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Mark-to-Market Accounting and Systemic Risk: Evidence from the Insurance Industry

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Abstract
One of the most contentious issues raised during the recent crisis has been the potentially exacerbating role played by mark-to-market accounting. Many have proposed the use of historical cost accounting, promoting its ability to avoid the amplification of systemic risk. We caution against focusing on the accounting rule in isolation, and instead emphasize the *interaction* between accounting and the regulatory framework. First, historical cost accounting, through incentives that arise via interactions with complex capital adequacy regulation, does generate market distortions of its own. Second, while mark-to-market accounting may indeed generate fire sales during a crisis, forward-looking institutions that rationally internalize the probability of fire sales are incentivized to adopt a more prudent investment strategy during normal times which leads to a safer portfolio entering the crisis. Using detailed, position- and transaction-level data from the U.S. insurance industry, we show that (a) market prices do serve as 'early warning signals', (b) insurers that employed historical cost accounting engaged in greater degrees of regulatory arbitrage before the crisis and limited loss recognition during the crisis, and (c) insurers facing mark-to-market accounting tend to be more prudent in their portfolio allocations. Our identification relies on the sharp difference in statutory accounting rules *between life and P&C companies* as well as the heterogeneity in implementation of these rules *within each insurance type* across U.S. states. Rather than promoting a shift away from market-based information, our results indicate that regulatory simplicity may be preferred to the complexity of risk-weighted capital ratios that gives rise, through interactions with accounting rules, to distorted risk-taking incentives and potential build-up of systemic risk.

JEL classification: G11, G12, G14, G18, G22

Keywords: Regulation, Systemic risk, Mark to market, Historical cost accounting, Fire sales, Capital ratios, Insurance companies

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One of the most contentious issues raised during the recent financial crisis – from, among others, the European Commission, the U.S. Congress, and various accounting regulatory bodies – has been the role played by mark-to-market (MTM) accounting (or fair value accounting) in creating and/or exacerbating the impact of the crisis on financial institutions and, indirectly through the lending channel, the broader economy. In a September 2008 letter to the SEC, the American Bankers Association stated: "The problems that exist in today's financial markets can be traced to many different factors. One factor that is recognized as having exacerbated these problems is fair value accounting."[1] Further, the U.S. Congress, likely responding to this concern, reportedly put significant pressure on FASB to alter the accounting rules for financial institutions.[2] The same debate took place in Europe, in policy[3], regulatory, and academic fora.[4]

An alternative to MTM accounting is the use of historical cost accounting (HCA), and it is precisely this variant that has been proposed as a better accounting method for financial institutions, at least in its capacity to avoid amplifying systemic risk during a crisis. Systemic risk can arise, in part, as a result of the fire-sale externality problem. In such a circumstance, one financial institution's desire to sell (potentially illiquid) downgraded assets for reasons of risk management or capital adequacy restrictions may create significant spillover effects onto the entire financial system.[5] Indeed, most of the theoretical literature that links the fire sale externality problem to accounting (for example, Allen and Carletti (2008), Plantin, Sapra and Shin (2008), and Sapra (2008)) argues that the specific nature of MTM accounting leads to

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[1] This sentiment was echoed by many sectors in the U.S. CFO.com on October 29, 2008 reported that "In perhaps the most sweeping indictment of fair-value accounting to date, the chairman of the Federal Deposit Insurance Corporation during the 1980s savings-and-loan debacle told the Securities and Exchange Commission today that mark-to-market accounting rules caused the current financial meltdown."

[2] These efforts were successful: the FASB revised its rules governing securities impairments in early 2009 at the height of the financial crisis. It issued FSP EITF 99-20-1 on January 12, 2009, FAS 115-2, FAS 157-4, and FAS 124-2 on April 9, 2009.

[3] On October 3, 2008, President George W. Bush signed the Emergency Economic Stabilization Act, giving the SEC the authority to suspend MTM accounting. A similar move was attempted in Europe as well when former French President Nicolas Sarkozy also reportedly sent a proposal to the European Commission recommending the suspension of MTM accounting. For example, former French President Sarkozy and others supported accounting changes at the E.U. level (see "Sarkozy seeks E.U. accounting change," Financial Times, 30 September 2008).

[4] Hellwig (2009) argues that "… in the present financial crisis, the system of mark-to-market or fair value accounting has created an additional channel through which market events influence the well-being of financial institutions…the imposition of fair value accounting for loans and mortgages enhances the scope for systemic risk, i.e., risk that has little to do with the intrinsic solvency of the debtors and a lot to do with the functioning – or malfunctioning – of the financial system."

[5] Elements of this mechanism have been described in work by Allen and Gale (2006), Brunnermeier and Pedersen (2008), Kyle and Xiong (2001), Gromb and Vayanos (2002), Morris and Shin (2004), and Shleifer and Vishny (1992, 1997), among many others.

additional selling pressure by financial institutions during times of market stress because trading pressures create feedback effects. MTM, in particular, may then amplify systemic risk during a financial crisis because one institution's forced selling results in a downward spiral of illiquidity and prices, so-called "liquidity black holes" (Morris and Shin (2008)), with potential contagion effects *as other institutions* are forced to recognize these lower asset values, thereby exacerbating capital adequacy issues and selling pressure system-wide. The articles mentioned above contend that HCA, in contrast, may limit systemic risk by avoiding these feedback effects. While MTM may indeed lead to a first-best outcome if the true asset value were known, the argument in favor of HCA is predicated on presumed MTM implementation shortfalls, due primarily to the existence of financial prices that may depart from fundamental values arising from various market frictions.

In contrast, Bleck and Liu (2011) argue that HCA can potentially make financial markets more, rather than less, volatile. They argue that HCA provides managers with a "veil" to mask the firm's true economic performance manifesting in a form of convexity: if an asset's market price falls, a manager can report the asset's historical value, whereas the manager can decide to sell the asset and recognize the market value if the asset's market price rises. This degree of 'optionality' may create managerial incentives for excessive risk taking. Under the veil of stability generated by HCA in the short-run, significant latent volatility may build with potential long-term implications. In their own words, "…historical cost accounting not only transfers volatility across time but also increases asset price volatility overall."

In this paper we explore whether, and in what way, accounting rules, through their interaction with capital regulations, are associated with the buildup of risk *before* and systemic risk *during* a financial crisis. While a considerable amount of work has been devoted to understanding the channels through which systemic risk spreads during the crisis, a novel contribution of this paper is to empirically explore how financial institutions exposed to different accounting rules invested and managed risk in the years *leading up* to the crisis. Indeed, many have argued that the pre-crisis period was characterized by excessive risk taking behavior, such as 'reaching-for-yield' investments, that aimed at regulatory arbitrage (Rajan (2010) and Yellen (2011), among many others). If it is indeed true that the severity of the feedback dynamic during a financial crisis is directly related to the amount of risk taken in the years before the crisis, then we must investigate how accounting rules influence portfolio choices in normal times. In other words, whether one accounting rule engenders more or less systemic risk should not be judged solely on the measured effects on the way down (during the crisis) but also on the incentives it generates on the way up (before the crisis).

Imagine a financial institution subject to MTM that engages in regulatory arbitrage (e.g., ‘reaching-for-yield’ or taking on tail risk); this institution should rationally anticipate that it will suffer from significantly deteriorating regulatory capital ratios during a period of severe price declines. That is, the elevated risk of fire sales and regulatory scrutiny are known *ex ante*. Anticipating these dynamics, such a financial institution may manage its portfolio more conservatively during normal times in comparison to a financial institution subject to HCA that is free from these concerns.

We acknowledge that MTM may indeed generate the feedback effects discussed elsewhere in the literature, but we emphasize that HCA is not itself free of imperfections with regards to the generation of distorted incentives that might create or amplify systemic risk. First, HCA may give rise to so-called “gains trading” where an institution selectively sells assets on its balance sheet to recognize trading profits in order to improve capital positions (Laux and Leuz (2009, 2010), amongst others). Ellul et al. (2012) show that HCA led financial institutions to engage in gains trading during the 2007-2009 financial crisis, causing significant price distortions in markets otherwise unrelated to the assets that experienced sizeable downgrades in the institutions’ portfolios.[6] Second, the existing theoretical literature has not given enough weight to the fact that a crucial element is not the chosen accounting rule per se, but rather the *interaction* between the set of accounting rules and the regulatory framework faced by financial institutions (Heaton, Lucas, and McDonald (2010)) that has a first-order effect on institutions’ trading incentives (Laux and Leuz (2009, 2010)) and on the accumulation and transmission of systematic risk. Our paper makes a contribution to the understanding of the second dimension in so far as it investigates how different accounting rules can impact the build-up of risk in financial institutions’ balance sheets.

[6] Ellul et al. (2012) focus exclusively on the gains trading incentives engendered by HCA which induce financial institutions to selectively sell assets whose market value is higher than their historical cost resulting in price and portfolio distortions, mostly *during* a financial crisis. While using the same insurance data, our focus is different: we are primarily interested in the incentives engendered by the interactions between capital adequacy regulation and accounting for the trading behavior of insurers in the years *before* the crisis, where tail risk is potential accumulated.

The fact that the regulatory capital framework is based on a risk-weighted calculation is particularly important. Financial institutions are required to have adequate equity capital in relation to the riskiness of the assets that they hold, often measured by risk-based capital (RBC) or risk-weighted assets. In the case of insurance companies, the RBC ratio is the primary measure of capital adequacy and financial health; it is calculated as the ratio of *statutory* (equity) capital to required *regulatory* capital or RBC. This is very similar to the way capital ratios in the banking industry are measured.[7] This ratio is a critical metric used by a host of agents, from regulators to credit rating agencies. Indeed, when an institution's RBC ratio falls below certain thresholds, it is put on a regulatory watch and immediate action must be taken. It is important to note that *both* types of accounting rules, MTM and HCA, have important effects on the calculation of the RBC ratio (see Ellul et al. (2012) and Merrill et al. (2012)) because they may directly or indirectly impact both the numerator (equity capital) and the denominator (required capital) of this- ratio. The accounting rules governing the recognition of portfolio assets (or book values) have clear implications for equity capital. In addition, the various incentives generated by either set of accounting rules, through their interaction with the regulatory framework, may lead to unintended trading behaviors, such as fire sales in the case of MTM or gains trading in the case of HCA, which affect portfolio risks.

We use the U.S. insurance industry as a laboratory to investigate our research question. While there are various similarities between the regulations faced by insurance companies and banks, using insurance companies has one crucial advantage: the accounting treatments used in determining the required regulatory capital for holding speculative-grade assets, under the National Association of Insurance Commissioners (NAIC)'s model law, differ significantly for life and property and casualty (P&C) insurers. Specifically, when an asset held by insurance companies is downgraded from investment to speculative grades, the Statutory Accounting Principles (SAP) state that P&C insurers have to immediately recognize the asset value as the lower of the book value (based on HCA) or the market price (or model price, in case no market price is available). On the other hand, life insurers may continue to hold the downgraded asset under HCA except in

[7] In banking, the capital ratio is the ratio of statutory capital over risk-weighted assets, which has to be at least 8 percent. In the insurance business, the statutory capital is set in relation to risk-based capital with a required ratio of at least 2.

the extreme case when it is classified as ‘in or near default’.[8] In other words, applying MTM or HCA was not a matter of choice left in the hands of the individual insurance company but rather imposed by regulation. Our main identification relies on this distinction.

We recognize that P&C and life insurers differ on various levels and the statutory accounting rules, while not a choice variable for each insurer, are not the only differences. As a result, our identification strategy- contrasting the two types of insurers- may not be sufficiently clean. Differences in the business models between the two types, rather than differences in the accounting rules, may induce commensurate differences in their investment strategies.[9] To address this problem, we supplement our *between-insurance-type* analysis with a *within-insurance-type* analysis where we investigate our research question *within* each insurance class (i.e. within life and P&C, separately). Specifically, we test our maintained hypothesis among life (P&C) insurers that differ along the following two dimensions: (a) the extent to which the reported RBC ratios mask unrealized investment losses, and (b) the U.S. states of domicile whose formal insurance codes allow different levels of discretion in imposing/enforcing the use of MTM. Importantly, the *within-insurance-type* will help us rule out alternative mechanisms induced by differences in business models that may drive the results obtained from the *between-insurance-type* analysis.

Our empirical investigation employs a panel of 1,882 life and P&C insurers over the period from 2004 to 2007 for which *portfolio-security level* data are readily available through the NAIC. We combine information on these securities with *firm-level* observations, provided by the NAIC, on insurance companies’ holdings of and transactions in individual corporate bonds and ABS. Further, for each ABS and corporate bond position, insurance companies provide, under SAP, both fair and book values to the NAIC.

We start by comparing the *reported* RBC ratio with a *hypothetical market-adjusted* RBC ratio (using fair values *for each position* as opposed to the value actually reported to adjust the capital numerator) for all insurance companies over the sample period. We are particularly interested in whether market informationused in calculating *market-adjusted* RBC ratios has any value in predicting *future* financial health. If market values contain useful information for regulators, then we should find that RBC ratios measured using market values, rather than book values, should have predictive power *before* the onset of the financial crisis about the financial

[8] We provide details of the Statutory Accounting Principles in Section 2.
[9] We thank the Editors and three referees for this suggestion.

institutions that eventually had problems. Given the theoretical debate about the true relevance of market values, it is an empirical question as to whether MTM can really inform regulators on the likelihood of future financial distress. The remarkable granularity in our data enables us to detect that market information is useful in predicting future financial health: the difference between reported RBC ratios and market-based RBC ratios before the onset of the financial crisis predicts (a) the RBC ratios during the financial crisis, and, more importantly (b) the insurance companies that are more likely to suffer during the crisis (i.e. with an RBC ratio that falls close to the threshold of 2 requiring regulatory action).[10] This result is important for policy makers in light of the American Bankers Association's view (2009, 2010) that historical cost for non-traded financial instruments is a better representation of banks' business model compared to MTM. In sharp contrast, our results show that market values do contain useful information that institutions and regulators may ignore at their own peril. Interestingly, the possible existence of financial prices that deviate from fundamental values due to various frictions would only contaminate the usefulness of our constructed market-adjusted RBC ratios and bias *against* finding their usefulness.

Second, we investigate the feedback effects induced by MTM and find that, consistent with Allen and Carletti (2008) and Plantin, Sapra and Shin (2008), conditional on being hit with large price declines, positions that are marked-to-market are likely to be sold. Moreover, P&C insurers are more likely than life insurers to sell assets that are hit with large price declines. Together, the evidence is consistent with the prediction of the extant theoretical literature that MTM can lead to fire sales and potentially downward spiral in prices.

Third, and most important, we find that insurers that will be subject to MTM in case of downgrades – P&C insurers – are significantly more prudent in their portfolio decisions in the years leading up to the crisis. This is true both for the portfolio allocation across asset classes and for the choice of securities in each class (i.e., regulatory capital arbitrage). Specifically, we find that P&C insurers do not increase their portfolio allocations to ABS and speculative-grade bonds as much as life insurers do. Moreover, the 'reaching-for-yield' behavior, documented by Becker and Ivashina (2012), is significantly less prevalent in P&C relative to life insurance companies. Hence, P&C insurance companies entered the financial crisis with a lower exposure to risky assets than life insurance companies did.

[10] Since the incidents where insurers' RBC ratios fall below 2 are very rare, our analysis uses the threshold of 3 as a proxy of regulatory intervention.

