16.40%
AMBAC FINANCIAL GROUP INC	ABK	21.06	2	424.10%	389.12%	8.05%

M B I A INC	MBI	43.15	3	383.11%	303.44%	6.71%
AMERICAN INTERNATIONAL GROUP	AIG	1033.87	4	277.42%	369.20%	3.40%
ALLSTATE CORP	ALL	160.54	5	183.66%	271.38%	2.97%
LOEWS CORP	L	79.54	6	136.79%	175.47%	2.67%
PRUDENTIAL FINANCIAL INC	PRU	461.81	7	240.25%	394.44%	2.33%
LINCOLN NATIONAL CORP IN	LNC	187.65	8	234.94%	403.58%	2.27%
AON CORP	AOC	24.79	9	32.41%	55.10%	2.26%
HARTFORD FINANCIAL SVCS GROUP	HIG	345.65	10	212.09%	368.41%	2.03%
TRAVELERS COMPANIES INC	STA	115.36	11	124.68%	171.62%	1.95%
CHUBB CORP	CB	51.73	12	164.91%	192.52%	1.73%
UNUM GROUP	UNM	52.07	13	118.33%	165.43%	0.98%
SAFECO CORP	SAF	13.97	14	123.95%	155.92%	0.85%
C N A FINANCIAL CORP	CNA	60.74	15	105.34%	218.89%	0.84%
METLIFE INC	MET	552.56	16	220.59%	362.62%	0.75%
TORCHMARK CORP	TMK	15.10	17	24.69%	182.45%	0.34%
AETNA INC NEW	AET	49.57	18	127.42%	192.96%	-0.12%
CIGNA CORP	CI	41.53	19	124.73%	267.69%	-0.56%
MARSH & MCLENNAN COS INC	MMC	17.19	20	31.82%	33.43%	-0.63%

Results from Table 1 reveal at a preliminary level the success of CDS MES as a predictor of how stressful each firm was during the crisis. Specifically, AMBAC Financial Group Inc. & MBIA Inc; which rank the highest among the five big insurance firms, are those that were the most seriously hurt during the crisis. As shown by their realized CDS SES, their CDS spreads skyrocketed from the beginning of the crisis and continued to increase over time. On the other hand, Hartford and MetLife, which have lower CDS MESs, also experienced widening CDS spreads but to a much smaller magnitude and at a much slower pace.

Figures 4 and 5 show at a more detailed level how well CDS MES can predict the realized systemic risk contribution of the 20 insurance firms during the July 2007- June 2008 crisis period. This realized contribution is measured using both the percentage change in CDS spreads, and the total percentage change in stock returns. As can be seen from the figures, CDS MES as an ex ante measure of systemic risk contribution does very well ex post. There is indeed a clear positive association between CDS MES as a measure of systemic risk and realized systemic costs over the crisis. Firms that had higher systemic risk ex ante were under greater stress ex post, that is, they experienced larger increases in CDS spreads and lower stock returns over the crisis.[xxxiv]

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Figure 4. CDS Marginal Expected Shortfall (MES) vs. Total Realized Return in CDS Spread measured during 1st July 2007- 30th June 2008

The graph depicts a scatter plot for 20 insurance firms of the CDS MES computed during the 1 July 2006-30 June 2007 period versus the total realized return on CDS spread during the period from 1 July 2007 to 30 June 2008.

CDS MES is the average CDS returns on the worst 5% days from 1 July 2006 to 30 June 2007, when the average CDS returns of the 40 companies are the highest.

