Mark-to-market

SUMMARY

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 US 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 US states. 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.

—*Andrew Ellul, Chotibhak Jotikasthira, Christian T. Lundblad and Yihui Wang*

Mark-to-market accounting and systemic risk: evidence from the insurance industry

Andrew Ellul, Chotibhak Jotikasthira, Christian T. Lundblad and Yihui Wang

Indiana University, CSEF and ECGI; University of North Carolina; University of North Carolina; Fordham University

1. INTRODUCTION

One of the most contentious issues raised during the recent financial crisis – from, among others, the European Commission, the US 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 US 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 *et al.* (2008), and Sapra (2008)) argues that the specific nature of MTM accounting leads to *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, 2004), 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 favour of HCA is predicated on presumed MTM implementation shortfalls, due primarily to

---

[1] This sentiment was echoed by many sectors in the US. CFO.com on 29 October 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' (Katz, 2008).

[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 12 January 2009, FAS 115-2, FAS 157-4, and FAS 124-2 on 9 April 2009.

[3] On 3 October 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 EU level (see Hall and Tait, 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.

financial prices that may depart from fundamental values arising from various market frictions.

In contrast, Bleck and Liu (2007) 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 this paper we explore whether, and in what way, accounting rules, through their interaction with capital regulations, are associated with the build-up 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 behaviour, 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.

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 *et al.*, 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.

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.

We use the US 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

---

[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 behaviour of insurers in the years *before* the crisis, where tail risk is potential accumulated.

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

asset under HCA except in 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 not only use a *between-insurance-type* analysis but we also carry out 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 US 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 information used 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 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

---

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

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 policymakers 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 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 *et al.* (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 a 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' behaviour, documented by Becker and Ivashina (2014), 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.

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.

---

[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.

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 US states* in the application of the NAIC's prescribed accounting rules. Our analysis shows that life insurers from US 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 behaviour 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 policymakers 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 build-up 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 versus 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 and 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 US 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.

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 unfavourable 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.

While the mechanisms shown above explain financial institutions' behaviour 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 *et al.*, 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[a]
Impact on regulatory (risk-weighted) capital	Increase	Increase
Impact on statutory (equity) capital	Immediate decrease	No impact[a]
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	Selling downgraded asset at heavy price discount lowers statutory capital. 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

[a]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

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 US 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 US is formally 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 domiciled in 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

---

[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.

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 US 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 US 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 US 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.

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. 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.[14] 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.

---

[12] This is a proprietary dataset. Further details of the NAIC data can be found in Ellul *et al.* (2011).

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

[14] 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.

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.

Table 1.   Summary statistics of insurance companies

	Mean	Std. dev.	Min.	10th Pct	50th Pct	90th Pct	Max.
Panel A: Life firms							
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: Property and casualty firms							
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	−19.82	0.00	11.86	42.14	95.28

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

Source: Weiss Ratings. Authors' calculation for holdings of risky assets by summing all asset holdings with capital requirement greater than or equal to Class 3 bonds.

At the end of 2007, we have complete financial information for 1,499 P&C compan-
ies 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), com-
pared 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 sim-
ilar, 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 down-
grades 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, profit-
ability, 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 profit-
ability and liquidity (not tabulated). The similarity between the two groups on various
aspects of the financial conditions shows that there is no significant systematic differ-
ence and the two groups are quite comparable in their financial circumstances. This
said, there are obvious business differences with regards to the types of insurance con-
tracts 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 cap-
ital 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 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 US 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 US 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 behaviour. 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.

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 2004–10. 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.