Overall, P&C firms (a) are more likely to engage in fire sales upon a large decline in asset price but (b) are more cautious *ex ante* in choosing the assets that may suffer such decline. It is not clear which effect prevails; that is, does MTM used by P&C firms for speculative-grade assets cause or increase systemic risk? To answer this ultimate question, we investigate asset-level prices during and after the financial crisis and find that the assets held disproportionately more by P&C firms *do not* exhibit higher pro-cyclicality in comparison to those assets held disproportionately more by life firms. This result suggests that the dampening effect on risk-taking activity that MTM induces before the onset of a crisis may counter-balance to some extent the fire sales effects that MTM otherwise induces during the crisis.

The above findings obtained from our between-insurance-type analyses are confirmed by our within-insurance-type analyses. First, we investigate whether the difference between the hypothetical market-adjusted RBC ratio and the reported RBC ratio influences the magnitude of reaching for yield within each insurance category. Specifically, life insurers whose market-adjusted RBC ratios are lower than their reported RBC ratios, recognizing that their reported RBC ratios may decline in the near future, have higher incentives to reach for yield. These differential incentives should be weaker for P&C insurers who must recognize investment losses should the seemingly high-quality bonds with higher yields get downgraded in the future. We find that this is indeed the case: life insurers with market-adjusted RBC ratios significantly lower than reported RBC ratios (i.e., where their reported RBC ratios are masking unrealized losses) are more likely to reach for yield in the years leading up to the financial crisis. The results are weaker and, in some cases, not significant within the P&C group. Second, we exploit observable differences *across U.S. states* in the application of the NAIC's prescribed accounting rules. Our analysis shows that life insurers from U.S. states with a larger (lower) incidence of MTM are less (more) likely to reach for yield. Even though the baseline incidence of MTM is larger for P&C insurers as a group, they too exhibit the same variation in reaching for yield behavior across states. Third, when we investigate insurers' allocation to riskier (ABS and speculative bonds) and safer (investment grade bonds) assets, we continue to find that life insurers whose market-adjusted RBC ratios are lower than their reported RBC ratios invest relatively more in risky securities (such as ABS) and relatively less in safe securities (such as investment-grade bonds) in the pre-crisis years. The same results are found for P&C insurers. Overall, the within-insurance-group results confirm that MTM induces more prudent portfolio decisions and limits insurers' incentives to engage in regulatory arbitrage.

To be clear, our results demonstrate that it is neither obvious nor clear that the problems associated with the amplification of the financial crisis that most regulators and policy-makers attribute to the use of MTM could be in fact solved through the use of HCA. This evidence yields several policy implications. At a minimum, these results show that regulators and policymakers' focus on the accounting rules in isolation may be misplaced. We apply this principle to argue that shifting from MTM to HCA without fully addressing the various other oft-discussed imperfections in the regulatory framework may not be welfare improving.

The remainder of the paper is organized as follows. Section 2 discusses the mechanisms behind MTM and HCA and explains how the use of MTM rather than HCA can influence financial institutions' capital positions and provides information about the Statutory Accounting Principles in the insurance industry. Section 3 discusses the sample construction and describes the summary statistics of the data. Section 4 presents our main empirical analysis and the results on how accounting rules are associated with the buildup of risk before and systemic risk during a financial crisis. Section 5 discusses the main policy implications that emerge from our results. Section 6 concludes.

2. Institutional Background

2.1 HCA vs. MTM in Financial Institutions: The Mechanism

We first explain in greater detail how the use of MTM rather than HCA can influence financial institutions' capital positions, the mechanism that is triggered by, and most easily observed when an institution is hit by significant downgrades of its assets. Because of risk-based capital requirements, the severe downgrades of ABS that occurred during 2007-2009, taking many such holdings from investment to speculative grades, significantly increased the regulatory (required) capital of various financial institutions holding the downgraded instruments.

Once these downgrades occur, each affected institution faces a stark decision: either keep the downgraded instruments and raise additional equity capital (affecting the numerator of the RBC ratio) – which is difficult during a financial crisis – or sell the downgraded instruments to reduce the required risk-based capital (the denominator) by swapping for low risk assets like U.S. Treasuries. As to be expected, these downgraded instruments also suffer from significant price declines at the same time. This is where the accounting rules used for these instruments should have a first-order effect on trading incentives. If the downgraded asset is held at market value, the price decline is automatically reflected in the balance sheet, and the loss would directly reduce the institution's equity capital (the numerator). While from a purely accounting point of view, the institution will be indifferent between keeping the asset on its balance sheet and selling it, but selling the downgraded asset for cash, as mentioned, can reduce the denominator of the RBC ratio. However, one institution's desire to satisfy regulatory constraints by selling the distressed asset produces feedback effects. As the asset is booked at increasingly lower prices by other institutions, MTM may elevate the likelihood of a liquidity black hole. It is precisely here that the accounting rules for these instruments are likely to have a first-order effect on trading and portfolio choices during a financial crisis. We explain this mechanism in Box 1.

[Insert Box 1 here]

The situation is potentially quite different if the asset is held under HCA, where the decline in value would not be recognized in the balance sheet unless the institution sold the asset or recognized Other-Than-Temporary Impairment (OTTI) (hence the numerator is unchanged). However, the RBC ratio remains affected because the regulatory capital requirement would still have increased to reflect the now elevated riskiness of the asset following the downgrade. Holding the downgraded asset has the advantage of limiting the unfavorable price impact and avoiding the recognition of a loss, but additional equity capital needs to be raised. It is precisely in this situation that the incentive for gains trading arises as the institution may sell *other existing risky assets* to shore up its capital position. The institution faces an incentive to *selectively sell* those assets that are held under HCA and have the *largest unrealized gains*. By doing so, these unrealized gains can be recognized and flow to its equity capital. This response, however, will create its own distortions, including significant price impacts in unrelated markets.

While the mechanisms shown above explain financial institutions' behavior during a crisis, it remains to be seen if and how these mechanisms are internalized by forward-looking institutions during non-crisis years. Arguably, one of the major characteristics leading up to the financial crisis as a way to boost performance was loading up on tail risk (Kashyap, Rajan and Stein (2008)).

Box 1. Impacts of accounting rules on financial institutions' RBC ratios and optimal responses following the downgrades of financial assets

	Mark-to-Market Accounting (MTM)	Historical Cost Accounting (HCA)
Price decline of downgraded instrument reflected in the balance sheet?	Yes	No*
Impact on regulatory (risk-weighted) capital	Increase	Increase
Impact on statutory (equity) capital	Immediate decrease	No impact*
Impact on RBC ratio	Decrease	Decrease (potentially of a smaller magnitude when compared to MTM)
Response 1: Accounting View	Indifferent between selling the downgraded instrument and keeping it on the balance sheet.	Selling downgraded instrument (when accompanied with price declines) will lead to recognition of massive trading losses with an immediate negative impact on the statutory capital.
Response 2: Regulatory capital requirement	Selling downgraded asset leads to lower required regulatory capital required	1. Selling downgraded asset at heavy price discount lowers statutory capital. 2. To avoid negative effects from selling in (1) requires that additional capital be raised to move RBC ratio closer to its original value.
Financial institution engaging in fire sales	Likely	Unlikely
Financial institution engaging in gains trading	No	Likely: Institution will engage in gains trading if statutory capital has to be raised to improve RBC ratio and avoid regulatory actions. Institution will selectively sell unrelated assets held at HCA with unrealized gains.
Pre-crisis portfolio choice and trading incentives	More conservative	Less conservative

* If the institution recognizes Other-Than-Temporary Impairment (OTTI), then its statutory (equity) capital and assets will immediately decrease by the amount of OTTI.

However, an institution that knows that it will face MTM accounting, including an elevated probability of fire sale externalities, may internalize this concern by selecting a more conservative portfolio *ex ante*. This means that such an institution may limit its exposure to tail risk as compared to another institution that operates under HCA. Taken together, it is not clear which of the two effects (in-crisis fire sales vs. pre-crisis conservatism) prevails, but part of our exploration involves the search for an answer to this question.

2.2 Accounting Treatment of Downgraded ABS Securities

Each fixed income security held by insurers falls in one of the six different risk classes defined by the NAIC. A particularly important threshold for our paper is between Classes 1-2 (securities with a BBB rating or better) and Classes 3-6 (securities with a BB rating or worse).

We need to point out an important distinction between the accounting rules followed by insurance companies for their financial statements, which are based on GAAP, and those based on the Statutory Accounting Principles (SAP) used by insurance regulators. This distinction is important because we are mostly interested in the way unrealized gains and losses on available-for-sale (AFS) securities, including most bonds and ABS, are treated under the two methods. GAAP states that AFS securities should be booked at market values and any unrealized gains and losses flow directly to the insurance company's economic capital. SAP adopts a different approach whereby safer securities are booked at modified historical costs while riskier securities are booked at market values. Specifically, in the case of securities downgraded to non-investment grades, thus passing from NAIC Class 2 or above to NAIC Class 3 or below, SAP allows life insurers more accounting flexibility: while P&C insurers have to immediately recognize the value of the bond as the lower of the amortized historical cost or the market price, life insurers face no such requirement, except in the extreme case where the securities are classified as 'in or near default' (Class 6).[11]

Each U.S. state has its own insurance department headed by a Commissioner of Insurance (or a similar role) in which the regulation of insurance companies operating within the state is officially and legally vested. That is, all insurance regulation in the U.S. is formally

[11] To put the definitions of the asset classes in perspective, a "Class 5" security is one that corresponds to a CCC/Caa credit rating; even in such cases life insurers can continue to hold the asset under HCA while P&C insurers have to recognize the market price if the price falls below the amortized historical value.

conducted at the state level under the NAIC's guidance. The insurance code of each state determines whether the Commissioner of Insurance should abide strictly with the regulatory rules established by the NAIC or is given some level of discretion in the application of these rules, among them the use of mark-to-market (MTM) accounting, for all insurers operating within the state. That is, even among life insurers that generally employ HCA under the NAIC guidelines, there is observable cross-state variation in the degree to which these insurers mark the assets in their portfolio to market (particularly those with lower credit quality) consistent with cross-state variation in the degree to which the local Commissioner has some discretion. Many U.S. states exhibit patterns consistent with the NAIC regulatory guidelines; others exhibit a higher incidence of MTM accounting than would be expected under a strict application of NAIC rules.

3. Data and Methodology

3.1 Sample Construction

We combine three sets of proprietary data in our analysis: information on U.S. insurance companies, ABS securities and their credit ratings, and corporate bonds and their credit ratings. We discuss in detail how we assemble the three sets of data below. Our sample period is from 2004 to 2010. This period covers the financial crisis of 2007-2009, as well as a non-crisis period that we shall use for comparison.

Our primary data on U.S. insurance companies' transactions and year-end positions are from the National Association of Insurance Commissioners (NAIC).[12] The NAIC data provide year-end holdings of invested securities for each insurance company and detailed transaction information on every trade. Both the position and transaction data provide the identities of the insurance firms and the relevant securities (e.g., 9-digit CUSIP). Finally, the NAIC data also provide detailed information about the *book-adjusted carrying value* and *fair value* of each position held by each insurance firm at year-end. We employ this information to infer whether an insurance company holds its ABS and corporate bonds at historical cost (HCA) or at fair value (MTM). We also infer bond prices from the reported fair values at year end and the transaction proceeds during the year.

[12] This is a proprietary dataset. Further details of the NAIC data can be found in Ellul, Jotikasthira, and Lundblad (2011).

The financial information on each insurance firm is from Weiss Ratings, which provides financial strength ratings and other related information.[13] From this source, we obtain annual firm characteristics, such as size, ‘capital and surplus’, and the RBC ratio. We eliminate small insurers with investment assets less than $13 million (the bottom 1%) and/or with an RBC ratio above 50 to avoid any bias from small or abnormal firms.[14] We also delete all of AIG’s affiliated insurers and 32 others that provide financial insurance and guarantees for bonds (the mono-line bond insurers), such as credit default swaps and municipal finance, as these firms were affected by the downgrade of ABS securities through a different business channel.[15] Our final sample of insurance firms consists of 13,739 firm-years representing 2,312 firms, among which 510 are life insurers and 1,802 P&C insurers.

Our data on ABS ratings are from S&P’s Ratings IQuery. We extract all the data in the structured credit subsector in Ratings IQuery, which comprehensively covers initial ratings and histories for all securitized issues rated by S&P from 1991 to 2010. The database records issue and tranche identity (9-digit CUSIP), gross principle, class, maturity, collateral type, rating, and rating date. The data on corporate bond characteristics are obtained from Mergent Fixed Income Securities Database (FISD). We merge the FISD data with the position and transaction data of insurance firms to identify the corporate bonds being held and transacted as well as relevant bond characteristics, such as issue size, coupon, maturity, and credit rating. We use the best credit rating among those given by three agencies- S&P, Moody’s, and Fitch.

3.2 Insurance Firms and Their Portfolio Holdings

Table 1 shows summary statistics on several key financial variables for our sample insurance companies at the end of 2007. We provide definitions of these measures in the Appendix.

[Insert Table 1 here]

[13] To focus on rating insurance companies, Weiss Ratings was split from the Street.com in 2010.

[14] Unlike Ellul et al. (2012), we keep firms with RBC ratio lower than 2 in order to study their characteristics in the years leading to supervisory interventions.

[15] We identify bond insurers from Ratings IQuery, which reports financial insurance providers in securitized issues. In addition to AIG, we also exclude Ambac Assurance Corp, MBIA Insurance Corp, Financial Guaranty Insurance Co., etc.

At the end of 2007, we have complete financial information for 1,499 P&C companies and 462 life companies in the sample. Life firms are generally larger than P&C firms. Invested assets are $5.5 billion, on average, (median of $454 million) for life firms and $798 million, on average, (median of $109 million) for P&C firms. The average 'capital and surplus' is also larger for life firms at $554 million (median of $73 million), compared to $377 million (median of $55 million) for P&C firms. In addition, life firms (like banks) operate at much higher leverage than P&C firms. Finally, the median return on equity is similar for both types.

The regulatory capital adequacy positions of life and P&C insurers are quite similar, as measured by the NAIC RBC ratio. The average life and P&C firms in our sample have RBC ratios of 11.61 and 10.34, respectively. We use the RBC ratio to capture the regulatory constraints that insurers may face during a crisis, as downgrades of assets held by these institutions can lead to higher associated risk weights and hence a lower RBC ratio (as the denominator increases).

Insurance companies heavily invest in investment-grade bonds, representing on average 55% and 63% of life and P&C insurers respectively. The holding of 'risky assets' (including non-investment grade bonds, common and preferred stocks, non-performing mortgages, real estate, and other investments, which according to the NAIC, have target capital percentages greater than or equal to that of the least risky class of non-investment grade bonds (BB)) is similar across the two groups of insurers, with a holding of 16% and 17% of life and P&C insurers respectively. Weiss Ratings also provides a number of standardized indices that measure insurers' liquidity, profitability, and other aspects of their overall financial conditions. Life and P&C firms are, on average, not systematically different in terms of Weiss Ratings' assessment of profitability and liquidity (not tabulated). The similarity between the two groups on various aspects of the financial conditions shows that there is no significant systematic differenceand the two groups are quite comparable in their financial circumstances. This said, there are obvious business differences with regards to the types of insurance contracts each group writes. We will control for various insurer-level characteristics to fully take into account any effect the business differences may have on our variables of interest in our multivariate analysis.