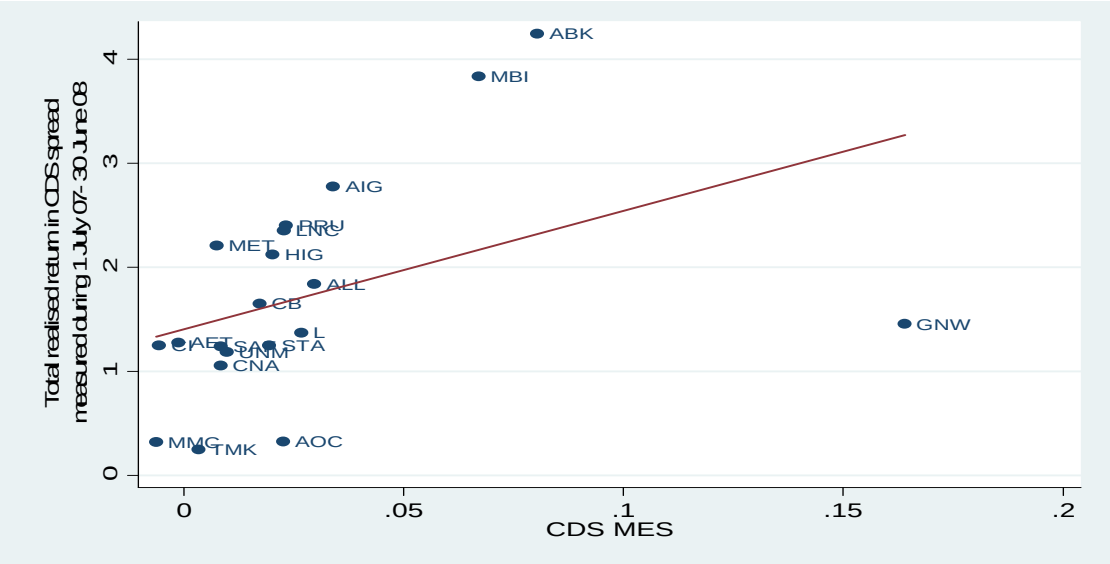
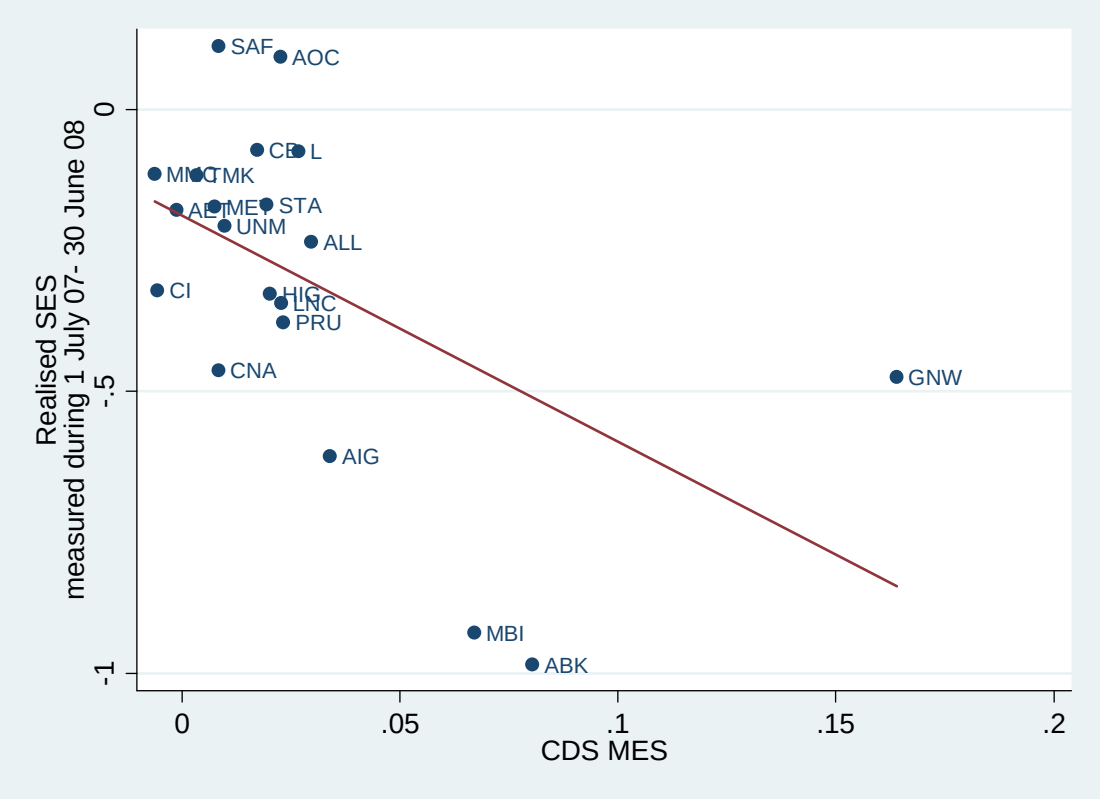


