ESSAYS ON INSURERS' TRANSPARENCY AND RISK MANAGEMENT PRACTICE

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ABSTRACT

This dissertation consists of two topics. Chapter 1 explores the relationship between firm transparency and managerial behaviors of the U.S. Property-Casualty (P&C) insurers. Using data between 1996 and 2015, we test whether credit rating agencies (CRAs) provide useful information to monitor insurers' loss reserve management behaviors as watchdogs. In addition, we investigate how insurers recognize the rating difference given by different CRAs. We find that holding a rating does not necessarily affect insurers' reserve management behaviors. However, loss reserve estimation tends to be more accurate as more ratings are given to an insurer. Such findings suggest that multiple CRAs stimulate insurers to accurately estimate their reserves through the enhanced monitoring function. We also find a marginal impact of rating difference on an insurer's loss reserve estimation. Firms with rating difference tend to underestimate their loss reserves. Nevertheless, this does not considerably deteriorate the reserve forecast accuracy. Although the Sarbanes–Oxley Act (SOX) aims at regulating publicly traded firms, it seems to affect over the market. Our empirical results show that insurers' reserve estimation accuracy is improved after the enactment of the SOX. Moreover, the enactment of SOX alleviates an under-reserving behavior of firms with rating difference.

Chapter 2 investigates the derivative practice of the U.S. life insurers. Over the last two decades, derivatives have been used extensively as a risk management tool in the financial market. In the U.S. insurance market, life insurers have accounted for over 95% of total derivative transactions, a proportion much higher than that in other countries. However, there are only a few prior studies examining the practical use of derivatives in the U.S. life insurance market. In addition, several limitations exist in terms of data they

used (single-year, outdated, and inaccurate). In this study, we compile accurate derivative transaction data by taking a close look at the underlying asset and the traded market. We then examine the determinants of derivative (swap in particular) participation and the extent of transactions using samples from 2001 to 2015 which includes major events such as the U.S. financial crisis and the Dodd-Frank Act. We find that the determinants of derivative/swap participation are different from those of transaction volumes. We also find that the impact of the financial crisis on derivative usage is very limited in the life insurance market. However, the enactment of the Dodd-Frank Act not only reduces the likelihood of swap participation but also stagnates the growth of the swap transaction volumes, while the total derivative transaction volumes are significantly increased. Such findings indicate that the costs of the new regulation outweigh its benefits, due to the inefficient and inadequate regulatory changes.

THIS DISSERTATION IS DEDICATED TO MY ALWAYS ENCOURAGING, CARING, AND FAITHFUL FAMILY

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CHAPTER 1

THE ROLE OF CREDIT RATING AGENCIES IN THE U.S. P&C INSURANCE MARKET: MONITORING INSURERS' LOSS RESERVE MANAGEMENT BEHAVIORS

1.1 Introduction

Conventionally, credit rating agencies (CRAs) are expected to reduce the information gap between firms and other relevant parties by reporting the ratings. CRAs normally have access to a firm's information, part of which is not available to the public, so they are more efficient at assessing the firm's financial strength. Myers and Majluf (1984) argue that CRAs provide objective and independent information to the market, thus improving market efficiency. As a result, many participants in the market have relied on information given by CRAs. For example, regulators use ratings to assess a firm's capital adequacy for regulatory purposes. Investors make their investment decisions based on information inherent in firm ratings. However, several scandals regarding financial statement frauds and the financial crisis over the 2000s made market participants skeptical of the function of CRAs as gatekeepers. This motivates us to examine whether the information embedded in firm ratings are effective in monitoring a firm's managerial behaviors.

In this paper, we focus on the U.S. property-casualty (P&C) insurance industry and investigate whether the information inherent in financial strength ratings (FSRs) effectively monitor an insurer's loss reserve management behavior. We ask three main research questions, i.e., 1) whether insurers with at least one rating are more conservative than those

without a rating when estimating their loss reserves; 2) whether holding more ratings affects loss reserve management behaviors of insurers; and 3) how insurers react to the rating difference given by different CRAs when they manage their loss reserves.

The P&C insurance industry provides a natural setting for this study. First, there are industry-specific FSRs for life, health, and P&C insurers. Unlike debt ratings that only reflect the risk of corporate debt at the parent firm level, FSRs reflect the rating agency's opinion on an insurer's overall ability to meet its financial obligations and remain solvent at the firm level.[1] Second, compared to other industries, insurers are more likely to be rated. In other industries, firms receive ratings when they issue debt securities or are to be publicly traded. Thus, only a small percentage of firms are rated. However, in the insurance industry, much more insurers are rated even when they do not issue debt or are not publicly traded. Third, loss reserve errors are more reliable to measure a firm's managerial discretion (McNichols, 2000). Every year, insurers accrue liabilities for the unpaid losses. Over time, they must disclose how these estimated losses have been developed as they reflect actual losses paid and changes in estimates due to regulatory requirement. This allows us to observe the actual error made in the original accounting estimate, reducing the measurement error.

As a preview of our results, we find that holding a rating itself does not have a significant impact on insurers' reserve management behaviors. However, when firms hold more ratings, loss reserve estimation tend to be more accurate. Such findings indicate that multiple CRAs encourages insurers to estimate their loss reserves more accurately through

[1] We discussed differences between debt ratings and financial strength ratings with Hina, an analyst of S&P Global intelligence team.

the enhanced monitoring function. We also find a marginal evidence that insurers with a larger rating difference tend to underestimate their loss reserves than firms with a smaller rating difference. However, such under-reserving behaviors do not significantly deteriorate the accuracy of reserve estimation. Moreover, the enactment of the Sarbanes–Oxley Act (SOX) reduces the variance of loss reserve estimation over the market, thus improving the accuracy of reserve estimation. Even the SOX alleviates the under-reserving behavior of firms with rating difference. Nevertheless, we fail to find any evidence that the reserve accuracy of those firms with rating difference is improved after the SOX.