3.3 Empirical methodology

We will first exploit the difference afforded by the regulators' SAP *between* life and P&C insurers to investigate how MTM and HCA, through their interaction with capital regulation, influence financial institutions' portfolio allocations, especially in the years before the financial crisis. The advantage of this identification strategy is that these accounting rules are not a choice variable at the single insurer level because they are NAIC guidelines implemented by state-level regulators. However, one can argue that the differences in SAP were introduced because of other differences that may exist between life and P&C insurers, such as business models, risks and, ultimately, their investment strategies. This may potentially constrain our identification strategy based on the SAP difference between insurer types. To address this problem, we carry out a *within-insurance-group* analysis where we investigate our research question *within* each insurance class (i.e. within life and P&C, separately) and test our maintained hypothesis among life (P&C) insurers that differ in terms of their capital adequacy positions (as measured by the difference between RBC ratio measured using market prices and reported RBC ratio) and their U.S. State of domicile. The *within-insurance-group* should allow us to rule out alternative mechanisms other than accounting rules that may drive results obtained from the *between-group* analysis.

We next briefly explain how we distinguish between different U.S. States of domicile in terms of the reliance on MTM. Accounting rules (SSAPs 26 and 43) state that if the decline in fair value of a bond or an ABS is considered "other than temporary," the cost basis of the security must be written down and the amount of the write-down shall be accounted for as a realized loss (the process often referred to as other-than-temporary impairment or OTTI). Both rules give insurers, however, some flexibility in determining whether the decline in value is other than temporary and in determining the fair value to be used as the new cost basis. Our data show that for the same securities, for example, those that are downgraded from investment to speculative grades, the recognition of value losses varies significantly across insurers and across states of domicile. For example, for all bond and ABS positions downgraded from investment to speculative grades during 2004-2007, life companies in Delaware on average recognize OTTI over 20% of the time while those in Missouri only do so in less than 5% of the time. Our extensive read of the state-level insurance regulations and discussion with state regulators reveal that state mandates given to the regulators can be quite different. In some states, the NAIC guidelines are strictly followed while in other states, regulators have power to institute rules both within and on top of the NAIC guidelines. Our supplemental identification strategy relies on this fine variation in accounting practices among insurers of the same type across domicile states.

To capture these across-state differences, we create a dummy variable for "high mark-to-market" states as follows. First, we determine whether a bond is marked to market by comparing the position's reported book-adjusted carrying value to its fair value; if the two are the same, the bond position is considered marked to market. Second, we calculate *each company's* mark-to-market frequency as its percentage of speculative-grade bond and ABS positions that are marked to market during 2004-2007, thus using exclusively the pre-crisis period to avoid any crisis-related behavior. Our focus on marking to market of speculative-grade bonds rather than OTTI recognition for downgraded bonds is due to the facts that (a) bonds that are held by insurers and downgraded from investment to speculative grades during the year are relatively few, (b) speculative-grade bonds include those that are recently downgraded and hence OTTI recognition for these bonds still show up in the mark-to-market measure, and (c) the mark-to-market measure better captures how close the book values are to the fair values which is what we want to economically capture for the riskiest group of bonds. Next, we average the mark-to-market frequency across all insurers of each type (life and P&C, separately) in the state to obtain the *state-level* mark-to-market frequency. Here, we use the equally weighted average to ensure that the state-level mark-to-market frequency is representative of the state's regulatory practice rather than risk management practices of a few large companies in the state. Finally, for each insurer type, we divide states with at least two insurers into two groups at the median mark-to-market frequency. For life companies, the average mark-to-market frequencies for the high and low groups of states are approximately 7% and 1%, respectively. For P&C companies, these numbers are 55% and 31%, respectively.

4. Results

4.1 Evolution of RBC Ratios before and during the Crisis

We start by comparing the distributions of *two different RBC ratios*: the one reported by each insurer in each year to the regulators and a hypothetical *market-adjusted* ratio which we compute using the market values of each of the assets held in the insurers' portfolios. The market-adjusted RBC ratio is calculated by adding unrealized gains and losses on all securities held at historical costs to the statutory (equity) capital, the numerator of RBC ratio. The granularity and level of price information in our dataset permits the calculation of market-adjusted RBC ratios that we can then benchmark against the ratios reported to the regulators. The first objective is to investigate the dynamics of the two RBC ratios. The descriptive statistics are shown in Table 2.

[Insert Table 2 here]

Starting from life insurers in Panel A, we observe that the cross-sectional mean of reported RBC ratio fluctuates within a very narrow range between 11.2 and 11.9 over the sample period 2004-2010. Even at the height of the financial crisis, the reported RBC ratio for the bottom 5% of insurers had a value of 3.3, which is significantly higher than the threshold of 2 where regulatory actions against these companies were implemented. When RBC ratios are market-adjusted, the picture that emerges for life insurers is very different. First, average market-adjusted RBC ratios for life insurers are more volatile than average reported RBC ratios, ranging between 8.2 in 2008 and 14.2 in 2010. Second, there is a large decline amounting to more than 30% in the average market-adjusted RBC ratios in 2008 compared to 2007, falling from an average value of 11.7 in 2007 to 8.2 in 2008. Third, and most important, when using market-adjusted RBC ratios, a significant proportion of life insurers are technically insolvent in 2008. We find that firms in the bottom decile have market-adjusted RBC ratios below 0 (negative equity). Before inferring too much from this, it is important to note that this situation was reversed in 2009 due to the significant improvement of overall market conditions. This finding does highlight the possibility that MTM accounting, in combination with fixed regulatory thresholds for the capital requirement, could exacerbate a crisis as regulatory triggers involve fire-sale price distortions.

It is important to investigate three related issues before we form an opinion on the contribution of MTM to the pro-cyclicality of asset prices. First, we explore the behavior of the P&C firms in our sample that actually were subject to MTM accounting for the downgraded ABS and corporate bonds. Second, even in the presence of plausible price distortions, does the difference between the reported and market-adjusted RBC ratio predict future outcomes? Last, we need to evaluate the *ex ante* incentives that the risk of MTM-induced fire sales might engender.

In Panel B, the evolution of reported and market-adjusted RBC ratios for P&C insurers appears to be very different. First, the (cross-sectional) average reported RBC ratios for P&C insurers have a larger range compared to those of life insurers (between 8.7 and 11.2 for P&C insurers). Second, the average market-adjusted RBC ratios for P&C do not suffer as large a decline during the crisis period: its value was 10.5 in 2007 and remained unchanged in 2008. Third, the cross-sectional distribution of market-adjusted ratio for P&C in 2008 is far different from those of life insurers: even at the 5th percentile, the market-adjusted RBC ratio is above the regulatory threshold of 2.

The evidence in Panels A and B of Table 2 suggests that life insurers held assets in their portfolios that were in the end relatively more sensitive to the unfolding of the crisis, insofar as the riskier securities they held were the ones that suffered the largest price declines. It is true that the dramatic declines of life insurers' market-adjusted RBC ratios during the crisis were temporary. Thus, one might argue that had the MTM requirement been also applied to life insurers, these insurers may have been forced to engage in fire sales that may have amplified already elevated systemic risk. On the other hand, it is also true that the institutions that employed MTM for speculative-grade bonds and ABS during the crisis seem to have entered the crisis with portfolios that were less sensitive and that their market-adjusted ratios were largely unaffected. Of course, given differences in their business and liability structure, life and P&C insurers naturally hold different portfolios. For example, life firms tend to hold bonds with much longer maturity than do P&C firms. We will show below that even after controlling for these effects and, more importantly, using the within-insurance-group analysis, insurers with more reliance on MTM exposed their portfolios to lower risk in the years leading up to the crisis.

One way to further investigate the impact of accounting rules on the investment approach used in the pre-crisis years and, as a consequence, on the RBC ratio during a financial crisis is to analyze the amount of (a) unrealized gains/losses, (b) realized gains/losses, and (c) the recognized Other-Than-Temporary-Impairments (OTTI). We do so for the 2004-2010 time period in Figures 1 and 2.

[Insert Figure 1 and 2 here]

Panel A of Figure 1 shows the magnitude of unrealized gains/losses (defined as reported fair values of the assets minus reported book-adjusted carrying values) as a percentage of the required regulatory capital, or RBC, for life and P&C insurers. The magnitude of unrealized gains/losses for P&C insurers is very small in each of the years in the sample period and very stable across time. In contrast, life insurers experience large unrealized gains in the early part of the sample period (the unrealized gains amounted to almost 200% of RBC in 2004) followed by a significant deterioration. Of particular importance are the unrealized losses in 2008, which amounted to around 300% of RBC. Such a significant deterioration suggests significant problems for many life insurers, some of which, as shown in Panel A of Table 2, became technically insolvent in 2008 had market values been fully recognized. The dynamics during the crisis of the unrealized losses of life insurers, when compared with analogous figures for P&C insurers, is not simply an artifact of the accounting rules. Rather, the difference suggests that the incentives produced by MTM may have a direct impact on the investment approach during normal times.

While it is true that a financial institution under HCA may mechanically have a larger wedge between reported and market-adjusted RBC ratio (more than if it had employed MTM), one should nevertheless ask why it is that P&C insurers did not experience the same significant magnitude of losses (unrealized in Panel A or realized in Panel B) as that experienced by life insurers? One possible answer to this question is that P&C insurers – by virtue of an anticipation of the potential constraints they might face during a future crisis – had a more conservative approach to their investments in the years before the crisis.

Given the type of assets held in the balance sheet of these insurers, it is likely that some of the unrealized losses we document were for assets that had also experienced a rating downgrade during the same period. One potential response is an attempt to sell some of those assets for capital adequacy purposes as the now lower rating implies a larger capital charge. However, a financial institution has to trade-off the price impact (and the implication under HCA of the now realized loss for equity capital) that it would face when it sells these assets in an illiquid market against the benefit of removing lower rated assets from its balance sheet. The implications of actual selling behavior for realized gains/losses are shown in Panel B of Figure 1. Despite the presumably larger numerator effect generated by selling the downgraded assets, life insurers realized a *larger* amount of losses, on average, in 2008 than P&C insurer. The fact that life insurers (under HCA) rather than P&C (facing MTM for speculative-grade bonds) exhibit larger realized, as well as unrealized, losses is inconsistent with the notion that systemic risk is always amplified by the fire-sale feedback problem associated with MTM. To be clear, P&C insurers do sell downgraded securities (see Ellul et al. (2012) and Merrill et al. (2012)), but this evidence suggests that, on average, the implications for realized losses were actually relatively less pronounced for P&C firms than for life firms.

Finally, Panel C of Figure 1 shows that life insurers were also forced to recognize significantly more OTTIs than P&C insurers during the financial crisis. In fact, in 2008 the OTTIs of life insurers amount to 50% of RBC while they amount to only around 5% of RBC for P&C insurers. Given the rules governing OTTIs, these losses are of a permanent nature. As life insurers entered the financial crisis, the assets they held were relatively more sensitive to the unfolding of the crisis.

A striking picture emerges when putting together the evidence in Panels A-C. The *total losses* suffered by insurers are made up of the (a) change in unrealized gains shown in Panel A, (b) realized losses shown in Panel B, and (c) OTTIs shown in Panel C. The *recognized losses* are those that are either realized (sold positions) or recognized in the balance sheet (as OTTIs). This means that whereas an average life insurer's total losses amount to almost 440% of RBC, it only recognizes losses that amount to around 113% of RBC in 2008. Contrasting this outcome with that of an average P&C insurer, that had total losses of about 51% of RBC and recognize losses of about 28% of RBC, shows that P&C insurers recognize most of their losses while life insurers do not. Overall this evidence lends credence to the conjecture that, going into the crisis, P&C insurers held a more conservative investment portfolio that suffered smaller losses during the crisis and allowed them more flexibility in selling potentially risky assets with carried losses and more transparency in recognizing much of these losses in the form of OTTIs.

Figure 2 shows the unrealized gains for life (Panel A) and P&C (Panel B) companies, where for each group we show the evolution of unrealized gains/losses for the less-constrained (high RBC ratio) and more-constrained (low RBC ratio) insurers. For both groups of insurers, unrealized losses are more pronounced for the group of insurers that are closest to regulatory scrutiny. What explains this pattern? On one hand, constrained insurers should have a greater incentive to sell their risky assets in order to reduce their regulatory capital and increase their RBC ratio. On the other hand, most of the risky assets that decline in value are potentially held at historical costs (for example, non-downgraded ABS) and thus selling them would force constrained insurers to recognize losses, further decreasing their already-low RBC ratios. This behavior biases their portfolios in favor of potentially poorer assets that carry large unrealized losses. Taking the behavior of unconstrained firms as optimal, we can see that constrained firms sub-optimally keep assets with high unrealized losses, consistent with the distorted incentive discussed above.

4.2 Relevance of Market-Adjusted RBC Ratios

The evidence shown in Table 2 suggests that the *difference* between reported and market-adjusted RBC ratios may contain important information about the future realizations of the level of the RBC ratio. On one hand, if market-adjusted RBC ratios capture risk that is not immediately reflected in the ratios based more heavily on historical values, then we should expect that the market-adjusted RBC ratio may be better than the reported RBC ratio in predicting future financial conditions. On the other hand, if market-adjusted ratios simply incorporate irrelevant price distortions inherited from deviations from fundamental values due to various frictions, then market-adjusted RBC ratios should have no value in predicting future financial health of the insurers.

To gauge the information content of our market-adjusted RBC ratios, we investigate whether the difference between market-adjusted and reported RBC ratios has forecasting power for future realizations of the RBC ratio, over and above that of the RBC ratio itself, in Table 3.

[Insert Table 3 here]

The dependent variable in the specifications shown in Table 3 is the future reported RBC ratio: in columns (1) to (3), it is the ratio in year *t+1*, in column (4), it is the ratio in year *t+2*, and in column (5), it is the ratio in year *t+3*. The main result of interest is shown in the first row: the RBC ratio difference in year *t* significantly predicts future RBC ratios one, two, and three years ahead. We find that the larger the difference, i.e. the higher is the market-adjusted RBC ratio relative to reported RBC ratio, the higher will be the RBC ratio in the future. The effect is statistically significant at either 1% or 5% levels, and is also economically significant. A one standard deviation increase in the ratio difference (0.929) is associated with an increase of 0.27 [= 0.929 x 0.291], 0.312, and 0.255 in the future realized RBC ratios for the 1-, 2-, and 3-year forecast horizon, respectively. Importantly, the effect of the RBC ratio difference is not temporary in nature since it persists even three years later.

The result that establishes a clear association between the RBC ratio difference and future RBC ratios is obtained after controlling for the level of the RBC ratio in year *t* (to control for initial regulatory capital adequacy of the insurer) and other insurer-level characteristics, specifically the capital and surplus, leverage, percentage invested in risky assets and return on equity (in columns

(3) to (5)). We also include insurer fixed effects, to control for unobserved heterogeneity, and year indicators.[16]

We also investigate the effects of the RBC ratio difference on the future probability of regulatory action, defined as having the RBC ratio below 3, using logistic regressions for one-, two-, and three-year horizons (up to *t+1*, *t+2*, and *t+3*). We focus on the threshold of 3 since (a) very few firms ever have RBC ratios below the traditional threshold of 2 and (b) for U.S. states that utilize trend tests on various solvency ratios, the first threshold for regulatory actions is 3. We study both the full panel, *t* = 2004-2007 to determine the general predictive power of market prices, and the pure cross section for *t* = 2007 to see whether market adjustments just before the crisis have predictive power for insurers' solvency during the crisis. We only include insurance companies in the bottom 60% percentile of insurers by RBC ratio because insurers with RBC ratios in the top 40% never have ratios below 3. The results are shown in Table 4.