Figure 5 CDS Marginal Expected Shortfall (MES) vs. Total realized stock return measured during the period 1st July 2007- 30th June 2008

The graph depicts a scatter plot (for 20 insurance firms) of CDS MES computed during the 1 July 2006-30 June 2007 period versus the total realized stock return during the period from 1 July 2007 to 30 June 2008. CDS MES is the average CDS returns on the worst 5% days over the 1 July 2006 - 30 June 2007 period, when the average CDS returns of the 40 companies are the highest.



IV. State Versus Federal Regulation of Insurance Companies

As described in the introduction, unlike other financial regulation, most insurance regulation is carried out by the states, as has been the case since the 19th century. Several legal attempts have been made over time to bring insurance regulation under the federal government as part of its power to regulate interstate commerce. Notably, in Paul v. Virginia in 1869, the Supreme Court ruled that insurance was not commerce and thus not subject to federal regulation. In United States v. South-Eastern Underwriters Association in 1944, the Supreme Court ruled that insurance was commerce, overruling Paul v. Virginia, and thus the regulation of insurance was a federal responsibility. In response to this ruling, in 1945, Congress passed the McCarron-Ferguson Act, which deferred insurance regulation to the states. This act reserved the federal government's right to oversee and, if necessary, to take greater responsibility for, insurance regulation.

Sections II and III above focused on one particular type of insurance regulation, namely systemic risk. These sections provided an analysis of whether the insurance sector can impose significant systemic risk on the economy. This leads to the question of whether federal regulation is necessary beyond the creation of the Federal Insurance Office, stipulated by the Dodd-Frank Act. In the long-term, would the U.S. financial architecture be better off by creating a National Insurance Regulator and an associated federal charter, by establishing a National Insurance Guarantee Fund, and by regulating some insurance companies through a dedicated systemic risk regulator (such as the FSOC within the Dodd-Frank Act's enhanced regulation of SIFIs)?

But insurance regulation comprises several other activities. Specifically, insurance regulation focuses on accounting and disclosure requirements and also the formation and licensing of companies, affiliation and holding company considerations, the licensing of agents and brokers, product approval, marketing methods, on-site examinations, and investment restrictions.

Each state has an insurance department and a commissioner of insurance. The commissioner usually is appointed by the governor of the state, but is elected in ten states. The NAIC promotes the effective performance of state regulation by developing model state laws and regulations, by codifying Statutory Accounting Principles, and in various other ways. The NAIC also rates investments for regulatory purposes. The NAIC's efforts have reduced, though not eliminated, the frictions resulting from state-level regulation of interstate insurers.

Interstate insurers and others have criticized the high cost and inefficiency of state-level regulation, preferring the *option* of a national insurance charter and federal insurance regulation. However, Congress generally has resisted changing the existing system except when faced with *force majeure* issues, such as terrorism and Hurricane Katrina. The states vigorously defend their performance in regulating local issues (consumer protection, complaints etc.), and they point to the far fewer failures of insurers then of partly or wholly federally regulated banks.