Table 2. Cross-sectional distribution of RBC ratios over time

Year	Reported RBC ratio							Market-adjusted RBC ratio							Correlations		Overlap
	Mean	Std. Dev.	1st Pct	5th Pct	10th Pct	50th Pct	90th Pct	Mean	Std. Dev.	1st Pct	5th Pct	10th Pct	50th Pct	90th Pct	Pearson	Spearman	in bottom 5%
Panel A: Life firms																	
2004	11.2	8.2	2.1	3.9	4.6	8.5	21.8	13.1	8.4	2.4	4.3	5.5	10.9	23.8	0.97	0.94	0.68
2005	11.2	7.7	1.9	4.1	5.0	8.7	21.7	11.9	7.7	1.9	4.1	5.1	9.7	22.2	0.98	0.96	0.73
2006	11.5	7.9	2.5	3.9	4.8	9.0	21.7	11.6	7.9	2.2	3.8	4.9	9.3	21.5	0.99	0.97	0.82
2007	11.6	8.1	1.9	3.8	4.5	9.1	21.4	11.7	8.4	1.7	3.4	4.5	9.2	21.3	0.99	0.98	0.70
2008	11.3	8.9	1.0	3.3	4.2	8.2	21.7	8.2	10.3	-8.6	-3.7	-1.0	5.6	21.3	0.92	0.76	0.17
2009	11.3	7.9	0.9	3.4	4.5	9.0	21.0	11.9	8.6	0.4	3.0	4.0	9.6	23.1	0.98	0.94	0.61
2010	11.9	8.2	2.8	4.0	5.1	9.5	21.4	14.2	9.0	3.0	5.0	5.9	12.1	24.3	0.96	0.93	0.70
Panel B: P&C firms																	
2004	8.7	7.1	0.8	2.3	3.0	6.7	16.5	9.0	7.3	0.8	2.3	3.1	7.0	16.9	1.00	1.00	0.94
2005	9.4	7.6	1.0	2.5	3.3	7.4	18.3	9.4	7.6	1.0	2.4	3.2	7.4	18.5	1.00	1.00	1.00
2006	10.1	7.8	1.4	2.8	3.7	7.9	19.4	10.1	7.8	1.1	2.7	3.6	7.8	19.3	1.00	1.00	0.95
2007	10.3	7.6	1.4	2.9	3.9	8.1	18.6	10.5	7.7	1.4	2.9	3.9	8.3	18.9	1.00	1.00	0.97
2008	10.6	8.1	1.2	2.8	3.8	8.2	20.2	10.5	8.1	1.1	2.8	3.6	8.1	19.9	1.00	0.99	0.92
2009	11.0	8.3	1.1	2.9	4.0	8.7	21.3	11.5	8.6	1.1	2.9	4.1	9.0	22.0	1.00	1.00	0.97
2010	11.2	8.7	1.3	3.0	3.9	8.6	21.4	11.7	9.0	1.4	3.2	4.1	9.0	22.0	1.00	1.00	0.94

Notes: 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. 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.

Source: Reported RBC ratios from Weiss Ratings. Authors' calculation of market-adjusted RBC ratios by adding unrealized gains and losses on all securities held at historical costs to the (adjusted) statutory capital, the numerator of RBC ratio.

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 behaviour 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 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 structures, life and P&C insurers naturally hold different portfolios. We will show below that even after controlling for these effects and, more importantly, using the within-insurance-type 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 analyse 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 2004–10 time period in Figure 1.

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 followed by a significant
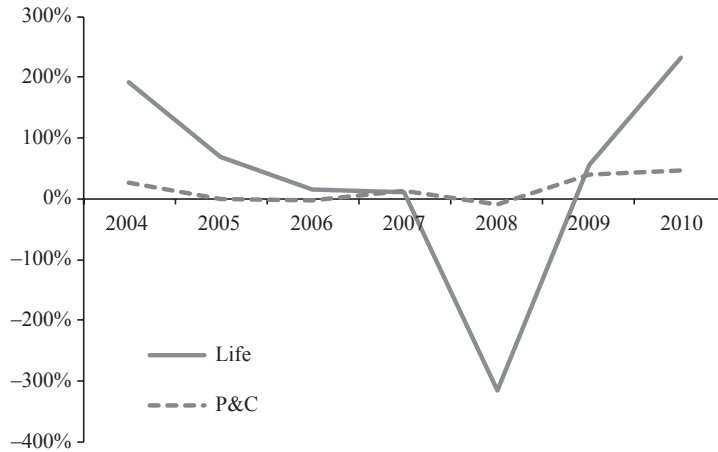
Figure 1. Average total unrealized gains as percentage of RBC for life versus P&C firms

Notes:This figure plots time series of average total unrealized gains as a percentage of risk-based capital (RBC). The solid line is for life insurance companies and the dashed line for P&C companies.

Source: Authors' calculation of unrealized gains based on NAIC Schedule D's position data. RBC from Weiss Ratings.

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 would have become technically insolvent in 2008 had market values been fully recognized. These differences between P&C and life insurers suggest 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, one should nevertheless ask why it is that P&C insurers did not experience the same significant magnitude of losses 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. The first potential response by insurers 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. In unreported results, we find that 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.

The second potential response by insurers is to recognize losses in the balance sheet via OTTIs. In unreported results, we find that 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. A striking picture emerges when putting together the evidence so far. 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.

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.

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

Table 3. Predicting future RBC ratio with current market-adjusted RBC ratio

	(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	0.059	0.063	0.022	0.030

Notes: 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 includes 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.

deviation increase in the ratio difference (0.929) is associated with an increase of 0.27 [= 0.929 × 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.[15]

In unreported results 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 $t + 3$).[16] The effect of the RBC ratio difference on the probability that future reported

---

[15] It is well known that dynamic panel regressions with lagged dependent variable and fixed effects can result in biased estimates. To gauge the extent of this problem, we perform a two-step Blundell and Bond (1998) system GMM using STATA procedure 'xtdpdsys'. The results for one-period predictive models, using various sets of instruments, 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.

[16] 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 US states that utilize trend tests on various solvency ratios, the first threshold for regulatory actions is 3.

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.

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.

4.3. Portfolio adjustments and price impacts

The results so far call for a deeper analysis of the selling behaviour of life and P&C insurers during the crisis. It is precisely through the selling activity, which 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.

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 4 reports the proportion of companies that reduce positions in a bond within 3 months following an observed price decline of 20% or greater.