[Insert Table 4 here]

Columns (1), (2) and (3) of Table 4 show the impact of the RBC ratio and the RBC ratio difference in each year during 2004-2007 on the probability that an insurance company will have an RBC ratio of less than 3 in year *t+1*, and any time during the period up to *t+2* or *t+3*, respectively. In each of the panel specification, we introduce an indicator variable to identify P&C insurers from life insurers, year fixed effects, and a number of insurer-level characteristics (the capital and surplus, leverage, percentage invested in risky assets and return on equity).

The effect of the RBC ratio difference on the probability that future reported RBC ratio will fall below 3 is largely consistent with our results in Table 3: insurers with a higher RBC ratio difference are less likely to experience a decline in their reported RBC ratio in year *t+1*, *t+2*, and *t+3* and hence are less likely to fall under regulatory scrutiny. The coefficient estimate is not statistically significant for year *t+1* (shown in column (1)) but it is statistically significant for years

[16] It is well known that dynamic panel regressions with lagged dependent variable and fixed effects can result in inconsistent estimates. To gauge the extent of this problem, we perform a two-step Blundell and Bond (1998)'s system GMM using STATA procedure 'xtdpdsys'. This method estimates the two-equation system of the regressions in levels and in first differences, using first differences and lags of first differences as instruments for the levels and further lags of levels as instruments for the first differences. The results for one-period predictive models show that the signs and magnitudes of the coefficients of RBC ratio difference are virtually the same as those reported in columns (2) and (3) of Table 3. Since the inconsistencies appear to be negligible in our case, we only report the simple OLS estimates in Table 3.

t+2 and *t+3* (shown in columns (2) and (3) respectively). The result carries economic significance as well: a one standard deviation increase in the RBC ratio difference is associated with 25%[17] decrease in the odds of RBC ratio falling below 3 in the following three years (unconditional odds are 6% to 94%).

These results are important for two main reasons. First, the documented effects are obtained after controlling for the reported RBC ratio in year *t*. That is, we control for the firm's existing capital adequacy position, thereby making it harder for us to detect significant predictive power of the RBC ratio difference. If the reported RBC ratio, along with the other control variables we employ, contains all the relevant information about the likely future path of the RBC ratio, especially the probability of approaching the regulatory threshold of 2, then we should not expect the RBC ratio difference to provide additional relevant information. Instead, we find that the RBC ratio difference is important, and the reason must be the ability of market values to provide important signals. Second, it is important to note that the RBC ratio difference does not simply have an impact on the RBC ratio in the following year; the impact appears to be persistent through time. This, in turn, means that market-adjusted RBC ratios provide a useful "early warning signal" in identifying troubled insurers.

In Columns (4)-(6) of Table 4, we conduct a similar analysis, but now we fix the RBC ratio and RBC ratio difference at the end of 2007 and investigate their predictive power for the probability of a fall of the RBC ratio below 3 in 2008 (column (4)), any time during 2008 and 2009 (column (5)), and any time during the 2008-2010 time period (column (6)). While somewhat weaker in statistical significance due to the smaller sample, the results here are in the same spirit as those obtained for the full sample. A one standard deviation increase in the RBC ratio difference is associated with 34% decrease[18] in the odds of RBC ratio falling below 3 in the 2008-2010 time period (unconditional odds are still 6% to 94%). In un-tabulated results, we further investigate the relationship in two sub-samples for which we split insurers based on the portfolio weight in risky assets (loosely defined as riskier than BB bonds). We find that, as expected, the effect is large (a coefficient estimate of -1.158) and statistically significant at the 10% confidence level for the

[17] The standard deviation of the RBC ratio difference for the logit sample is 0.871, which translates to the economic effect on the odd ratio of exp(0.871 x -0.334)-1 which is about 25% decrease in the odds of RBC ratio falling below 3 within the next 3 years.

[18] The standard deviation of the RBC ratio difference for the logit sample in 2007 is 0.589, which translates to the economic effect on the odd ratio of exp(0.589 x -0.694)-1 which is about 34% decrease in the odds of RBC ratio falling below 3 during 2008-2010.

group of insurance companies with an above-median portfolio weight in risky assets and small (-0.440) and with no statistical significance for the group of insurance companies with a below-median portfolio weight in risky assets.

4.3 Portfolio Adjustments and Price Impacts

So far we have shown, among other results, that (a) market-adjusted RBC ratios of P&C insurers are far less volatile, especially during the financial crisis, compared to those of life insurers, and (b) life insurers have far larger unrealized and realized losses compared to P&C insurers. These results call for a deeper analysis of the selling behavior of life and P&C insurers during the crisis. It is precisely through the selling activity, that may or may not be forced given capital constraints, and its implications for price declines that systemic risk may arise or be amplified with a consequent negative spiral of prices and liquidity. Such liquidity black holes have also attracted the attention of academics and regulators alike.

We start our analysis by investigating the selling of life and P&C insurers *in response* to a significant price decline in risky assets that they held. We investigate two groups of risky assets held by insurance companies: corporate bonds and non-agency ABS securities. Table 5 reports the proportion of companies that reduce positions in a bond within 3 months following an observed price decline of 20% or greater.

[Insert Table 5 here]

Each year, we identify bonds whose change in price, calculated using prices between two consecutive dates on which either transaction prices or fair value positions are observed, is 20% or greater. From the date on which the price change is observed, the position of each company holding the bond is tracked over the next 3 months. The bond position is considered to have been reduced if the holdings of that bond held by an insurance company has been either reduced or completely eliminated. The reported proportions are calculated as the total number of reduced positions divided by the total number of positions in the bonds suffering the price decline (company-bond) for life vs. P&C insurance companies (Panel A) and for positions that are held at HCA vs. MTM (Panel B).

Starting with ABS positions held by both groups of insurers (Panel A), one can note that, a statistically significant larger proportion of P&C insurers (6.3%) sell their ABS positions compared to life insurers (4.5%) in 2008 conditional on the observed price decline. The same behavior occurs when we investigate the selling behavior of corporate bonds.[19] This evidence is consistent with Allen and Carletti (2008) and Plantin, Sapra and Shin (2008) as far as the financial crisis is concerned. Of equal importance, however, is the behavior of life and P&C insurers in the years before the crisis. Conditional on a price decline of 20% or more in 2005 and 2006, we also find that P&C insurers reduced position in the particular ABS as compared to life insurers. This means that P&C insurers may be more responsive to the pressures induced by MTM, even in normal times. The interesting question then is whether the rational anticipation of this problem may have generated incentives that left P&C insurers with stronger balance sheets as they entered the crisis.

A similar conclusion is reached when we investigate the ABS and corporate bond positions that are held at HCA and MTM shown in Panel B (where we do not distinguish between life and P&C companies). Conditional on the observed price decline experienced by an ABS, a larger proportion of the ABS positions held by insurers at MTM values (7.6%) are sold compared to those held at HCA values (4.8%) in 2008 with the difference being statistically significant at the 1% confidence level. Pre-crisis behavior is again quite similar for firms facing MTM accounting on such assets.

In Panel C we provide descriptive statistics of the securities and the positions that experienced significant price declines.[20] It is important to note that P&C insurers do not hold a larger proportion of assets that lose value compared to life insurers. For example, in 2005 (2008), an average position that experienced a price decline of 20% or more account for 0.5% (0.8%) of the capital and surplus of life insurers and 0.4% (0.8%) of capital and surplus of P&C insurers. Thus the higher propensity to sell is not due to the larger exposure of P&C insurers to these securities.

We investigate further the general trading behavior of life and P&C insurers for the different types of assets they hold both during the pre-crisis years and the crisis years. Besides

[19] We carried out the same analysis where (a) we reduce the price decline cut-off from 20% to 10% and (b) we limit the window over which the price changes are calculated to 120 days or less. The results remain essentially the same as those in Table 5.

[20] Panel C also shows that a downgrade of these securities is one of the reasons that explain the price declines but not the only one.

introducing the P&C indicator to distinguish between the selling behavior of life and P&C insurers, we also reintroduce the RBC ratio difference that we used before in Section 4.2 in the multivariate analysis. Panel A of Table 6 reports OLS estimates for cross-sectional regressions of portfolio allocation changes (in %) of all insurers for different types of risky assets (stocks, speculative-grade bonds, ABS, and investment grade bonds) from 2004 to 2007 (Pre-Crisis) in columns 1-4, and from 2007 to 2010 (Crisis) in columns 5-8.[21]

[Insert Table 6 here]

The results for the change in the portfolio allocations during the pre-crisis period are important because they speak to *ex ante* incentives. The first main result is that from 2004 to 2007, P&C firms increased their holdings of risky assets (speculative grade bonds and ABS) and decreased their holdings of investment grade bonds less than life firms did. Thus, P&C insurers entered the crisis with less risky balance sheets as compared to those of life insurers. Second, while the RBC ratio *per se* again has no effect on the allocation change of any of the risky asset class held by insurers, the RBC ratio difference has a statistically and economically significant effect on allocation of ABS and investment-grade bonds. Importantly, the effect of the RBC ratio difference on ABS holdings was the opposite of the effect on investment-grade bonds holdings: larger market-adjusted RBC ratios (compared to reported RBC ratios) led to a *smaller increase of ABS holdings* and *a smaller decrease of investment grade bonds* before the crisis. Thus, insurers that may appear healthy according to reported RBC ratio but are less so according to forward-looking market information enter the crisis with riskier balance sheets.

There are two main results that emerge from the crisis period. First, P&C insurers were more aggressive than life in reducing the holdings of risky assets (speculative grade bonds and ABS) while increasing their holdings of investment grade bonds. Second, while the RBC ratio *per se* had no effect on the change of the allocation of any type of risky asset class held by insurers, the RBC ratio difference had a statistically and economically significant effect on the allocation of speculative-grade bonds and ABS. This is an important result. Speculative-grade bonds and ABS in general suffered larger price declines and became musch riskier compared to investment-grade

[21] We carry out the analysis over shorter time horizons, i.e. one and two years. The results are qualitatively similar to those in Table 6, which are obtained over a three-year horizon.

bonds during the crisis period. Given this information, a reasonable response by a financial institution that wanted to maintain the risk-reward tradeoff of its portfolio at similar levels should have been to reduce precisely the holdings of the riskiest assets in the balance sheet. These results confirm that this response was carried out more by financial institutions whose market-adjusted RBC ratios were larger than the reported RBC ratios. These institutions were arguably truly healthy according to market values of their portfolios and hence their incentives to risk-shift are less than those with poor capital positions. We should also note that the impact of the RBC ratio difference is obtained in a specification where we control for the P&C dummy variable, portfolio allocation (%), and other insurer-level control variables at the end of each period.

While Panel A investigates the differences in trading behavior across insurer groups, in Panel B and C we investigate these differences, separately, *within* insurer group. Panel B (Panel C) shows the same specification as that in Panel A for life (P&C) insurers. The main result from Panel B is that both the RBC ratio and the RBC ratio difference explain the changes in the allocations of life insurers in riskier assets, especially in the pre-crisis period, consistent with our maintained hypothesis. For example, we find that life insurers whose market-adjusted RBC ratios are lower than reported RBC ratios (i.e., those with unrealized losses in their balance sheets) invested more in risky securities (such as ABS) in the pre-crisis years, compared to other life insurers.[22] The same results are found when we focus exclusively on P&C insurers, as shown in Panel C. All these results are obtained for each insurer type and after controlling for, amongst other things, the portfolio's initial allocation[23] that each insurer has in the particular asset class. Overall, these additional results give us comfort that our earlier findings are not driven by the different business models of life and P&C insurers or because of their naturally different portfolio allocations.

The overall picture that emerges from the results is more complex than that considered so far by the theoretical literature. While it is true that assets held at MTM values are more likely to be sold in response to a significant price decline compared to assets held at HCA values during a financial crisis, it is also true that the same behavior takes place in normal times. The latter result has a very important implication that has so far been ignored: there may be *ex ante* effects of the

[22] For life insurers, it is also important to note that our results are significant despite the sample that is significantly smaller than that of P&C insurers, which could limit the power of our tests.

[23] In the last row of Panels B and C we produce the summary statistics on the allocation (percentage of the portfolio) of life and P&C insurers in each of the four groups of securities-- (i) stock; (ii) speculative-grade bond; (iii) ABS; and (iv) investment-grade bonds-- for both life and P&C insurers.

interaction between accounting rules and the regulatory framework that provides incentives to financial institutions using MTM to dispose of riskier assets (and perhaps buy fewer of them to begin with – more on this below) than institutions using HCA. This implies that we have to look at both *ex ante* and *ex post* effects to gauge the precise impact of MTM accounting.

We next investigate the price dynamics of assets held by insurance companies over our sample period. These are shown in Figure 3.

[Insert Figure 3 here]

Figure 3 plots the time series of quarterly price indices for bonds with above-median holdings by P&C companies, and below-median holding by P&C companies which we construct as follows. At the beginning of *each year* (end of previous year), we calculate P&C companies' holding for *each bond* as the total par value of the bond that is held by P&C companies divided by the total par value of the bond that is held by all insurance companies (life and P&C). For *each year* and *each bond type* (ABS, corporate bonds, or speculative-grade bonds), we then determine the median of P&C holding and use it to split bonds (in that year and that bond type) into two equal groups—high and low P&C holdings. Each bond's return is tracked over the course of the year as the bond is transacted during the year or its fair value is reported at the end of the year.[24] The index is then calculated as the median of bond returns in each group (high vs. low P&C holdings) and each type (ABS, corporate bonds, or speculative-grade bonds). Each index is normalized to 100% at the end of 2004. Panel A is for ABS instruments, Panel B is for corporate bonds, and Panel C is for all speculative-grade bonds with rating better than CCC.

Starting from Panel A, where the price dynamics of ABS instruments are analyzed, we observe that it is not the ABS held disproportionately by institutions that faced MTM (above-median holdings by P&C insurers) that suffered the largest price declines in 2008, but rather the ABS mostly held by institutions that faced HCA (below-median holdings by P&C insurers). The same picture emerges when we analyze the price dynamics of corporate bonds shown in Panel B. When we extend the analysis for all speculative-grade bonds with rating better than CCC, shown in Panel C, we find that both groups of assets experienced the same magnitude of price declines.

[24] If there is more than one price reported for the bond on each day, the median of all reported prices is used.

The picture that emerges from the evidence in Figure 3 is somewhat inconsistent with the view that assets held under MTM suffer *larger* price declines when compared to the assets held at HCA values. Putting together the evidence in Tables 5 and 6 and Figure 3, we can say that while it is true that MTM may induce institutions to *sell more* of their assets as compared to HCA, it is also true that these institutions may sell assets of *better quality* as compared to those sold by institutions with HCA requirements or hold fewer assets in the first place that are the most sensitive to the fire sale feedback problem. Our results so far indicate that, if it is indeed true that the severity of the feedback dynamic during a financial crisis is directly related to the amount of risk taking in the years before the crisis, then whether one accounting rule produces more or less systemic risk should not be judged solely on the measured effects on the way down (during the crisis) but also on the incentives it engenders on the way up (before the crisis).

4.4 Reaching for Yield

Many have argued that the pre-crisis period was characterized by excessive risk taking behavior and 'reaching-for-yield' investment decisions that aimed at regulatory arbitrage (Rajan (2010) and Yellen (2011), among many others).[25] The term 'reaching for yield' is used by the literature to describe investors' preference for those assets that promise higher expected returns, regardless of the risk, *so long as these assets comply with regulatory requirements or investment limits*.

In this section, we investigate the reaching-for-yield behavior of life and P&C insurers during the years before the crisis and then document the price performance of the instruments bought by the two groups of insurers during and after the crisis. Under the maintained hypothesis that the application of MTM during a crisis should lead to a more conservative investment approach before the crisis, we should find that (a) P&C insurers exhibited less "reaching-for-yield" behavior compared to life insurers in the 2004-2007 time period, and, as a consequence of the lower risk, (b) the assets held by P&C insurers performed better than those held by life insurers during and after the crisis.