The states have a point. State regulators argue that their proximity to the ground help them better regulate insurance companies. Perhaps, an even stronger argument is the generally dismal performance of federal regulators, across various agencies, to regulate banks, securities dealers and other shadow banks during financial crises. (See Kimball and Boyce (1958) and Tyler and Hornig (2009) for a discussion of why state regulation is preferred.)[xxxv] For instance, a striking example is the regulation of mortgages (or lack thereof) leading up to the recent financial crisis even though many federal regulations were at the disposal of regulators. To the extent there are inefficiencies within the state system, pro-state advocates argue that the NAIC has, and will continue, to address these over time (e.g., Baird and Cobb (2005)).[xxxvi]

That said, the federal government does intervene in states insurance regulation. For example, the Employee Retirement Income Security Act (ERISA) preempted state supervision of pensions and health plans administered by insurers. The Securities and Exchange Commission (SEC) regulates insurers' offerings of variable annuities and other performance-based investment products, as well as the financial reporting of publicly traded insurers. When insurance industry capacity is challenged by large unexpected shocks or ongoing uncertainty, the federal government may take actions to free up industry capacity or provide insurance itself. For example, the terrorist attacks of September 11, 2001 yielded large property liability claims that reduced insurers' capital and, more importantly, very high uncertainty about potential future terrorist events that effectively froze terrorism reinsurance markets. The Terrorism Risk Insurance Act (TRIA) solved the latter problem by providing government reinsurance of losses from a terrorist attack when the industry's aggregate losses reached a certain level.[xxxvii]

Moreover, the Federal Liability Risk Retention Act of 1986 does allow some insurers, known as risk retention groups (RRGs), to do nationwide business under one license. These RRGS allow for a controlled experiment to compare RRGs to other more standard state-regulated commercial

liability insurers. Leverty (2011) documents substantial costs associated with duplicative regulation across states, providing strong support (albeit using limited data) for national regulation.[xxxviii] (See also Waterfield (2002) for a more general analysis of state versus federal regulation of insurance companies.)[xxxix]

Putting aside the issue of efficiency, there is also the question of whether states can reasonably be expected to address the systemic risks of insurers offering nontraditional insurance products. State insurance regulators are inherently limited in their ability to do so, for various reasons. These regulators generally will not have access to all of the relevant information about the insurers operating in multiple states and the overall financial system in which they operate, and so will not be able to see the potential magnitude of and avenues for insurers' systemic risk. With considerable variation across states, state regulators lack the financial resources and technical skills to measure the systemic risk contributions of individual insurers, as well as the ability to levy premiums for these contributions or even ban systemically risky products. Were a state to levy higher premiums, treat insurers' systemic risk contributions more onerously, or ban certain insurance products, insurers would have the incentive to re-domicile in more lenient states, i.e., engage in regulatory arbitrage. An example of regulatory arbitrage was given in Section II above (see Koijen and Yogo (2013)).[xl]Of course, it is an open question whether the Dodd-Frank Act's Bureau of Consumer Finance Protection or the FSOC will be capable of filling this void.[xli]

V. Conclusion

As a final comment, there are clear reasons to question the existing regulatory architecture of the insurance industry. First, if systemic risk is indeed present within the insurance sector, then there must be a role for federal regulation. The question is whether the FSOC is sufficient to address this issue. Second, wherever the regulation takes place, the current system is antiquated in terms of its current regulatory architecture. Cummins and Phillips (2009) for example argue that, even though the insurance industry appears to have been prudently managed by state regulators, the current system is vastly out of date, especially when compared to regulation in Europe.[xlii] Third, others, such as Brown (2008), go even further and suggest that the debate regarding state versus federal regulation misses the point.[xliii] Her argument is that insurance is no longer a unique financial service, and that the boundaries between insurance and financial services products have converged so much, regulation must really be at the risk and product level of these institutions (see also Cummins (2005)).[xliv] Of course, this argues both against state regulation and against having a national insurance regulator.

End Notes

[i] Viral Acharya is CV Starr professor of economics at the NYU Stern School of Business; John Biggs is an executive-in-residence at the NYU Stern School of Business and former Chairman and Chief Executive Officer of TIAA-CREF; and Matthew Richardson is the Charles E. Simon Professor of Applied Financial Economics at the NYU Stern School of Business.