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 versus P&C insurance companies (Panel A) and for positions that are held at HCA versus 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

Table 4.   **Propensity to sell upon large price decline**

Year	2005	2006	2007	2008	2009	2010
Panel A: Life vs. P&C firms						
ABS						
Life (%)	0.0	0.0	3.3	4.5	9.4	7.2
P&C (%)	7.0	10.5	2.5	6.3	9.8	7.7
P&C – Life (%)	7.0	10.5	−0.8	1.8	0.5	0.5
t-statistic	(2.562)	(3.325)	(−0.672)	(4.810)	(0.727)	(0.657)
Corporate bonds						
Life (%)	11.6	11.4	11.9	9.9	13.5	5.7
P&C (%)	9.6	24.7	12.3	11.7	15.4	6.9
P&C – Life	−2.0	13.4	0.4	1.9	1.9	1.2
t-statistic	(−2.863)	(10.711)	(0.472)	(9.784)	(4.855)	(2.738)
Panel B: Positions held at market values vs. historical costs						
ABS						
HCA (%)	3.0	4.9	2.2	4.8	8.6	7.3
MTM (%)	9.1	0.0	3.6	7.6	12.8	7.5
MTM – HCA (%)	6.1	−4.9	1.4	2.8	4.2	0.2
t-statistic	(1.724)	(−2.265)	(1.269)	(7.106)	(6.478)	(0.228)
Corporate bonds						
HCA (%)	10.4	16.1	10.9	9.4	12.7	6.0
MTM (%)	12.0	19.8	14.9	13.2	18.5	7.5
MTM – HCA (%)	1.7	3.7	4.1	3.8	5.8	1.4
t-statistic	(2.513)	(3.182)	(4.834)	(20.437)	(14.767)	(3.166)

Notes: This table reports the 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 two 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). *t*-statistics for the tests of difference in proportion are in parentheses.

positions compared to life insurers (4.5%) in 2008 conditional on the observed price decline. The same behaviour occurs when we investigate the selling behaviour of corporate bonds.[17] This evidence is consistent with Allen and Carletti (2008) and Plantin *et al.* (2008) as far as the financial crisis is concerned. Of equal importance, however, is the behaviour 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

---

[17] 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.

Table 5. Changes in allocation to different types of assets during pre-crisis and crisis periods

	Allocation change from 2004 to 2007 (pre-crisis)				Allocation change from 2007 to 2010 (crisis)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Stock	Spec.-grade bonds	ABS	Inv.-grade bonds	Stock	Spec.-grade bonds	ABS	Inv.-grade bonds
Panel A: All insurance firms								
P&C dummy	0.371	−0.361***	−2.041**	5.950***	0.769	−0.605***	−2.656***	2.887**
	(0.767)	(0.118)	(0.838)	(1.197)	(0.575)	(0.215)	(0.504)	(1.183)
RBC ratio difference	0.082	0.033	−0.547**	0.727**	0.166	−0.230*	−0.683***	0.326
	(0.111)	(0.036)	(0.242)	(0.293)	(0.162)	(0.119)	(0.248)	(0.311)
RBC ratio	−0.052	−0.000	0.066	0.096	−0.054	−0.004	−0.011	0.072
	(0.034)	(0.005)	(0.056)	(0.076)	(0.034)	(0.011)	(0.033)	(0.083)
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
Panel B: Life firms								
RBC ratio difference	0.147	−0.012	−0.435*	0.580**	0.170	−0.146	−0.308	−0.145
	(0.119)	(0.040)	(0.259)	(0.289)	(0.169)	(0.097)	(0.239)	(0.289)
RBC ratio	−0.038	−0.007	0.245**	−0.218*	0.014	−0.010	−0.162**	0.007
	(0.044)	(0.011)	(0.097)	(0.115)	(0.059)	(0.018)	(0.075)	(0.090)
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
Panel C: P&C firms								
RBC ratio difference	−0.502	0.145	−2.845***	5.240***	0.138	−1.389***	−2.707***	5.919**
	(0.534)	(0.112)	(0.872)	(1.327)	(0.897)	(0.534)	(0.838)	(2.374)
RBC ratio	−0.048	−0.001	0.038	0.153	−0.071*	0.017	0.053	0.006
	(0.042)	(0.007)	(0.080)	(0.112)	(0.043)	(0.017)	(0.037)	(0.120)
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	15.53	62.767

Note: 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. The control variables included in all the regressions but not reported are ln(capital and surplus), Leverage, % risky assets, ROE, and Allocation, which is the beginning portfolio allocation in the asset class. 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. Panel A includes all insurers with P&C insurers dummied out. Panels B and C include only life and only P&C insurers, respectively. The average allocation to each asset class among life and P&C firms are reported in the last raw of Panel B and Panel C, respectively. Detailed definitions of the variables are in the Appendix. Bootstrapped standard errors, calculated using 1,000 repetitions, are in parentheses.

*, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

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 behaviour is again quite similar for firms facing MTM accounting on such assets.