[Insert Figure 4 here]

[25] This process is aptly described by Admati and Hellwig (2013) as follows: "Banks have developed various techniques for "risk-weight optimization" that allow them to choose investments that are in fact riskier than the supervisors believe and have return prospects reflecting these risks so that, on average, returns are higher than the returns on investments that are in fact safer" (page 184).

In Figure 4, we show the time series of the *difference* of the median yields across all bonds purchased in each calendar quarter, both at issuance and in secondary markets, by life vs. P&C companies for different types of assets rated as A-AAA (NAIC category 1) and with maturities between 2 and 5 years: ABS (Panel A) and corporate bonds (Panel B). In so doing, our analysis holds the regulatory requirement constant by considering the highest rated group for each asset class across both life and P&C insurers. Moreover, the homogeneity in rating and maturity means that life and P&C companies holding these securities potentially use them for the same purposes, e.g. matching short-term liabilities, even if their overall portfolios might be different due to the differences in their liability structures. We then ask whether there is any difference in the yields of that asset group between life and P&C insurance companies. This analysis is similar to the one adopted by Becker and Ivashina (2012) but applied to our environment and our research question by focusing on the differences between two insurance groups associated with different accounting rules.

If the anticipation of the potential consequences of MTM causes P&C insurers to engage in less regulatory arbitrage than life insurers, we should find that the yields of assets bought by P&C firms are lower than those bought by life holding the general rating and the associated capital requirement constant. This is precisely what we find in Figure 4: in all quarters over the 2005 to 2007 time period except one, life insurance companies purchased ABS that had higher yields than those purchased by P&C. The average difference over this time period was 48 basis points which is economically significant given that this is the highest rating class that carries little to no capital charge. The same picture, albeit with a slightly lower yield difference, emerges when we look at corporate bonds in Panel B. This is to be expected given that regulatory arbitrage is more likely to be undertaken using structured, rather than more traditional, instruments.

We next move to investigate the reaching for yield behavior in the pre-crisis period (2005-2007) between-insurer-group and within-insurer-group in a multivariate set-up. The results are shown in Table 7.

[Insert Table 7 here]

In columns 1-3, we show the results for the difference in the yields of bonds and ABS purchased by insurers between life and P&C companies. Focusing on column 3, where we have the most comprehensive set of variables to control for insurance-level and bond-level characteristics as well as calendar quarter fixed effects, we find two important results. First, bonds and ABS purchased by P&C insurers have lower yields compared to those bought by life, confirming the univariate results shown in Figures 4 and 5. Second, insurers with unrealized investment losses (i.e. where the market-adjusted RBC ratio is lower than the reported RBC ratio) bought bonds and ABS with higher yields compared to other insurers (with either no unrealized losses or with unrealized investment gains).

We next move to investigate the reaching for yield *within* the life insurance group (columns 4-5) and within the P&C insurance group (columns 6-7). Life insurers with lower market-adjusted RBC ratios, recognizing that their RBC ratios may decline in the near future, have higher incentives to reach for yield. These differential incentives should be weaker for P&C insurers who must recognize investment losses should the seemingly high-quality bonds with higher yields get downgraded in the future. We find that this is indeed the case. The results in columns 4-5 show that life insurers with market-adjusted RBC ratios significantly lower than reported RBC ratios are more likely to reach for yield in the years leading up to the financial crisis compared to other life insurers whose market-adjusted RBC ratios are either very close or higher than the reported RBC ratios. The results are not significant for P&C insurers.

We then move to exploit observable differences *across U.S. states* in the application of the NAIC's prescribed accounting rules. As explained in Section 3.3, we identify this variation in the data by ranking U.S. states into two groups for each insurance type: states with an above- and below-median incidence of MTM. The results in column 5 show that life insurers from U.S. states with a larger (lower) incidence of MTM are less (more) likely to reach for yield. The results in column 7, investigating the reaching for yield within the P&C group, show that even though the baseline incidence of MTM is larger for P&C insurers as a group, they still exhibit the same variation in reaching for yield behavior across states. These within-insurer-type results link MTM directly to the extent of reaching for yield in the manner that is free from differences in business models.

Finally, we also investigate a specific alternative hypothesis that in comparison to P&C insurers, life insurers have longer-term liabilities (due to the nature of their business) and as a result have higher capacity to bear risk and are better suited to hold illiquid assets. Just like our maintained hypothesis, this alternative hypothesis also predicts that life insurers would reach for yield more than P&C insurers during the pre-crisis period. To distinguish between these hypotheses, we investigate the investments of life and P&C insurers in (unaffiliated) common stocks. Since *both* life and P&C insurers must mark-to-market common stock positions, our maintained hypothesis predicts that life insurers would not take more risk in this asset class than P&C insurers. On the other hand, the alternative hypothesis predicts that since life insurers inherently have higher risk capacity, they would take more risk in this asset class, just as in ABS and bonds, than P&C insurers. The results are shown in Table 8.

[Insert Table 8 here]

The main results are shown in column 1 (where we look at a stock's beta) and column 4 (where we look at a measure of the stock's illiquidity). After controlling for insurance-level controls and calendar-quarter fixed effects, we find that P&C insurers invest in stocks with higher betas and lower liquidity (measured using the Amihud measure) compared to life insurers. Overall, while the economic significance of the difference between the two insurance groups is small, the results are consistent with our maintained hypothesis but not with the alternative hypothesis in that both the betas and the Amihud ratios of stocks purchased by life insurers are *not higher* than those purchased by P&C insurers.

A critical implication of the results shown in Figure 4 and Table 7 is that P&C insurers were indeed reaching less for yield by buying less risky assets than life insurance companies *within the same rating class*. This means that the assets held by P&C firms, by virtue of their lower riskiness compared to those held by life insurers, should suffer lower price declines during the crisis if these assets were indeed associated with less, say, tail risk. We next examine this question in Figure 5 which plots the time series of quarterly (value weighted) price indices for portfolios of bonds held by life and P&C insurance companies at the end of 2007. Only bonds rated in the A to AAA categories and with maturities between 2 and 5 years are included. For each bond, the price in each quarter is calculated as the median of all transactions that occur in the quarter and the price index is calculated by dividing the quarterly price by the price in the last quarter of 2007. The portfolio price index is the weighted sum of individual bond price indices where the weight is the portfolio allocation in each bond by each group of insurance companies.

[Insert Figure 5 here]

The results shown in Figure 5 confirm this view: on the value-weighted average basis, prices of the highest rated assets held by life insurance companies fell significantly more than the prices of similar assets held by P&C insurers. Indeed, the price dynamics of the assets held by life insurers show the V-shape price reaction consistent with what has been generally found by the fire sales literature in other contexts: a significant price decline and subsequent reversal. It should be noted that the price dynamics of the assets in the same rating class held by P&C are very different and do not show comparable dynamics. This is an important result because it is not consistent with the view that MTM necessarily induces procyclicality in asset prices. One reason why this may not be so is that a forward-looking financial institution rationally anticipating the implications of MTM requirements during a financial crisis may purchase fewer risky securities than another institution facing instead HCA rules.

5. Policy Implications and Generalizability to the Financial Sector

The results we show in the paper have a number of important policy implications for the current debate surrounding financial institutions' capital adequacy rules and systemic risk exposures. First, our results are consistent with the view that, while MTM can certainly induce a fire-sale feedback problem during a crisis as compared to HCA, the *ex ante* incentives that it generates may induce financial institutions to adopt a more conservative approach to their investments. This means that the balance sheets of financial institutions using MTM may contain less risky assets *entering into a crisis*, thus dampening systemic risk amplification. These results should help the financial industry, regulators, and policy makers understand that the focus on MTM as one of the major "culprits" of the financial crisis may be misplaced. The distortions that may be engendered by MTM are not solved by simply replacing MTM with HCA.

Second, while a fully-fledged MTM system has the benefit of acting like an early warning signal it also suffers from the fire sale problem that potentially leads to contagion effects. These issues should be addressed and policymakers can do this either by changing the accounting system, to provide some level of flexibility during a financial crisis, or through prudential regulation. The challenge with any change in the accounting system is to strike the balance between relevance and reliability, because the benefits from flexibility have to be traded-off against management's strategic behavior (Laux and Leuz, 2009). Perhaps a better way to address such a problem is to recognize the benefits of MTM as an early warning device rather than changing prudential regulations in such a way that explicitly introduces counter-cyclical capital requirements.

Third, our results indicate that the present system to assess capital adequacy through regulatory capital ratios that employ detailed, but necessarily imperfect, risk-weights may be adding excessive complexity when simplicity may be a better approach (see Admati and Hellwig (2013) and Haldane (2012)). Such a complex capital adequacy system may be introducing distorted incentives arising from its interaction with the accounting rules that may add, rather than control, risks in the system. The evidence on "reaching-for-yield" is an example of such behavior, where life insurers facing HCA may have accumulated tail risk within the system in the years leading up to the crisis. It is potentially this accumulated tail risk in normal times that may heighten systemic risk during the crisis and as a result should be the focus of regulators and policy makers. Admati and Hellwig (2013) describe this environment as follows: "The risk-weighting approach is extremely complex and has many unintended consequences that harm the financial system. It allows banks to reduce their equity by concentrating on investments that the regulation treats as safe….In theory, risk weights are meant to adapt equity requirements to the risks of the banks' investments; in practice, the weights are determined by a mixture of politics, tradition, genuine and make-believe science, and the banks' self-interest. In this mixture, some important but real risks are completely overlooked."

While our evidence does not speak directly to the potential efficacy of various regulatory modifications that have been proposed, our results indicate that the continued focus on regulatory capital ratios that employ complex risk-weights may prove counterproductive. As was recently stated in the Financial Times[26], "whether you call [regulatory arbitrage] gaming the system or legitimate management, the capital hawks will need to watch both the banks and the national regulators if RWA [risk-weighted assets] is not to mean Really Weird Accounting."

While our results are obtained from the insurance industry, the broad similarities in the way insurers and banks invest and are regulated imply that these results are important for the financial sector in general. In addition, our results are broadly consistent with the recent literature that investigates questions related to ours using data from the U.S. banking sector (Bhat et al.

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[26] October 24, 2011, Braithwaite, Financial Times, "Banks turn to financial alchemy in search for capital."

(2011), Badertscher et al. (2010), Bowen et al. (2010) and Blankespoor et al. (2012) among others). For example, Blankespoor et al. (2012) find that leverage measured using fair values explains significantly more variation in bond yield spreads and bank failure than non-market-based leverage. Due to the importance of the MTM vs. HCA debate for the banking sector, and to the extent that bank data cannot be used to cleanly identify the effects of accounting rules because most banks follow the same accounting practices, our results should shed light on this issue beyond the strict relevance of the insurance industry.

6. Conclusion

The fire sale feedback problem associated with mark-to-market accounting has been identified as a potential culprit in amplifying systematic risk in the recent financial crisis. In response, many have proposed the use of historical cost accounting. In this paper, we caution against focusing on the accounting rule in isolation. Rather, we emphasize the *interaction* between accounting and the regulatory framework in which these rules are applied.

We use the insurance industry as a laboratory in which to explore whether, and in what way, accounting rules are associated with the buildup of risk *before* and systemic risk *during* a financial crisis. Using detailed, position-level data from the insurance industry, we document several important results. First, the difference between reported regulatory (RBC) ratios and hypothetical market-based ratios predicts both future realized ratios and, in particular, the insurance companies that are more likely to generate regulatory scrutiny. That is, market prices, even in the face of potential distortions, do serve as 'early warning signals'. Second, P&C insurers, forced to mark more of their positions to market, do sell securities that have faced significant price declines, potentially exacerbating the fire-sale feedback problem. However, our third result shows that P&C insurers are significantly more prudent in their portfolio decisions in the years leading up to the crisis. In contrast, life insurers, that employ historical cost accounting, engage to greater degrees in regulatory arbitrage before the crisis and limited loss recognition during the crisis. Finally, we show that the assets that are held in larger proportion by P&C insurers do not exhibit higher procyclicality in prices or larger price declines during the crisis. Together, these results suggest that the *ex ante* prudence induced by MTM helps offset the fire-sale feedback problem and hence the claim that this accounting rule is responsible for heightened systemic risk during a financial crisis seems to be misplaced.

Rather than promoting a shift away from market-based information, our results indicate that regulatory simplicity may be preferred to the complexity of risk-weighted capital ratios that gives rise, through its interactions with accounting rules, to distorted incentives and potentially amplified systemic risk.

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Appendix: Descriptions of Variables

Variable	Specific to	Definition
% ABS	Insurer-year	Percentage of investment assets invested in asset-backed securities (ABS), including residential mortgage-backed securities (RMBS), commercial mortgage-backed securities, etc. Most of the ABS are in NAIC classifications 1 (ratings A- to AAA), which have the lowest capital requirements, but some are in the riskier classifications (2-6).
% investment-grade bonds (Holding of investment-grade bonds)	Insurer-year	Percentage of investment assets invested in investment-grade bonds, excluding ABS. These bonds are in NAIC classifications 1 (ratings A- to AAA) and 2 (ratings BBB- to BBB+).
% risky assets (Holding of risky assets)	Insurer-year	Percentage of investment assets invested in any of the following asset classes: non-investment grade bonds, common and preferred stocks, non-performing mortgages, real estate, and other investments. According to NAIC, the target capital percentages for these assets are greater than or equal to those of the least risky class of non-investment grade bonds (BB).
% speculative-grade bonds	Insurer-year	Percentage of investment assets invested in speculative-grade bonds, excluding ABS. These bonds are in NAIC classifications 3 (ratings BB- to BB+), 4 (ratings B- to B+), 5 (ratings CCC- to CCC+), and 6 (in or near default).
% stock	Insurer-year	Percentage of investment assets invested in common and preferred stocks. Most of the holdings are in common stocks of unaffiliated companies, which are carried at fair values for both life and P&C insurance companies. High-grade preferred stocks and common stocks in affiliated companies are held at historical costs.
Amihud ratio	Stock-quarter	Measure of stock illiquidity, calculated as the average daily Amihud ratio over the quarter where the daily Amihud ratio is calculated as |return|/(volume x closing price/1,000,000). A minimum of 22 trading days in the estimation window are required.
Beta	Stock-quarter	CAPM beta, estimated by regressing the stock's daily return on CRSP value-weighted market return over a 2-year window up to the current-quarter end. A minimum of 60 trading days in the estimation window are required.
Calendar quarter fixed effects and year fixed effects	Quarter	Set of dummy variables for calendar quarters in which the observations fall and set of dummy variables for years in which the observations fall, respectively.
Capital and surplus	Insurer-year	The insurance company's statutory net worth (including paid-in capital or unimpaired surplus and additional funds in surplus) in millions of dollars through the most recent year end.
Firm fixed effects	Insurer	Set of dummy variables for firms to which the observations belong.
High mark-to-market state dummy	Insurer	Dummy variable equal to 1 if the life (P&C) insurer is domiciled in a state in which the mark-to-market frequency for speculative-grade bonds is greater than or equal to the national median, and 0 otherwise. It is calculated as follows. First, for each company, the mark-to-market dummy (defined below) is averaged across all of its speculative-grade bond positions during 2004-2007 to obtain company-level mark-to-market frequency. Second, the company-level mark-to-market frequency is averaged across all insurers of each type (life and P&C, separately) in the state to obtain the state-level mark-to-market frequency. Finally, for each type of insurer, states are divided into two groups at the median mark-to-market frequency, which is calculated across all states with at least two insurers of that type.
Historical cost accounting dummy (HCA)	Position-year	Dummy variable equal to 1 if the position has the book value that is not equal to its reported fair or market value, and 0 otherwise.
Invested assets	Insurer-year	Total assets that are invested to generate financial returns. Operating assets, such as office buildings, are excluded.
Issue size	Bond	Offering amount of the bond, measured in million dollars.