[ii] Cummins, David J., 2013, "Systemic Risk and Regulation of the U.S. Insurance Industry," *****in this volume*****; Harrington, Scott, 2009, The Financial Crisis, Systematic Risk, and the Future of Insurance Regulation, *Journal of Risk and Insurance* 76, 785-819; Harrington, Scott, 2010, "Insurance Regulation and the Dodd-Frank Act", working paper, Wharton School at the University of Pennsylvania; Harrington, Scott, 2013, "Designation and Supervision of Insurance SIFIs" *****in this volume*****; Tyler, Ralph and Karen Hornig, 2009, "Reflections on State Regulation: A Lesson of the Economic Turmoil of 2007-2009", Journal of Business & Technology Law, vol. 4:2, 349-370.

[iii] This is not to say that different types of policies do not differ in the diversifiability of claim payments. For example, automobile claims are more diversifiable than product liability claims. Moreover, some policies with generally diversifiable risks exhibit specific risks that are not diversifiable. For example, life insurers are exposed to pandemics, which occur rarely but can devastate life insurers when they do occur.

[iv] Froot, Kenneth A., 2001, "The Market for Catastrophe Risk: A Clinical Examination," *Journal of Financial Economics*, 60: 529-571; and Froot, Kenneth A. and Paul G.J. O'Connell, 1999, "The Pricing of U.S. Catastrophe Reinsurance," chapter 5 of The Financing of Catastrophe Risk, editor Kenneth A. Froot, University of Chicago Press, p. 195-232.

[v] Garmaise, Mark J., and Tobias J. Moskowitz, 2009, "Catastrophe Risk and Credit Markets," *Journal of Finance*, 64: 657-707. The evidence of supply effects in capital markets are just not related to catastrophe reinsurance markets. For example, Ivashina and Scharfstein (2010) document a sharp decline in bank loans with the onset of the financial crisis and show that some of this drop is supply driven (see Ivashina, Victoria and David Scharfstein, 2010, "Bank Lending During the Financial Crisis of 2008," *Journal of Financial Economics*, 97: 319-338.).

[vi] Dick-Nielsen, Jens, Peter Feldhutter and David Lando, 2012, "Corporate Bond Liquidity before and after the Onset of the Subprime Crisis," Journal of Financial Economics, 103:3, pp. 471-492.

[vii] Paulson, Anna, Thanases Plestis, Richard Rosen, Robert McMenamin and Zain Mohey-Dean, 2013, "Assessing the Vulnerability of the U.S. Life Insurance Industry," *****in this volume*****.

[viii] Manconi, A., M. Massa and A. Yasuda (2012) "The Role of Institutional Investors in Propagating the Crisis of 2007-08", *Journal of Financial Economics*, Vol. 104, No. 3, 491-518.

[ix] Stanton, R., and Wallace, N. (2010). CMBS subordination, ratings inflation, and the crisis of 2007-2009. Unpublished manuscript, University of California at Berkeley.

[x] Ellul, A., P. Jotikasthira and C. Lundblad, "Regulatory Pressure and Fire Sales in the Corporate Bond Market", Working Paper, Indiana University Bloomington.

[xi] FSOC, July 8, 2013, "Basis of the Financial Stability Oversight Council's Final Determination Regarding American International Group, Inc".

[xii] Acharya, Viral V, John Biggs, Hanh Le, Matthew Richardson and Stephen Ryan (2010), "Systemic Risk and the Regulation of Insurance Companies", Chapter 9 in *Regulating Wall Street: The Dodd-Frank Act and the Architecture of Global Finance*, edited by Viral V Acharya, Thomas Cooley, Matthew Richardson and Ingo Walter, John Wiley & Sons.

[xiii] For a detailed discussion of the cycle of market and funding liquidity, see Brunnermeier, Marcus K. and Lasse H. Pedersen (2009) "Market Liquidity and Funding Liquidity", *Review of Financial Studies*, 22: 2201-2238.

[xiv] Acharya, Viral V, Thomas Cooley, Matthew Richardson and Ingo Walter, 2010, "Manufacturing Tail Risk: A Perspective on the Financial Crisis of 2007-2009," *Foundations and Trends in Finance*, 4: 247-325.