We investigate further the general trading behaviour 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 introducing the P&C indicator to distinguish between the selling behaviour 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 5 reports OLS estimates for cross-sectional regressions of portfolio allocation changes (in per cent) 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.[18]

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 insurers 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 differ-

---

[18] We carry out the analysis over shorter time horizons, i.e. one and two years. The results are qualitatively similar to those in Table 5, which are obtained over a three-year horizon.

ence had a statistically and economically significant effect on the allocation of specu-lative-grade bonds and ABS. This is an important result. Speculative-grade bonds and ABS in general suffered larger price declines and became much riskier com-pared to investment-grade bonds during the crisis period. Given this information, a reasonable response by a financial institution that wanted to maintain the risk–reward trade-off of its portfolio at similar levels should have been to reduce pre-cisely 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 behaviour across insurer types, in Panel B and C we investigate these differences, separately, *within* insurer type. 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 the others.[19] The same results are found for P&C insurers, as shown in Panel C. All these results are obtained within each insurer type and after controlling for, amongst other things, the portfolio's initial alloca-tion[20] 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 consid-ered 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 behaviour 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 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

---

[19] For life insurers, it is also important to note that our results are significant despite the sample that is sig-nificantly smaller than that of P&C insurers, which could limit the power of our tests.
[20] 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.

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 2.

Figure 2 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.[21] 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 analysed, 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 analyse the price dynamics of corporate bonds shown in Panel B. When we extend the analysis for all speculative-grade bonds with a rating better than CCC, shown in Panel C, we find that both groups of assets experienced the same magnitude of price declines.

The picture that emerges from the evidence in Figure 2 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 4 and 5 and Figure 2, 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, 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).

---

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

Panel A: Asset-Backed Securities (ABS)

Panel B: Corporate Bonds

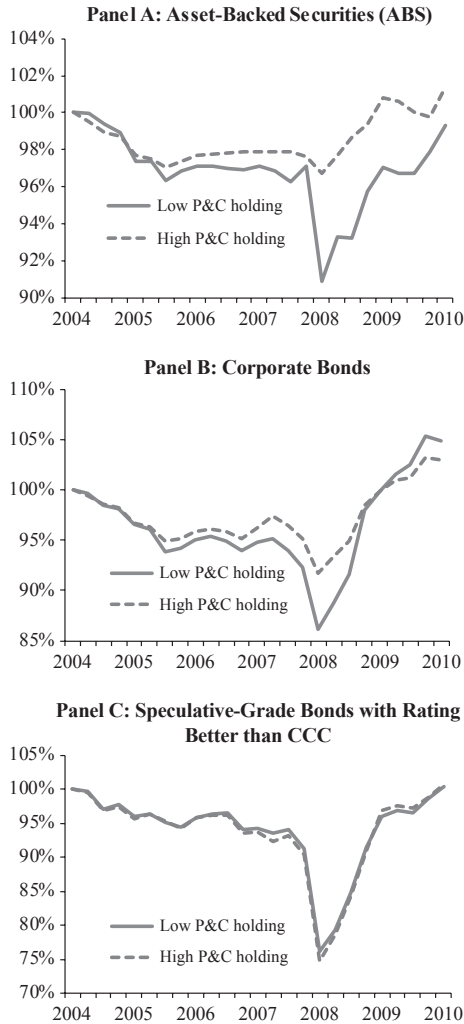**Panel C: Speculative-Grade Bonds with Rating Better than CCC**

Figure 2. Price performance of bonds with high vs. low holding by P&C firms

Notes: This figure plots time series of quarterly price index for bonds with above-median holding by P&C firms (solid line) and below-median holding by P&C firms (dashed 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 insurers and have maturity 10 years or lower. At the beginning of each year (end of previous year), P&C firms' holding for each bond is calculated 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 insurers (life and P&C). For each year and each bond type (ABS, corporate bonds, or speculative-grade bonds), the median of P&C holding is then determined and used in splitting the 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.

Source: Authors' calculation based on NAIC Schedule D's position and transaction data.

4.4. Reaching for yield

Many have argued that the pre-crisis period was characterized by excessive risk taking behaviour and 'reaching-for-yield' investment decisions that aimed at regulatory arbitrage (Rajan, 2010 and Yellen, 2011, among many others).[22] 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 behaviour 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' behaviour 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.

In Figure 3, 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 require-ment 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, for example 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 Bec-ker and Ivashina (2014) but applied to our environment and our research question by focusing on the differences between two insurance groups associated with differ-ent 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 3: in all quarters over the 2005 to 2007 time period except one, life insur-ance companies purchased ABS that had higher yields than those purchased by P&C.