Variable	Specific to	Definition
Leverage	Insurer-year	Debt as percentage of total assets, all measured at book values.
Mark-to-market dummy (MTM)	Position-year	Dummy variable equal to 1 if the position has the book value that is equal to its reported fair or market value, and 0 otherwise.
Market-adjusted risk-based capital ratio (Market-adjusted RBC ratio)	Insurer-year	Ratio of total adjusted capital (capital, surplus, and applicable valuation reserves) plus unrealized gains and losses on all securities held at amortized historical costs to NAIC risk-based capital (RBC). Unrealized gains and losses are calculated as the company's reported fair value minus book-adjusted carrying value of each security position.
Maturity	Bond-quarter	Maturity of the bond at the beginning of quarter of interest or the beginning of quarter in which the interested transactions fall (depending on specifications), measured in years.
NAIC risk-based capital ratio (RBC ratio)	Insurer-year	Ratio of total adjusted capital (capital, surplus, and applicable valuation reserves) to NAIC risk-based capital (RBC). RBC is the *minimum* amount of capital that the insurance company must maintain based on the inherent risks in its operations. RBC is calculated based on the NAIC's formula which reflects its assessment of risks of different asset classes and businesses. For example, a company with RBC ratio of 1.0 has capital equal to its RBC. Insurance companies with higher RBC ratios are considered better capitalized. Insurance companies with RBC ratio below 2.0 are subject to supervisory interventions. The levels of supervisory actions depend on the level of RBC ratio. Low RBC ratio dummy equals 1 for RBC ratios below the annual median, and 0 otherwise.
RBC ratio difference	Insurer-year	Market-adjusted RBC ratio minus RBC ratio. Positive value indicates that the fair value of invested assets are higher than the book-adjusted carrying value; or, in other words, the company has net unrealized gains on its invested assets.
ROE	Insurer-year	Return on equity, measured as net income divided by book value of equity at the beginning of the year. Positive ROE dummy equals 1 if ROE is greater than zero, and 0 otherwise.

Table 1: Summary Statistics of Insurance Companies

This table presents descriptive characteristics of life (Panel A) and P&C (Panel B) insurance companies in our sample at the end of 2007. Our sample is restricted to insurance companies with invested assets not less than $13 million and RBC ratio not greater than 50. We also exclude 33 bond insurers including AIG, AMBAC, MBIA, etc. Definitions of the variables are in the Appendix.

Panel A: Life companies

	Mean	Std. Dev.	Minimum	10th Pct	50th Pct	90th Pct	Maximum
Number of Firms	462						
Invested Assets ($ million)	5,498	18,641	13	26	454	11,430	210,000
Capital and Surplus ($ million)	554	1,595	0	8	73	1,225	17,827
Leverage	0.80	0.20	0.01	0.50	0.88	0.96	1.00
Return on Equity (ROE)	0.02	1.04	-21.46	-0.08	0.08	0.25	2.44
NAIC Risk-Based Capital Ratio (RBC ratio)	11.61	8.07	0.10	4.53	9.08	21.42	49.00
Holding of Investment-Grade Bonds (%)	54.97	20.26	0.00	32.00	54.55	82.10	104.30
Holding of Risky Assets (%)	16.39	15.77	0.00	2.25	12.16	32.20	98.80

Panel B: P&C companies

	Mean	Std. Dev.	Minimum	10th Pct	50th Pct	90th Pct	Maximum
Number of Firms	1,499						
Invested Assets ($ million)	798	4,055	13	22	109	1,250	99,104
Capital and Surplus ($ million)	377	2,204	-103	11	55	548	63,577
Leverage	0.57	0.16	-0.03	0.35	0.60	0.74	1.77
Return on Equity (ROE)	0.09	0.40	-14.68	0.01	0.10	0.22	0.95
NAIC Risk-Based Capital Ratio (RBC ratio)	10.34	7.63	-6.20	3.90	8.10	18.60	49.40
Holding of Investment-Grade Bonds (%)	62.77	21.69	0.00	34.23	64.09	91.51	129.84
Holding of Risky Assets (%)	17.06	18.47	0.00	0.00	11.86	42.14	95.28

Table 2: Cross-Sectional Distribution of RBC Ratios Over Time

This table presents distributional statistics on RBC ratios and market-adjusted RBC ratios by year for life (Panel A) and P&C (Panel B) insurance companies. Our sample is restricted to insurance companies with invested assets not less than $13 million and RBC ratio not greater than 50. We also exclude 33 bond insurers including AIG, AMBAC, MBIA, etc. Market-adjusted RBC ratio is calculated by adding unrealized gains and losses on all securities held at historical costs to the (adjusted) statutory capital, the numerator of RBC ratio. The last three columns report cross-sectional Pearson correlations, Spearman rank correlations, and the percentage of firms in the bottom 5% by RBC ratio that are also in the bottom 5% by market-adjusted RBC ratio. Detailed definitions of the variables are in the Appendix.

	Reported RBC Ratio						Market-Adjusted RBC Ratio						Correlations		Overlap
Year	Mean	Std. Dev.	5th Pct	10th Pct	50th Pct	90th Pct	Mean	Std. Dev.	5th Pct	10th Pct	50th Pct	90th Pct	Pearson	Spearman	Bottom 5%
Panel A: Life companies															
2004	11.2	8.2	3.9	4.6	8.5	21.8	13.1	8.4	4.3	5.5	10.9	23.8	0.97	0.94	0.68
2005	11.2	7.7	4.1	5.0	8.7	21.7	11.9	7.7	4.1	5.1	9.7	22.2	0.98	0.96	0.73
2006	11.5	7.9	3.9	4.8	9.0	21.7	11.6	7.9	3.8	4.9	9.3	21.5	0.99	0.97	0.82
2007	11.6	8.1	3.8	4.5	9.1	21.4	11.7	8.4	3.4	4.5	9.2	21.3	0.99	0.98	0.70
2008	11.3	8.9	3.3	4.2	8.2	21.7	8.2	10.3	-3.7	-1.0	5.6	21.3	0.92	0.76	0.17
2009	11.3	7.9	3.4	4.5	9.0	21.0	11.9	8.6	3.0	4.0	9.6	23.1	0.98	0.94	0.61
2010	11.9	8.2	4.0	5.1	9.5	21.4	14.2	9.0	5.0	5.9	12.1	24.3	0.96	0.93	0.70
Panel B: P&C companies															
2004	8.7	7.1	2.3	3.0	6.7	16.5	9.0	7.3	2.3	3.1	7.0	16.9	1.00	1.00	0.94
2005	9.4	7.6	2.5	3.3	7.4	18.3	9.4	7.6	2.4	3.2	7.4	18.5	1.00	1.00	1.00
2006	10.1	7.8	2.8	3.7	7.9	19.4	10.1	7.8	2.7	3.6	7.8	19.3	1.00	1.00	0.95
2007	10.3	7.6	2.9	3.9	8.1	18.6	10.5	7.7	2.9	3.9	8.3	18.9	1.00	1.00	0.97
2008	10.6	8.1	2.8	3.8	8.2	20.2	10.5	8.1	2.8	3.6	8.1	19.9	1.00	0.99	0.92
2009	11.0	8.3	2.9	4.0	8.7	21.3	11.5	8.6	2.9	4.1	9.0	22.0	1.00	1.00	0.97
2010	11.2	8.7	3.0	3.9	8.6	21.4	11.7	9.0	3.2	4.1	9.0	22.0	1.00	1.00	0.94

Table 3: Predicting Future RBC Ratio with Current Market-Adjusted RBC Ratio

This table reports OLS estimates for the panel regressions of RBC ratio in year *t*+*n* on RBC ratio difference, RBC ratio, and other control variables in year *t*. Columns (1) to (3) are for *n* = 1, column (4) is for *n* = 2, and column (5) is for *n* = 3. The sample include all life and P&C insurance companies from year *t* = 2004 to *t* = 2007. All specifications include insurance company dummies and year dummies. Detailed definitions of the variables are in the Appendix. Standard errors, clustered by insurance company, are in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	(1) *t*+1	(2) *t*+1	(3) *t*+1	(4) *t*+2	(5) *t*+3
RBC ratio difference	0.396***	0.305***	0.291**	0.336***	0.275**
	(0.124)	(0.117)	(0.115)	(0.102)	(0.140)
RBC ratio		0.193***	0.161***	-0.042	-0.067*
		(0.033)	(0.039)	(0.032)	(0.039)
ln(capital and surplus)			-0.038	-0.091	0.056
			(0.470)	(0.372)	(0.375)
Leverage			-4.699**	-0.700	0.969
			(2.172)	(1.750)	(1.930)
% risky assets			-0.009	-0.002	-0.001
			(0.012)	(0.011)	(0.010)
ROE			-0.011	0.708	-0.093
			(0.322)	(0.484)	(0.285)
Firm fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Observations	7,462	7,462	7,412	7,292	7,129
Adjusted R-squared (within)	0.023	0.058	0.062	0.021	0.029

Table 4: Predicting Whether Future RBC Ratio Will Fall Below 3 with Current Market-Adjusted RBC Ratio

This table reports logit coefficient estimates for the probability that an insurance company will have RBC ratio below 3 in year *t+n* as a function of RBC ratio difference, RBC ratio, and other control variables in year *t*.. Only insurance companies in the bottom 60% by RBC ratio each year are included (companies with RBC ratio in the top 40% never have RBC ratios below 3 in the next three years). Columns (1) to (3) are for the panel of insurance companies from year *t* = 2004 to *t* = 2007. Columns (4) to (7) are for the cross section of insurance companies in year *t* = 2007. Detailed definitions of the variables are in the Appendix. Bootstrapped standard errors, calculated using 200 repetitions, are in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	Panel from *t* = 2004 to *t* = 2007			Cross section in *t* = 2007		
	(1)	(2)	(3)	(4)	(5)	(6)
	Up to *t*+1	Up to *t*+2	Up to *t*+3	Up to *t*+1	Up to *t*+2	Up to *t*+3
P&C dummy	0.028	-0.126	-0.116	0.662	0.534	0.737
	(0.399)	(0.297)	(0.237)	(0.777)	(0.546)	(0.552)
RBC ratio difference	-0.220	-0.271*	-0.334*	-0.349	-0.496	-0.694*
	(0.194)	(0.161)	(0.172)	(0.360)	(0.305)	(0.382)
RBC ratio	-1.113***	-0.886***	-0.784***	-0.977***	-0.888***	-0.786***
	(0.145)	(0.095)	(0.070)	(0.235)	(0.165)	(0.132)
ln(capital and surplus)	-0.336***	-0.341***	-0.338***	-0.343**	-0.284***	-0.350***
	(0.080)	(0.057)	(0.048)	(0.150)	(0.100)	(0.103)
Leverage	1.459	0.944	1.238	5.702***	3.714***	3.590***
	(1.305)	(0.957)	(0.838)	(2.009)	(1.317)	(1.286)
% risky assets	0.004	0.003	0.006	0.018	0.010	0.024***
	(0.007)	(0.005)	(0.004)	(0.012)	(0.010)	(0.009)
ROE	-0.165	-0.088	-0.227	0.299	-0.115	-0.316
	(0.511)	(0.442)	(0.376)	(0.761)	(0.688)	(0.583)
Year fixed effects	YES	YES	YES	-	-	-
Observations	4,014	4,014	4,014	1,058	1,058	1,058
Pseudo R-squared	0.249	0.217	0.202	0.283	0.252	0.247

Table 5: Propensity to Sell upon Large Price Decline

This table reports proportion of companies that reduce positions in a bond within 3 months following an observed price drop of 20% or greater. Only ABS and corporate bonds that are held by at least 2 insurance companies are included in the analysis. Each year, we identify bonds whose change in price is 20% or greater (between two consecutive dates on which transaction price or position fair value is observed). From the date on which the price change is detected, the position of each company holding the bond is tracked over the next 3 months. The position is considered reduced if it is reduced or eliminated. The reported proportions are calculated as the total number of reduced positions divided by the total number of positions in the bonds suffering the price drop (company-bond) for life vs. P&C insurance companies (Panel A) and for positions that are held at amortized historical cost (HCA) vs. marked to market (MTM) (Panel B). Panel C reports descriptive statistics of the positions and securities that are in the sample. Detailed definitions of the variables are in the Appendix. *t*-statistics for the tests of difference in proportion are in parentheses.

Panel A: Life vs. P&C companies

Year	2005	2006	2007	2008	2009	2010
ABS						
Life	0.0%	1.2%	3.2%	4.5%	9.1%	7.2%
P&C	7.0%	15.5%	2.5%	6.3%	9.6%	7.5%
P&C - Life	7.0%	14.3%	-0.8%	1.8%	0.5%	0.3%
t-statistic	(2.562)	(4.539)	(-0.689)	(4.830)	(0.859)	(0.432)
Corporate Bonds						
Life	11.6%	11.1%	11.8%	9.8%	13.4%	5.6%
P&C	9.6%	28.0%	12.5%	11.7%	15.4%	6.8%
P&C - Life	-2.0%	16.9%	0.6%	1.8%	2.0%	1.2%
t-statistic	(-2.927)	(13.583)	(0.744)	(9.797)	(5.202)	(2.839)

Panel B: Positions under HCA vs. MTM

Year	2005	2006	2007	2008	2009	2010
ABS						
HCA	3.0%	6.4%	2.2%	4.8%	8.4%	7.2%
MTM	9.1%	4.8%	3.5%	7.6%	12.4%	7.3%
MTM - HCA	6.1%	-1.6%	1.3%	2.8%	3.9%	0.1%
t-statistic	(1.724)	(-0.636)	(1.279)	(7.011)	(6.253)	(0.164)
Corporate Bonds						
HCA	10.4%	17.1%	10.9%	9.3%	12.6%	5.9%
MTM	12.1%	22.4%	14.2%	13.1%	18.3%	7.4%
MTM - HCA	1.8%	5.3%	3.3%	3.8%	5.7%	1.5%
t-statistic	(2.679)	(4.443)	(4.056)	(20.657)	(14.772)	(3.274)

Table 5, Cont'd: Propensity to Sell upon Large Price Decline

Panel C: Descriptive statistics of securities and positions that experience large price decline

Year	2005	2006	2007	2008	2009	2010
ABS						
Number of positions	87	143	451	7,199	4,502	2,312
% of capital and surplus						
- Life	0.5	0.7	0.6	0.8	0.6	0.4
- P&C	0.4	0.5	0.5	0.8	0.4	0.3
Number of securities	41	29	133	1,391	986	592
Average rating notches before price change	15.8	14.7	15.9	18.4	14.4	12.7
Average rating notches after price change	15.7	14.6	15.0	17.5	13.9	12.6
% downgrade	4.3	6.9	15.0	14.5	7.0	2.0
Corporate Bonds						
Number of positions	3,954	1,943	2,993	54,270	16,363	6,107
% of capital and surplus						
- Life	1.1	1.2	1.0	0.9	0.7	0.8
- P&C	1.5	1.8	1.0	0.6	0.5	0.7
Number of securities	248	112	171	2,700	838	231
Average rating notches before price change	10.7	12.1	12.1	11.2	10.9	10.3
Average rating notches after price change	10.2	11.9	11.8	10.6	10.2	10.2
% downgrade	24.7	9.9	16.3	19.8	19.2	4.6