[xv] An exception to this statement occurs when insurers experience rare and extremely adverse underwriting outcomes. For example, epidemics that kill large numbers of people in short periods of time are rare—the last significant one in the U.S. was the Spanish Flu in 1918-1919—but when they occur, they can devastate life insurers.

[xvi] Park, Sojung Carol, and Xiaoying Xie, 2011, "Reinsurance and Systematic Risk: The Impact of Reinsurer Downgrading on Property-Casualty Insurers," working paper, California State University, Fullerton.

[xvii] Brewer, E., Carson, J.M., Elyasiani, E., Mansur, I., & Scott, W.L. (2007). Interest rate risk and equity values of life insurance companies: A GARCH-M model. *The Journal of Risk and Insurance, 74(2)*, 401-423; Baranoff, E.G.,

& Sager, T.W. (2009). The impact of mortgage-backed securities on capital requirements of life insurers in the financial crisis of 2007-2008. *Geneva Papers on Risk and Insurance, 34(1)*, 100-118.

[xviii] Paulson, Anna, Thanases Plestis, Richard Rosen, Robert McMenamin and Zain Mohey-Dean, 2013, "Assessing the Vulnerability of the U.S. Life Insurance Industry," *****in this volume*****.

[xix] Cummins, D.J., & Lewis, C. M. (2003). Catastrophic events, parameter uncertainty and the breakdown of implicit long-term contracting: The case of terrorism insurance. *Journal of Risk and Uncertainty, 26(2-3),* 153-178; Epermanis, K. & Harrington, S. (2006). Market discipline in property/casualty insurance:Evidence from premium growth surrounding changes in financial strength ratings.*Journal of Money, Credit, and Banking, 38*, 1515–1544.

[xx] AIG also incurred larger losses on its insurance subsidiaries in 2008 than on the Financial Products group, and these losses were due largely to its securities lending, certain repurchase agreement transactions and its direct purchase of the super senior tranches of subprime mortgage-based CDOs, which were the same type as those insured by the CDSs sold by the Financial Products group.

[xxi] Koijen, Ralph S.J., and Motohiro Yogo, 2013, "Shadow Insurance," working paper, London Business School.

[xxii] Brown, Elizabeth F., 2008, "The Fatal Flaw of Proposals to Federalize Insurance Regulation", Research Symposium on Insurance Markets and Regulation. Pp. 1-84; Cummins, D.J., & Weiss, M.A. (2009). Convergence of insurance and financial markets: Hybrid and securitized risk-transfer solutions. *Journal of Risk and Insurance, 76(3),* 493-545.

[xxiii] Billio, M., Getmansky, M., Lo, A.W. & Pelizzon, L. (2010). Measuring systemic risk in the finance and insurance sectors, forthcoming *Journal of Financial Economics* .

[xxiv] Chen, Hua, j. David Cummins, Krupa S. Viswanathan and Mary Weis, 2012, "Systemic Risk and the Inter-Connectedness between Banks and Insurers: An Econometric Analysis," working paper, Temple University.

[xxv] Grace, Martin F., 2010, "The Insurance Industry and Systemic Risk: Evidence and Discussion," working paper, Georgia State University.

[xxvi] For example, Grace (2010) looks at excess returns of P/C insurers, life insurers, AIG and distressed insurers around seven events relevant to the financial crisis. Grace (2010) reasons that, because the excess returns are not particularly negative around these events, little systemic risk emerged. But Grace (2010) also reports extraordinarily high market betas, especially for the struggling insurance companies, which suggests very large losses during extreme market downturns. The question is whether these losses were broad enough across the insurance sector that resulted in financial disintermediation.

[xxvii] See Acharya, Viral V., Lasse Pedersen, Thomas Philippon and Matthew Richardson, 2010, *Measuring Systemic Risk*, 2010, working paper, NYU Stern School of Business.