---

[22] 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' (p. 184).
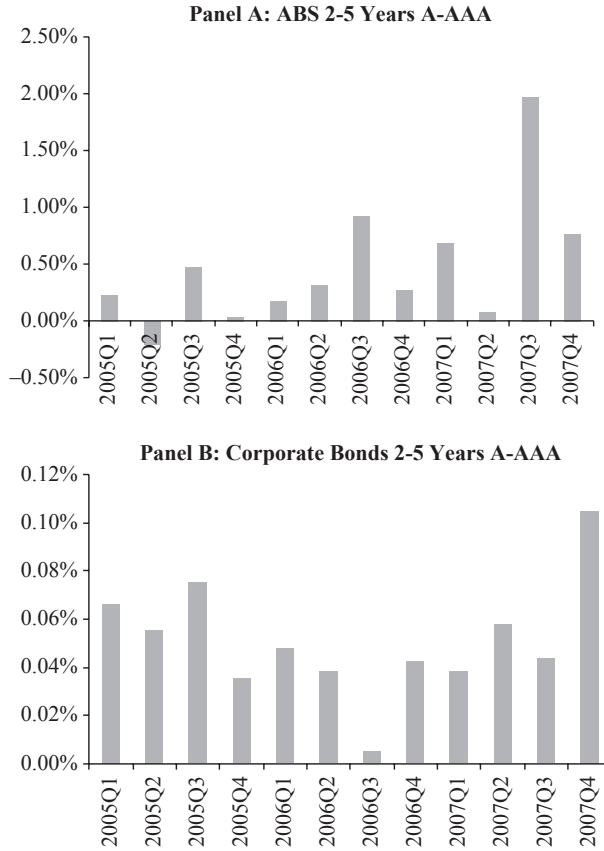
Panel A: ABS 2-5 Years A-AAA

Panel B: Corporate Bonds 2-5 Years A-AAA

Figure 3. Difference in yields for bonds purchased by life versus P&C firms

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

Source: Authors' calculation based on NAIC Schedule D's position and transaction data.

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 behaviour 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 6.

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

Table 6. 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			−0.013**	−0.011*	−0.010*	0.036	0.031
ratio difference			(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-					−0.048**		−0.046*
market					(0.020)		(0.025)
state dummy							
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			0.003	−0.026**	−0.026**	0.020***	0.021***
and surplus)			(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	Yes	Yes	Yes	Yes	Yes	Yes	Yes
quarter fixed							
effects							
Observations	48,192	48,192	47,849	21,269	21,269	26,580	26,580
Adjusted	0.186	0.285	0.287	0.301	0.302	0.259	0.259
R-squared							

Note: 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 class 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 insurers with P&C firms dummied out. Columns (4)–(5) include only life firms. Columns (6)–(7) include only P&C firms. 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.

Source: Weiss Ratings. Authors' calculation of yields using NAIC Schedule D's transaction data.

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 Figure 3. 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 US 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 US 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 US 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 behaviour 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. In untabulated results we find that, after controlling for insurance-level controls and calendar-quarter fixed effects, P&C insurers invest in stocks with higher betas and lower liquidity (measured using the Amihud measure) compared to life insurers.

A critical implication of the results shown in Figure 3 and Table 6 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 4 which plots the time series of quarterly (value weighted) price indices for portfolios of bonds held by life and P&C insur-
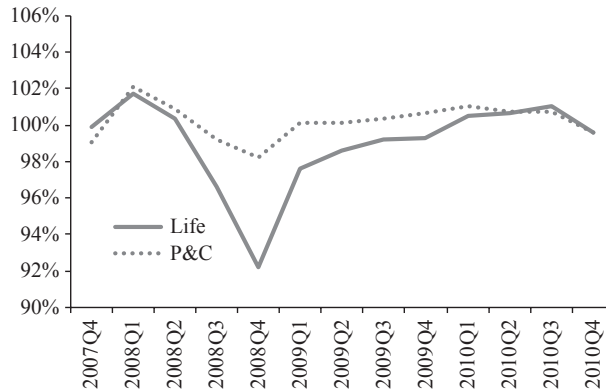
Figure 4. **Price performance of bond portfolios of life versus P&C firms during crisis period**

Notes: This figure plots time series of quarterly (value weighted) price index for portfolio of bonds held by life firms (solid line) and P&C firms (dashed line) at the end of 2007. Only bonds rated in the A to AAA categories (NAIC class 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 insurers.

Source: Authors' calculation based on NAIC Schedule D's position and transaction data.

ance companies at the end of 2007. 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.

The results shown in Figure 4 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 policymakers 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. Policymakers can address this problem either by changing the accounting system, to provide some level of flexibility during a financial crisis, or through prudential regulation. Changing the accounting system is very challenging due to the trade-off between relevance and reliability of information (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; 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 behaviour, 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 policymakers. 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.'

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*, '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' (Braithwaite, 2011).

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 findings are broadly consistent with the recent literature that investigates questions related to ours using data from the US banking sector (Bhat *et al.*, 2011; Badertscher *et al.*, 2012; Bowen *et al.*, 2010; 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. Badertscher *et al.* (2012) find no support for claims that the fair value provisions of US accounting rules significantly depleted regulatory capital or caused pro-cyclical selling of securities. Due to the importance of the MTM versus 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.