Table 6: Changes in Allocation to Different Types of Risky Assets during Pre-Crisis and Crisis Periods

This table reports OLS estimates for the cross-sectional regressions of portfolio allocation changes (%) from 2004 to 2007 (Pre-Crisis) and from 2007 to 2010 (Crisis) on P&C dummy variable, RBC ratio difference, RBC ratio, and other control variables at the beginning of each period. Columns (1) and (5) are for stocks, (2) and (6) for speculative-grade bonds, (3) and (7) for ABS, and (4) and (8) for investment-grade bonds. Allocation refers to beginning portfolio allocation in the asset class in each column. Panel A includes all insurers with P&C insurers dummied out. Panels B and C include only life and only P&C insurers, respectively. Detailed definitions of the variables are in the Appendix. Bootstrapped standard errors, calculated using 200 repetitions, are in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Panel A: All insurance companies

	Allocation change from 2004 to 2007 (Pre-Crisis)				Allocation change from 2007 to 2010 (Crisis)			
	(1) Stock	(2) Speculative-grade bonds	(3) ABS	(4) Investment-grade bonds	(5) Stock	(6) Speculative-grade bonds	(7) ABS	(8) Investment-grade bonds
P&C dummy	0.371	-0.361***	-2.041**	5.950***	0.769	-0.605***	-2.656***	2.887**
	(0.721)	(0.113)	(0.813)	(1.340)	(0.556)	(0.212)	(0.549)	(1.148)
RBC ratio difference	0.082	0.033	-0.547**	0.727**	0.166	-0.230**	-0.683***	0.326
	(0.112)	(0.033)	(0.246)	(0.318)	(0.156)	(0.106)	(0.258)	(0.312)
RBC ratio	-0.052	-0.000	0.066	0.096	-0.054	-0.004	-0.011	0.072
	(0.034)	(0.005)	(0.057)	(0.076)	(0.035)	(0.011)	(0.036)	(0.078)
Allocation	-0.228***	-0.370***	-0.234***	-0.234***	-0.294***	-0.243***	-0.699***	-0.846***
	(0.031)	(0.050)	(0.025)	(0.025)	(0.043)	(0.061)	(0.017)	(0.033)
ln(capital and surplus)	0.319***	0.043	0.078	-1.008***	0.241**	0.132***	0.341***	0.338
	(0.123)	(0.027)	(0.161)	(0.219)	(0.122)	(0.046)	(0.110)	(0.246)
Leverage	-4.697**	0.674**	1.002	9.203***	-7.874***	0.566	2.525**	14.611***
	(1.971)	(0.308)	(2.164)	(3.421)	(1.672)	(0.574)	(1.190)	(3.046)
% risky assets	0.057***	0.004	-0.052***	-0.035	0.117***	0.006	-0.026***	-0.642***
	(0.021)	(0.002)	(0.016)	(0.033)	(0.037)	(0.005)	(0.010)	(0.034)
ROE	1.145**	0.117	-1.316	-0.502	-0.828	0.175	0.392	0.308
	(0.478)	(0.123)	(1.050)	(1.746)	(0.918)	(0.429)	(0.847)	(1.450)
Observations	1,750	1,750	1,750	1,750	1,793	1,793	1,793	1,793
Adjusted R-squared	0.103	0.199	0.090	0.153	0.095	0.022	0.667	0.487

Table 6, Cont'd: Changes in Allocation to Different Types of Risky Assets during Pre-Crisis and Crisis Periods

Panel B: Life insurance companies

	Allocation change from 2004 to 2007 (Pre-Crisis)				Allocation change from 2007 to 2010 (Crisis)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stock	Speculative -grade bonds	ABS	Investment -grade bonds	Stock	Speculative -grade bonds	ABS	Investment -grade bonds
RBC ratio difference	0.147	-0.012	-0.435*	0.580*	0.170	-0.146	-0.308	-0.145
	(0.115)	(0.039)	(0.240)	(0.309)	(0.156)	(0.094)	(0.236)	(0.306)
RBC ratio	-0.038	-0.007	0.245***	-0.218**	0.014	-0.010	-0.162**	0.007
	(0.039)	(0.012)	(0.092)	(0.110)	(0.060)	(0.017)	(0.072)	(0.090)
Allocation	-0.205***	-0.317***	-0.180***	-0.215***	-0.200***	-0.174**	-0.581***	-0.781***
	(0.070)	(0.048)	(0.040)	(0.036)	(0.059)	(0.072)	(0.038)	(0.058)
ln(capital and surplus)	-0.018	0.058	0.177	-0.849***	-0.082	0.069	0.181	0.198
	(0.135)	(0.049)	(0.250)	(0.319)	(0.139)	(0.070)	(0.225)	(0.336)
Leverage	-2.454	0.474	6.938*	-8.784	-6.545***	0.737	2.469	15.629***
	(2.612)	(0.525)	(3.683)	(6.087)	(2.408)	(0.640)	(2.280)	(4.820)
% risky assets	0.053**	-0.009*	-0.013	-0.013	0.023	-0.001	-0.041*	-0.659***
	(0.027)	(0.005)	(0.032)	(0.049)	(0.030)	(0.008)	(0.021)	(0.069)
ROE	1.257	-0.013	-1.438	-1.422	-1.949	0.585	0.639	0.111
	(0.888)	(0.323)	(1.794)	(2.650)	(1.652)	(0.603)	(1.136)	(1.835)
Observations	435	435	435	435	431	431	431	431
Adjusted R-squared	0.112	0.234	0.106	0.163	0.145	0.043	0.576	0.560
Mean allocation (%)	7.093	2.731	19.73	56.86	7.882	2.493	21.275	54.975

Table 6, Cont'd: Changes in Allocation to Different Types of Risky Assets during Pre-Crisis and Crisis Periods

Panel C: P&C insurance companies

	Allocation change from 2004 to 2007 (Pre-Crisis)				Allocation change from 2007 to 2010 (Crisis)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stock	Speculative-grade bonds	ABS	Investment-grade bonds	Stock	Speculative-grade bonds	ABS	Investment-grade bonds
RBC ratio difference	-0.502	0.145	-2.845***	5.240***	0.138	-1.389***	-2.707***	5.919**
	(0.575)	(0.126)	(0.851)	(1.339)	(0.967)	(0.524)	(0.833)	(2.472)
RBC ratio	-0.048	-0.001	0.038	0.153	-0.071*	0.017	0.053	0.006
	(0.043)	(0.007)	(0.078)	(0.110)	(0.041)	(0.018)	(0.036)	(0.126)
Allocation	-0.235***	-0.431***	-0.254***	-0.400***	-0.344***	-0.312***	-0.737***	-0.878***
	(0.037)	(0.091)	(0.030)	(0.032)	(0.051)	(0.081)	(0.019)	(0.038)
ln(capital and surplus)	0.508***	0.031	0.136	-1.168***	0.431**	0.175***	0.443***	0.342
	(0.195)	(0.032)	(0.189)	(0.293)	(0.180)	(0.051)	(0.122)	(0.335)
Leverage	-5.244**	0.648*	-1.795	17.464***	-7.478***	0.644	2.179	13.400***
	(2.053)	(0.354)	(2.650)	(4.623)	(2.192)	(0.822)	(1.477)	(4.677)
% risky assets	0.056**	0.007***	-0.068***	-0.048	0.163***	0.005	-0.031***	-0.645***
	(0.024)	(0.003)	(0.018)	(0.039)	(0.046)	(0.006)	(0.011)	(0.040)
ROE	1.233*	0.157	-1.311	-0.248	-0.694	0.120	0.341	0.281
	(0.672)	(0.158)	(1.355)	(2.014)	(1.411)	(0.707)	(1.438)	(2.782)
Observations	1,315	1,315	1,315	1,315	1,362	1,362	1,362	1,362
Adjusted R-squared	0.104	0.192	0.099	0.179	0.098	0.029	0.702	0.463
Mean allocation (%)	13.231	0.613	13.903	63.844	13.021	0.637	15.530	62.767

Table 7: Yields of Bonds Purchased during Pre-Crisis Period

This table reports OLS estimates for the regressions of yields of bonds and ABS purchased by insurance companies in 2005-2007 (Pre-Crisis) on P&C dummy variable, RBC ratio difference, RBC ratio, dummy variable for the domicile states in which an average company marks to market speculative-grade bonds more frequently than the across-state median, and other bond-specific and company-specific control variables. Only bonds rated in the A to AAA categories (NAIC category 1) and with maturities between 2 and 15 years are included. Bond yields are calculated from purchase prices and are winsorized at 2.5th and 97.5th percentiles. Columns (1)-(3) include all insurance companies with P&C companies dummied out. Columns (4)-(5) include only life companies. Columns (6)-(7) include only P&C companies. Detailed definitions of the variables are in the Appendix. Standard errors, clustered by insurance company-calendar quarter, are in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Table 7' Cont'd: Yields of Bonds Purchased during Pre-Crisis Period

	(1) All	(2) All	(3) All	(4) Life	(5) Life	(6) P&C	(7) P&C
Main Variables							
P&C dummy	-0.264***	-0.150***	-0.121***				
	(0.016)	(0.014)	(0.020)				
RBC ratio difference			-0.013**	-0.011*	-0.010*	0.036	0.031
			(0.006)	(0.006)	(0.006)	(0.049)	(0.048)
RBC ratio			-0.002	0.001	0.002	-0.006*	-0.006*
			(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
High mark-to-market state dummy					-0.048**		-0.046*
					(0.020)		(0.025)
Bond Controls							
ln(maturity)		0.460***	0.459***	0.456***	0.457***	0.456***	0.454***
		(0.013)	(0.013)	(0.018)	(0.018)	(0.018)	(0.018)
ln(issue size)		-0.153***	-0.153***	-0.125***	-0.124***	-0.166***	-0.166***
		(0.009)	(0.009)	(0.017)	(0.017)	(0.009)	(0.009)
Insurance Company Controls							
ln(capital and surplus)			0.003	-0.026**	-0.026**	0.020***	0.021***
			(0.005)	(0.011)	(0.011)	(0.005)	(0.005)
Leverage			0.160***	0.523***	0.514***	-0.060	-0.072
			(0.058)	(0.124)	(0.122)	(0.078)	(0.079)
% risky assets			-0.000	0.004**	0.004**	-0.002***	-0.002***
			(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
ROE			-0.016	0.053	0.047	-0.024	-0.025
			(0.029)	(0.057)	(0.056)	(0.033)	(0.033)
Calendar quarter fixed effects	YES	YES	YES	YES	YES	YES	YES
Observations	48,192	48,192	47,849	21,269	21,269	26,580	26,580
Adjusted R-squared	0.186	0.285	0.287	0.301	0.302	0.259	0.259

Table 8: Betas and Amihud Ratios of Stocks Purchased during Pre-Crisis Period

This table reports OLS estimates for the regressions of betas and Amihud ratios of stocks purchased by insurance companies in 2005-2007 on P&C dummy variable, RBC ratio difference, RBC ratio, and other company-specific control variables. In columns (1)-(3), the dependent variables are stock betas. For each stock-quarter, beta is estimated by regressing the stock's daily return on CRSP value-weighted market return over a 2-year window up to the current-quarter end. A minimum of 60 trading days in the estimation window are required. In columns (4)-(6), the dependent variables are Amihud ratios x 100. For each stock-quarter, Amihud ratio is the average daily Amihud ratio over the quarter, where the daily Amihud ratio is calculated as |return|/(volume x closing price/1,000,000). A minimum of 22 trading days in the estimation window are required. Columns (1) and (4) include all insurance companies with P&C companies dummied out. Columns (2) and (5) include only life companies. Columns (3) and (6) include only P&C companies. Detailed definitions of the variables are in the Appendix. Standard errors, clustered by insurance company-calendar quarter, are in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	Stock beta			Amihud ratio x 100		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Life	P&C	All	Life	P&C
Main Variables						
P&C dummy	0.022**			0.047***		
	(0.009)			(0.009)		
RBC ratio difference	0.000	-0.006	0.023*	0.010	0.014*	-0.007
	(0.005)	(0.005)	(0.013)	(0.006)	(0.008)	(0.014)
RBC ratio	0.006***	0.004***	0.006***	0.005***	0.002	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Insurance Company Controls						
ln(capital and surplus)	0.011***	0.012***	0.009***	0.003**	0.005	0.003*
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
Leverage	0.100***	0.098**	0.098***	0.251***	0.215***	0.237***
	(0.028)	(0.046)	(0.031)	(0.025)	(0.054)	(0.030)
% risky assets	0.001**	0.002***	0.000**	0.001***	0.002***	0.001***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
ROE	0.004	0.169**	-0.003	0.017	0.018	0.017
	(0.009)	(0.080)	(0.009)	(0.017)	(0.105)	(0.017)
Calendar quarter fixed effects	YES	YES	YES	YES	YES	YES
Observations	220,426	54,559	165,867	221,535	54,932	166,603
Adjusted R-squared	0.0110	0.0134	0.0105	0.0279	0.0369	0.0191

Panel A:Unrealized Gains as % of RBC

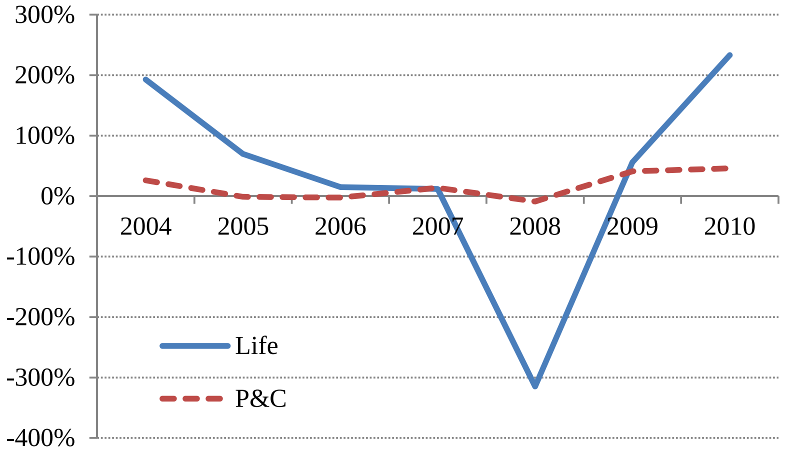
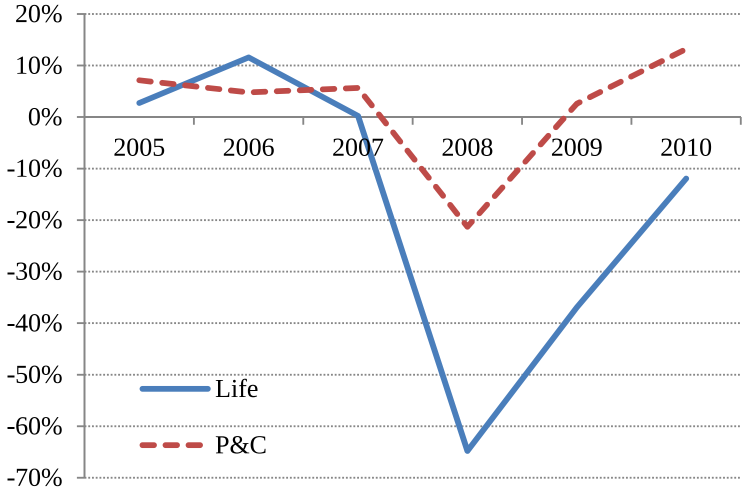


Figure 1: Average Unrealized Gains, Realized Gains, and OTTI over Time for Life vs. P&C Companies.