[xxviii] Acharya, Viral V., Lasse Pedersen, Thomas Philippon and Matthew Richardson, 2010, *Measuring Systemic Risk*, 2009, working paper, NYU Stern School of Business; Brownlees, Chrtistian and Robert F. Engle, 2010, *Volatility, Correlation and Tails for Systemic Risk Measurement*, working paper, NYU Stern School of Business).

[xxix] See Corvasce, Giuseppe, 2011, "The Role of Capital in Financial Institutions and Systemic Risk," working paper. Corvasce (2011) calculates the assets/market value of equity ratio for the cross-section of financial institutions and documents that the median ratio for insurance companies and other financial companies for five years prior to the financial crisis, during the crisis and subsequent to the crisis. Corvasce (2010) generally documents higher ratios for property-casualty companies and slightly lower ratios for life insurance companies than, for example, the regional banking sector.

[xxx] Quasi market value of assets is equal to the book value of assets plus the difference between the market value and book value of equity.

[xxxi] CDS data for this study is the spread on the 5-year senior unsecured credit default swaps.

[xxxii] Viral V. Acharya, Lasse H. Pedersen, Thomas Philippon, and Matthew Richardson, 2010, "Measuring Systemic Risk," Working paper, NYU Stern School of Business.

[xxxiii] CDSs are not as frequently traded as stocks. Hence, to eliminate the effect of CDS return on a given day being the aggregated return over many non trading days, we only use returns on days where CDS spread information is available for that day and the previous trading day. No return is used for a day when no spread information can be obtained for the trading day immediately preceding it. The worst days of the CDS index are defined as days when returns on the CDS index are the highest.

[xxxiv] In unreported results, we also measured realized performance over the July 2007-December 2008 period. We argue that CDS MES should explain ex post performance better when realized systemic risk contribution is measured for the July 2007- June 2008 period, as the government bailout programs introduced during the later part of 2008 could have had a stabilizing effect on CDS spreads and stock returns. In fact, we document the same

patterns as in Figures 4 and 5. To confirm our conjecture, these effects are, nevertheless, weaker when realized CDS spreads or stock returns are measured up until December 2008.

[xxxv] Kimball, Spencer L. and Ronald Boyce, 1958, "The Adequacy of State Insurance Rate Regulation: The McCarran-Ferguson Act in Historical perspective", Michigan Law review, 56:4, pp. 545-578; Tyler, Ralph and Karen Hornig, 2009, "Reflections on State Regulation: A Lesson of the Economic Turmoil of 2007-2009", Journal of Business & Technology Law, vol. 4:2, 349-370.

[xxxvi] Webel, Baird and Carolyn Cobb, 2005, "Insurance Regulation: Histopry, Backround, and Recent Congressional Oversight", CRS Report for Congress.

[xxxvii] To be precise, the insurer pays all losses up to a deductible and pays coinsurance of 15% for losses above the deductible up to an aggregate event limit of $100 billion. Above the event limit, the government covers all losses at no charge.

[xxxviii] Leverty, J. Tyler, 2011, "The Cost of Duplicative Regulation: Evidence form Risk Retention Groups," The Journal of Risk and Insurance, 79:1, pp. 105-127.

[xxxix] Waterfield, Danielle F., 2002, "Insurers Jump on Train for Federal Insurance Regulation: Is It Really What They Want or Need?", *Connecticut Insurance Law Journal*, vol 9:1, pp. 283-337

[xl] Koijen, Ralph and Motoriho Yogo, 2013, "Shadow Insurance," working paper, London Business School.

[xli] Currently, insurance products are exempted from oversight by the Bureau of Consumer Finance Protection.

[xlii] Cummins, D.J., & Phillips, R.D. (2009). Capital adequacy and insurance risk-based capital systems**.** *Journal of Insurance Regulation*, *28(1)*, 25-72.

[xliii] Brown, Elizabeth F., 2008, "The fatal flaw of proposals to federalize insurance regulation", Research Symposium on Insurance Markets and Regulation. pp. 1-84.

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