Our results should not be interpreted in an absolute sense that the interaction between accounting and capital regulations is the only driver of the banking industry's risk accumulation prior to the crisis. For banks, in particular, other institutional aspects, such as the presence of an institution that acts as a lender of last resort and the 'too big to fail' and 'too many to fail' concepts of banking regulations, may also matter. Existing theoretical and empirical literature has already established the link between these regulatory structures and (higher) risk-taking behaviour in the banking industry. It is thus clear that the channel which is our focus in this paper, that is, the interactions between accounting rules and regulatory capital requirements, is *one* of a few important channels that influence financial institutions' risk-taking behaviour and ultimately systemic risk of the financial system.

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 build-up 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.

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.

Discussion

Isabel Schnabel

Johannes Gutenberg University Mainz

This paper contributes to the important debate on whether fair-value accounting raises risks in the financial sector and whether in turn the reliance on historical cost accounting may stabilize financial systems. The paper exploits an interesting institutional feature of the US insurance industry: different types of insurers are subject to different types of accounting rules. The authors exploit this institutional variation in order to identify the causal effects of accounting rules. Specifically, the authors compare the performance, risk and investment behaviour of life insurance companies, which are subject to historical cost accounting (HCA), with property and casualty (P&C) insurers, which are subject to market-to-market (MTM) accounting rules, before and during the financial crisis. Moreover, the authors conduct a within-insurance type analysis for each group of insurers. The study is based on a detailed data set containing information about individual portfolio positions and trading transactions, including a pre-crisis (2004–2007) and a crisis (2007–2010) period.

The authors set up two main hypotheses that are then tested in the following empirical analysis. The first hypothesis states that MTM firms are more likely to sell assets that experienced a negative price shock than HCA firms. The reason is that the selling of risky assets is likely to set free capital for MTM firms whereas HCA firms prefer selling assets with unrealized gains (gains trading). The second hypothesis states that MTM firms invest in less risky assets than HCA firms because they anticipate the danger of fire sales in a crisis. In contrast, HCA firms care less about fire sale effects and

are thus more likely to search for yield (i.e., invest in assets with higher returns but the same regulatory risk weights). The authors argue that the risk-reducing effect from *ex-ante* incentives may even overcompensate the negative effects from fire sale externalities.

In the empirical analysis, both hypotheses are confirmed. MTM firms are indeed more likely to sell assets that experienced a negative price shock than HCA firms. However, MTM firms also appear to invest in less risky assets than HCA firms and to be less subject to 'search for yield' strategies. While the first result confirms conventional wisdom, the second result is noteworthy and interesting. It also has important policy implications. Whereas most of the literature has stressed the destabilizing effect of mark-to-market accounting, the second result suggests that there may be a counter-vailing stabilizing effect. This leads the authors to conclude that the role of MTM in amplifying the financial crisis may have been overstated.

This is an interesting and important paper. It asks a highly relevant question and finds striking results with strong implications for economic policy. I would like to discuss two issues: (1) the plausibility of the *ex-ante* incentive effect, and (2) the identification strategy and interpretation of results.

Plausibility of *ex-ante* incentive effect

The paper presents a number of results suggesting that firms subject to MTM accounting may take fewer risks *ex ante* by investing less into assets that were subject to fire sales in the crisis and by reaching less for yield. The authors rationalize this evidence by an *ex-ante* incentive effect: firms anticipate the tail risk of certain assets and react by avoiding this type of asset if they are subject to MTM accounting. Although I find the evidence on the differences in risk-taking overall convincing, I have some doubts about the authors' interpretation. The reason is that tail risk and the danger of fire sales were largely ignored before the crisis. This was especially true for financial institutions, which typically employed risk models that largely abstracted from tail risk. This makes it unlikely that P&C insurers abstained from investing in those assets for the given reason. It also implies that tail risk was probably not priced, such that the observed differences in yields before the crisis cannot be explained by differences in tail risk. Moreover, banks were also holding these types of assets in huge volumes in their trading books where they had to be valued at market prices. Why did banks not anticipate these risks if some insurance companies did? Therefore, while not questioning the results as such, I do not find the authors' explanation convincing and there must have been other reasons for the observed differences in risk-taking.

One potential explanation is that higher risk-taking of life insurers may actually be efficient. Due to their liability structure, life insurers may be better suited to take certain risks than other market participants. Especially regarding asset-backed securities, it was frequently argued that such assets should not be held by banks but rather by life insurance companies. Another potential explanation is that competitive pressure

pushed life insurers to move into higher-yielding assets in a low interest environment (which is less of an issue for P&C insurers). Finally, there may be excessive risk-taking due to implicit or explicit government protection, which may be more prevalent for the life insurance companies due to their greater size and stronger interconnectedness.

These concerns are somewhat mitigated by the within-industry type analysis. But even within insurance groups, there is heterogeneity, which is not controlled for in the analysis (regarding, for example, the maturity structure of liabilities, company size, business lines).