This figure plots time series of average unrealized gains (Panel A), average realized gains (Panel B), and average Other-Than-Temporary Impairment (OTTI) (Panel C), all presented as percentage of risk-based capital (RBC). The solid blue (dashed red) line is for life (P&C) companies.

Panel B: Realized Gains as % of RBC



Panel C: OTTI as % of RBC

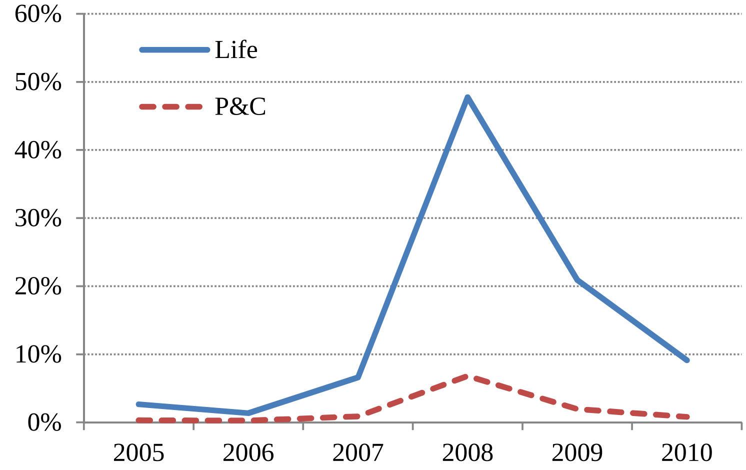
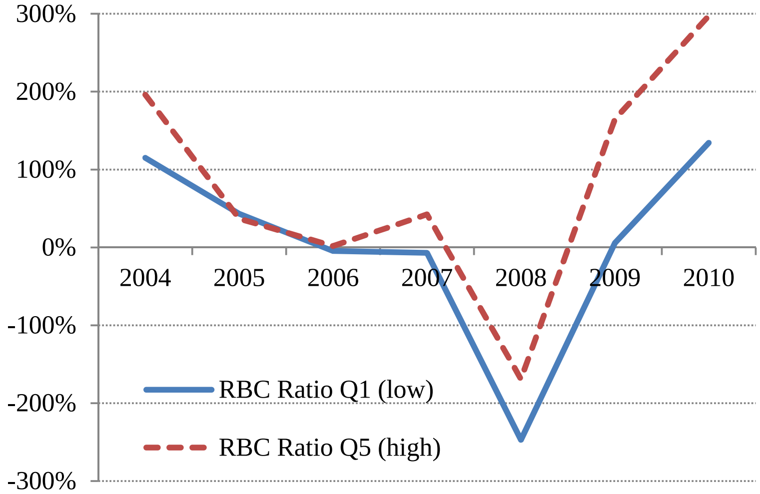


Figure 1, Cont'd: Average Unrealized Gains, Realized Gains, and OTTI over Time for Life vs. P&C Companies.

Panel A: Unrealized Gains as % of RBC



Panel B: Unrealized Gains as % of RBC

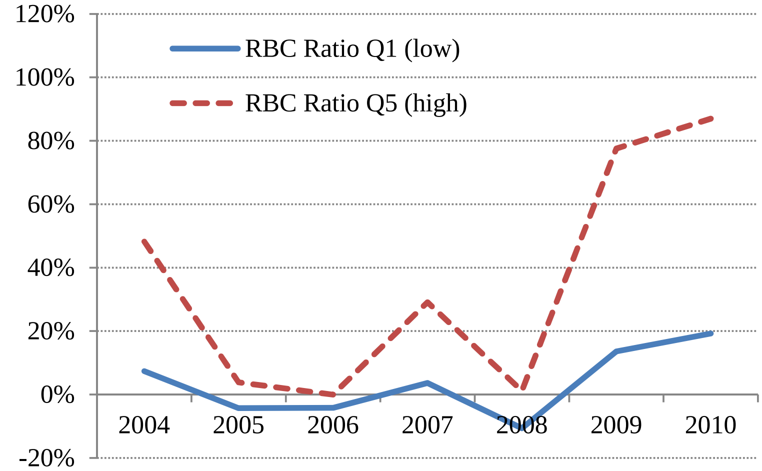


Figure 2: Average Unrealized Gains over Time for Insurance Companies with High vs. Low RBC Ratios.

This figure plots time series of average unrealized gains as percentage of RBC for life (Panel A) and P&C (Panel B) insurance companies that are in the highest (Q5) (dashed red line) and lowest (Q1) (solid blue line) quintiles of RBC ratio.

Panel A: Asset-Backed Securities (ABS)

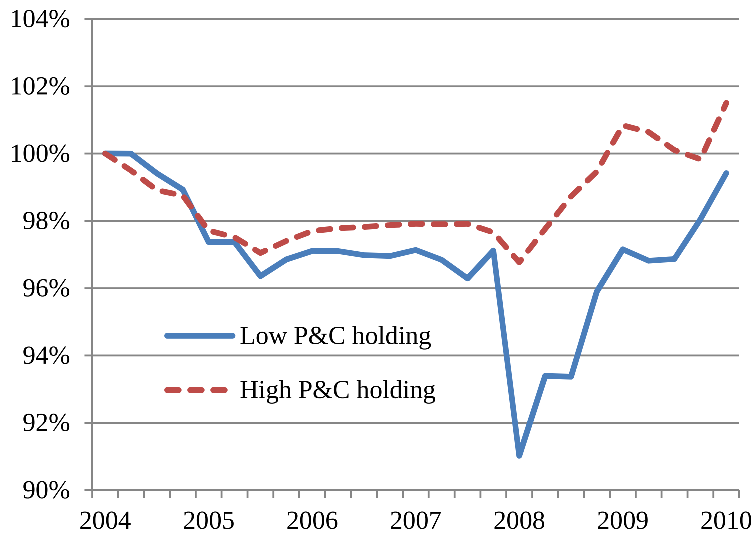
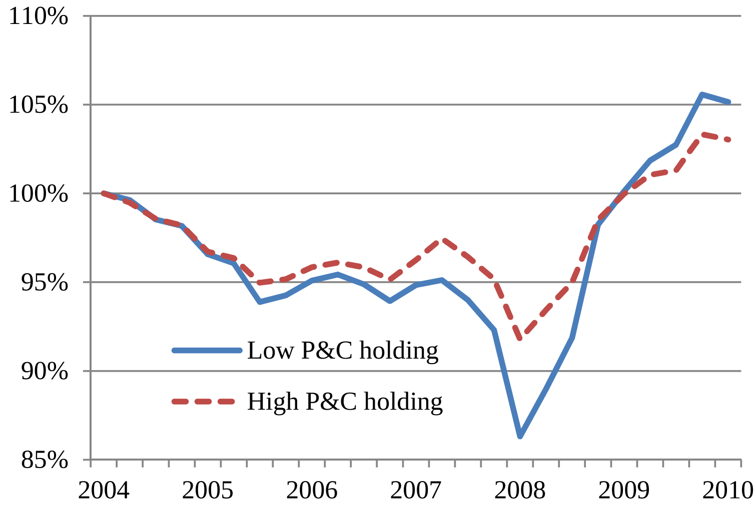


Figure 3: Price Performance of Bonds with High vs. Low Holding by P&C Companies.

This figure plots time series of quarterly price index for bonds with above-median holding by P&C companies (blue line) and below-median holding by P&C companies (red line). Panel A is for ABS, Panel B is for corporate bonds, and Panel C is for all speculative-grade bonds with rating better than CCC. The sample includes only bonds that are held by at least 2 insurance companies and have maturity 10 years or lower. At the beginning of *each year* (end of previous year), we calculate P&C companies' holding for *each bond* as the total par value of the bond that is held by P&C companies divided by the total par value of the bond that is held by all insurance companies (life and P&C). For *each year* and *each bond type* (ABS, corporate bonds, or speculative-grade bonds), we then determine the median of P&C holding and use it to split bonds (in that year and that bond type) into two equal groups—high and low P&C holdings. Each bond's return is tracked over the course of the year as the bond is transacted during the year or its fair value is reported at the end of the year. If there is more than one price reported for the bond on each day, the median of all reported price is used. The index is then calculated as the median of bond returns in each group (high vs. low P&C holding) and each type (ABS, corporate bonds, or speculative-grade bonds). Each index is normalized to 100% at the end of 2004.

Panel B: Corporate Bonds



Panel C: Speculative-Grade Bonds with Rating Better than CCC

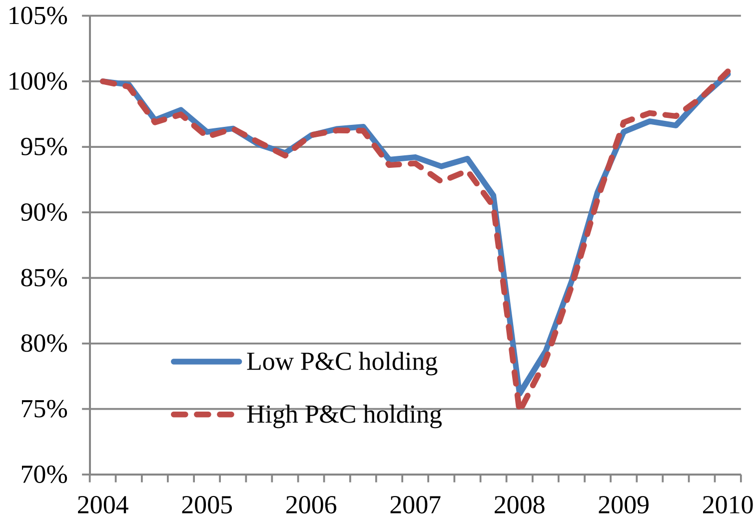


Figure 3, Cont'd: Price Performance of Bonds with High vs. Low Holding by P&C Companies.

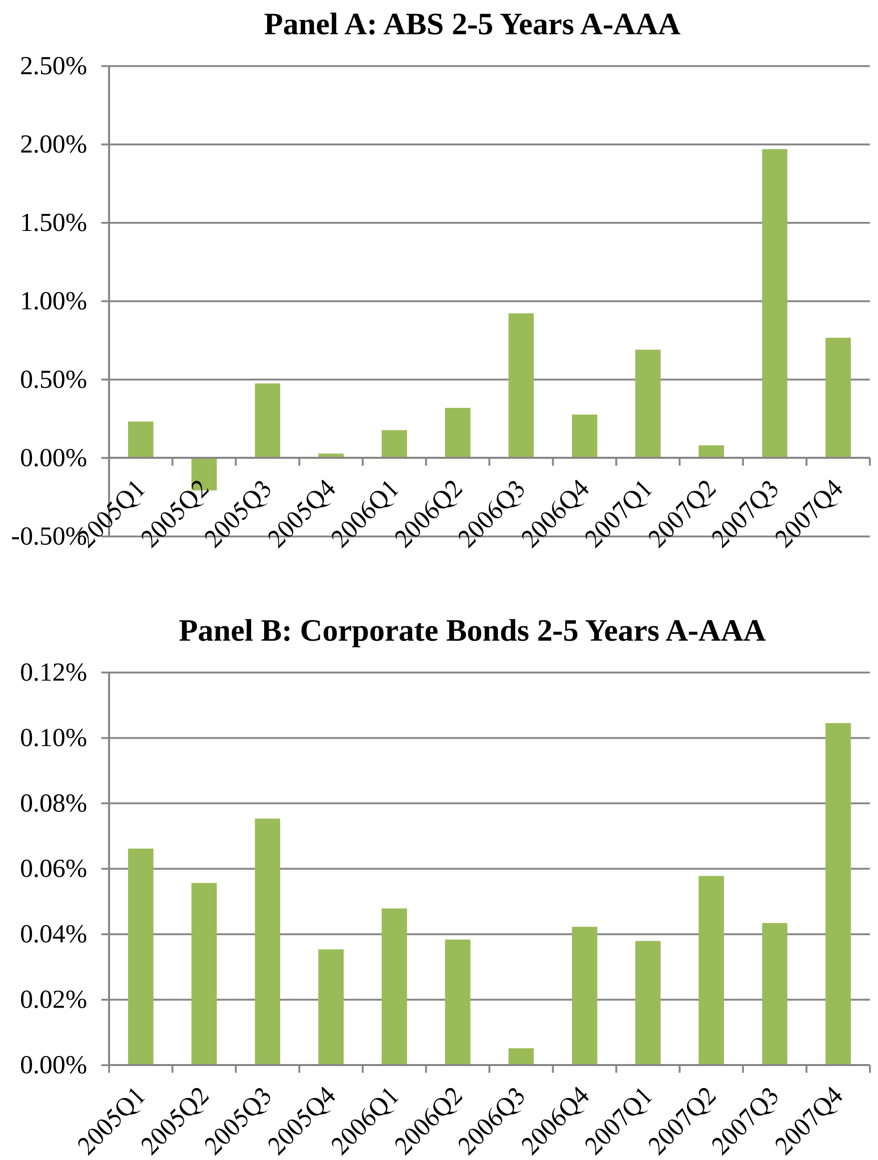


Figure 4: Difference in Yields for Bonds Purchased by Life vs. P&C Companies.

This figure plots time series of difference in median yields for all bonds purchased in each calendar quarter by life vs. P&C companies (life minus P&C). Only bonds rated in the A to AAA categories (NAIC category 1) and with maturities between 2 and 5 years are included. Panel A is for ABS and Panel B is for corporate bonds.

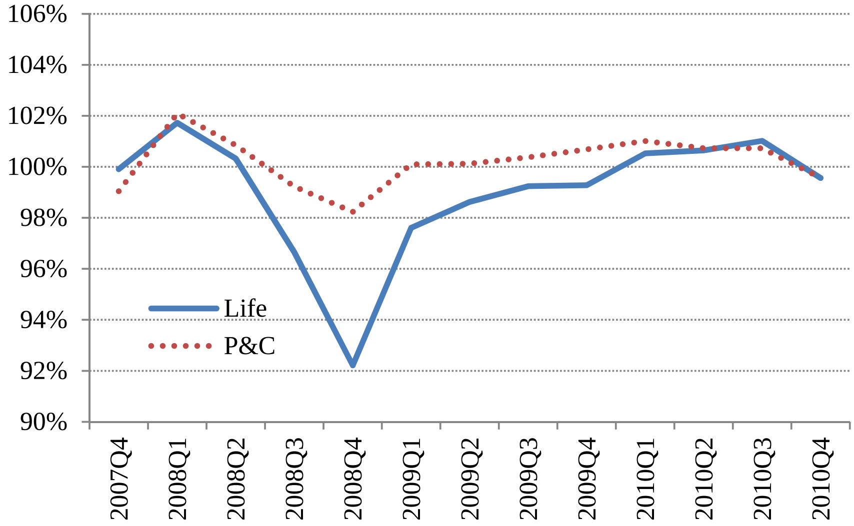


Figure 5: Price Performance of Bond Portfolios of Life vs. P&C Firms.

This figure plots time series of quarterly (value weighted) price index for portfolio of bonds held by life insurance companies (blue line) and P&C insurance companies (red line) at the end of 2007. Only bonds rated in the A to AAA categories (NAIC category 1) and with maturities between 2 and 5 years are included. For each bond, the price in each quarter is calculated as the median of all transactions that occur in the quarter and the price index is calculated by dividing the quarterly price by the price in the last quarter of 2007. The portfolio price index is the weighted sum of individual bond price indices where the weight is the portfolio allocation in each bond by each group of insurance companies.