Identification strategy and interpretation of results

My main concern in the discussion at the panel meeting concerned the identification strategy when comparing life and P&C insurers. The identification strategy assumes that accounting rules are assigned randomly to different types of insurance companies. In reality, as the authors acknowledge, accounting rules are endogenous to the firms' business models. In fact, the business models of the two different types of insurance companies are very different. P&C insurers receive premia from their customers for insuring risks that are distributed largely independently across customers. Hence, aggregate damages are approximately known due to the law of large numbers. Therefore, there is little need for long-term investment and financing. In contrast, life insurers receive premia from their customers who obtain long-term claims in return. Since both investment and financing are mostly long term, there is little maturity transformation. Hence, life insurers are an attractive counterparty for banks who want to transfer credit risk (for example, in the form of asset-backed securities). Since life insurance companies are better able to smooth valuation changes over time, it is reasonable to have HCA rules for such firms. Hence, accounting rules may be a consequence of business models and risk structures, rather than the cause.

In order to alleviate such concerns, the authors add a within-insurance type analysis where they compare (life or P&C) insurers with different levels of the RBC ratio difference, which is the difference in the market-adjusted and reported risk-based capital ratio. They show that firms where this difference is greater invest more in safe assets and less in risky assets (especially ABS) in both the pre-crisis and the crisis period. For example, a firm whose assets are strongly overvalued in the books (implying a negative RBC ratio difference) runs a riskier strategy and searches for yield. The question is what drives the differences in RBC ratios. The authors stress the role of the accounting system. But it could also be differences in the firms' previous risk-taking, irrespective of accounting systems. Then the observed reaction could be interpreted as gambling for resurrection. Somewhat surprisingly, this effect is much stronger in the P&C sample for asset allocations, but insignificant for P&C insurers in the yield regressions. It would be interesting to understand why this is the case.

The second alternative identification strategy is in my view most credible. Here the authors use the share of bonds that are actually marked to market and then create a

high MTM state dummy. The underlying assumption is that the observed differences are driven by legislation, which is, however, not shown. The results suggest that in states where firms mark a lower share of their assets to market, the yields are on average higher, which may be an indication of search-for-yield behaviour. These results support the authors' interpretation.

Summing up, this is a fascinating paper contributing to an important policy debate and offering an innovative identification procedure and striking results. The paper does a great job in putting forward different identification strategies. As always, one can quibble about these strategies. However, all of them lead by and large to consistent results, which supports the authors' interpretation that mark-to-market accounting may not necessarily lead to more systemic risk even if it gives rise to fire sales. Although I raised some doubts about the interpretation of lower risk-taking before the recent crisis, it may well be that the crisis, which reminded market participants of the importance of tail risks, makes such considerations more relevant in the future, reinforcing the authors' policy conclusions.

Panel discussion

Hans-Werner Sinn suggested adding a third accounting rule to the analysis. Specifically, he proposed the 'lowest value principle' which takes the minimum of the historical cost accounting and mark-to-market accounting values. Sinn argued that this rule generates plenty of equity capital and is likely to lead to more prudent behaviour. Jeromin Zettelmeyer vehemently advised the authors to formulate a theoretical model in order to evaluate the welfare effects. Regarding Isabel Schnabel's point on business models, Frank Westermann wondered if this issue could be addressed by examining a sample of various insurance companies with the same investment portfolios but different accounting standards, and employing data on loss provisioning. Second, he questioned the extent to which the authors' results could be generalized to other parts of the industry. Alex Michaelides noted that in some countries managers can choose between mark-to-market and historical cost when recording an asset (comes with the decision on whether to hold the asset to maturity). He enquired how regulators should respond to such activity and requested further information on the status quo across countries regarding this matter.

Responding to Schnabel's comment on the identification strategy, Andrew Ellul noted that business model differences across life and P&C insurers are taken into consideration by examining each group separately. Moreover, he stressed that relocation of insurance companies across states is not observed in their sample. On the issue of higher risk-taking by life insurers, Ellul reported that at least for stocks this pattern is not evident. However, Isabel Schnabel thought that it would be more appropriate to look at ABSs rather than stocks. Addressing Sinn, Ellul stated that the proposed

accounting rule is not employed in the US. On the other hand, Ellul acknowledged that it would be useful to consider it as a policy implication in the analysis. He agreed with Zettelmeyer and indicated that this task is left to future research. Replying to Michaelides, Ellul explained that regulators in the US are quite strict, with managers having limited powers.

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	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	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.
Calendar quarter or year fixed effects	Quarter or Year	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

Appendix (Continued)

Variable	Specific to	Definition
		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.
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 is 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.

REFERENCES

Admati, A. and M. Hellwig (2013). *The Bankers' New Clothes*, Princeton University Press, Princeton, NJ.

Allen, F. and E. Carletti (2008). 'Mark-to-market accounting and cash-in-the-market pricing', *Journal of Accounting and Economics*, 45, 358–78.

Allen, F. and D. M. Gale (2006). 'Systemic risk and regulation', in M. Carey and R. Stulz (eds.), *The Risks of Financial Institutions*, University of Chicago Press, Chicago, pp. 341–75.

American Bankers Association (2008). 'Letter to SEC', 23 September.

American Bankers Association (2009). 'Comment Letter to the U.S. Treasury Secretary Timothy Geithner and Federal Reserve Chairman Ben Bernanke on the G-20 Accounting Recommendations', 9 September.

American Bankers Association (2010). 'Letter to U.S. Treasury Secretary Timothy Geithner', 5 August.

Badertscher, B., J. Burks and P. Easton (2012). 'A convenient scapegoat: fair value accounting by commercial banks during the financial crisis', *The Accounting Review*, 87, 59–90.

Becker, B. and V. Ivashina (2014). 'Reaching for yield in the corporate bond market', *Journal of Finance*, forthcoming.

Bhat, G., R. Frankel and X. Martin (2011). 'Panacea, Pandora's box, or placebo: feedback in bank mortgage-backed security holdings and fair value accounting', *Journal of Accounting and Economics*, 52, 153–73.

Blankespoor, E., T. J. Linsmeier, K. Petroni and C. Shakespeare (2012). 'Fair value accounting for financial instruments: does it improve the association between bank leverage and credit risk?', Working Paper, Stanford University.

Bleck, A. and X. Liu (2007). 'Market transparency and accounting regimes', *Journal of Accounting Research*, 45, 229–56.

Blundell, R. and S. Bond (1998). 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, 87, 115–43.

Bowen, R., U. Khan and S. Rajgopal (2010). 'The economic consequences of relaxing fair value accounting and impairment rules on banks during the financial crisis of 2008–2009', Working Paper, Foster School of Business, University of Washington.

Braithwaite, T. (2011). 'Banks turn to financial alchemy in search for capital', *Financial Times*, 24 October.

Brunnermeier, M. and L. H. Pedersen (2009). 'Market liquidity and funding liquidity', *The Review of Financial Studies*, 22, 2201–38.

Ellul, A., C. Jotikasthira and C. Lundblad (2011). 'Regulatory pressure and fire sales in the corporate bond market', *Journal of Financial Economics*, 101, 596–620.

Ellul, A., C. Jotikasthira, C. Lundblad and Y. Wang (2012). 'Is historical cost accounting a panacea? Market stress, incentive distortions, and gains trading', Working Paper, Indiana University.

Gromb, D. and D. Vayanos (2002). 'Equilibrium and welfare in markets with financially constrained arbitrageurs', *Journal of Financial Economics*, 66, 361–407.

Haldane, A. G. (2012). 'The dog and the frisbee', paper given at the Federal Reserve Bank of Kansas City's 36th economic policy symposium, 'The Changing Policy Landscape', Jackson Hole, Wyoming.

Hall, B. and N. Tait (2008). 'Sarkozy seeks E.U. accounting change', *Financial Times*, 30 September.

Heaton, J., D. Lucas and R. McDonald (2010). 'Is mark-to-market accounting destabilizing? Analysis and implications for policy', *Journal of Monetary Economics*, 57, 64–75.

Hellwig, M. (2009). 'Systemic risk in the financial sector: an analysis of the subprime-mortgage financial crisis', *De Economist*, 157, 129–207.

Kashyap, A. K., R. Rajan and J. C. Stein (2008). 'Rethinking capital regulation', Federal Reserve Bank of Kansas City Symposium on 'Maintaining Stability in a Changing Financial System', Jackson Hole, Wyoming

Katz, D. M. (2008). 'Former FDIC chief: Fair value caused the crisis', CFO.com, 29 October.

Kyle, P. and W. Xiong (2001). 'Contagion as a wealth effect', *Journal of Finance*, 56, 1401–40.

Laux, C. and C. Leuz (2009). 'The crisis of fair-value accounting: making sense of the recent debate', *Accounting, Organizations and Society*, 34, 826–34.

Laux, C. and C. Leuz (2010). 'Did fair-value accounting contribute to the financial crisis?' *Journal of Economic Perspectives*, 24, 93–118.

Merrill, C. B., T. D. Nadauld, R. M. Stulz and S. M. Sherlund (2012). 'Did capital requirement and fair value accounting spark fire sales in distressed mortgage-backed securities?', Working Paper, Ohio State University.

Morris, S. and H. S. Shin (2004). 'Liquidity black holes', *Review of Finance*, 8, 1–18.

Plantin, G., H. Sapra and H. Shin (2008). 'Marking-to-market: panacea or Pandora's box?' *Journal of Accounting Research*, 46, 435–60.

Rajan, R. (2010). *Fault Lines*, Princeton University Press, Princeton, NJ.

Sapra, H. (2008). 'Do accounting measurement regimes matter? A discussion of mark-to-market accounting and liquidity pricing', *Journal of Accounting and Economics*, 45, 379–87.

Shleifer, A. and R. W. Vishny (1992). 'Liquidation values and debt capacity: a market equilibrium approach', *Journal of Finance*, 47, 1343–66.

Shleifer, A. and R. W. Vishny (1997). 'The limits of arbitrage', *Journal of Finance*, 52, 35–55.

Yellen, J. (2011). 'Remarks at the international conference: Real and financial linkage and monetary policy', Bank of Japan, http://www.federalreserve.gov/newsevents/speech/yellen20110601a.htm.