This study contributes to existing literature in several ways. First, the insurance market is known for severe information asymmetry (e.g., OECD, 2009; Financial Stability Board (FSB) and International Monetary Fund (IMF), 2009).[2] Prior literature has found evidence that insurance firms have greater information asymmetries than other industries (e.g., Ross, 1989; Polonchek and Miller, 1996; Morgan, 2000). In this aspect, this study examines whether FSRs can be used as a channel to monitor an insurer's loss reserve behavior and thus increase the market transparency. Second, most previous studies focus on publicly traded firms only. As a proxy of firm transparency, prior literature uses data on trading volume, bid-offer spread, the number of reports, return volatility, or standard deviation of analysts' earnings per share (EPS) forecasts (see Section 2.1 for more details). Such data are available only to publicly traded firms, so the results from these studies shed

[2] OECD (2009) describes an insurance sector as a black box due to the complexity of insurance products and coverages, less transparency in pricing and transactions, technical provision, and broad industry level. The report of Financial Stability Board and International Monetary Fund (2009) recognizes the insurance market as a sector in need of better data for transparency. In addition, The P&C insurance market is less transparent than the life insurance market due to the complex product type and difficult estimation of loss amount.

little or no light on private firms.[3] Our paper uses FSRs from four major rating agencies (i.e., AM Best, Fitch, Moody's, and Standard and Poor's (S&P)) to measure firm transparency in the insurance market, which is not limited to publicly traded firms. Third, contrary to most of the previous studies that examine the impact of firm transparency on market reactions from the perspective of investors, this paper investigates from the perspective of firms as to whether insurers regard the disagreement of FSRs as a result of random errors or the source of information asymmetry. If insurers believe the rating disagreement is simply a result of random errors, they have no incentive to manipulate loss reserves. If the rating disagreement is a result of information asymmetry, insurers are encouraged to use their discretionary powers for loss reserve manipulation.

This paper proceeds as follows: In Section 1.2, it discusses background literature on firm transparency, ratings, and earnings management. Section 1.3 suggests research hypothesis. Section 1.4 outlines the research design and data. Furthermore, empirical results and implications are suggested in Section 1.5. The last section 1.6 summarizes remarkable findings and explains the limitations of this study.

[3] Publicly traded firms represent only a small fraction of all firms in the insurance market. Ho (2015) shows that stock firms and non-stock firms account for 78.5% and 21.5% respectively in the P&C insurance. Within stock firms, only 19.5% of them are public firms. In addition, previous studies have shown different characteristics between public firms and non-public firms such as quality of financial reporting (Ball and Shivakumar, 2005), financing costs (Brav, 2009; Saunders and Steffen, 2011), cash holding (Gao, Harford and Li, 2013). Therefore, public firms and private firms might have different motivations.

1.2 Literature Review

1.2.1 Firm Transparency

The concept of corporate transparency has been interpreted differently in the existing literature. Some studies define firm transparency as a voluntary disclosure in its annual reports (Botosan, 1997; Sengupta, 1998). Gernon and Meeks (1997) construe transparency as information in annual disclosures and additional sources such as press releases and newspapers. Bushman, Piotroski, and Smith (2004) define corporate transparency as the availability of firm-specific information, such as financial performance, investment opportunities, governance, value, and risk of firms to those outside publicly traded firms. In the insurance literature, Schwarcz (2014) describes transparency as relevant information available to consumers and others, such as academics, journalists, newspapers, consumer organizations, or other market watchdogs. Pottier and Sommer (2006) suggest that an insurer is transparent when the insurer's financial statements and other public information present a complete and unambiguous picture of the insurer's risk. Otherwise, the insurer would be considered as opaque to some degree.

In the finance and accounting literature, several proxies have been used to measure the degree of firm transparency. Among several measures of corporate transparency, the following proxies are frequently used: the number of analysts (e.g., Patel, Balic, and Bwakira, 2002; Berglöf and Pajuste, 2005; Aksu and Kosedag, 2006; Akhigbe, McNulty, Stevenson, 2013), return volatility and trading volume (e.g., Anderson, Duru, and Reeb, 2009; Wang, 2011; Akhigbe, McNulty, Stevenson, 2017), forecast error (e.g., Anderson, Duru, and Reeb, 2009; Akhigbe, McNulty, Stevenson, 2013, 2017; Livingston and Zhou, 2010), and bid-offer spread (e.g., Anderson, Duru, and Reeb, 2009; Wang, 2011). Some

studies measure firm transparency from the governance structure (e.g., Biswas and Bhuiyan, 2008; Bhagat and Bolton, 2008). Similarly, Kim, Lee, and Yang (2013) and Patel, Balic, and Bwakira (2002) estimate a degree of firm transparency with Transparency and Disclosure index (T&D index).[4]

Some insurance literature follows the aforementioned approaches to measure an insurer's transparency. For example, Han, Lai, and Ho (2018) measure P&C insurer's transparency with bid-ask spreads, trading volume, and analyst's forecasting error. They also include six types of governance characteristics: the number of directors, a portion of busy board director, stock ownership, the number of director meetings, duality, and board independence. Consistent with Polonchek and Miller (1996) and Ross (1989), Zhang, Cox, and Ness (2009) suggest that an insurer's opacity is originated from the characteristics of assets and liabilities. They measure the degree of asset opacity with a ratio of opaque assets to total assets and the level of liability opacity with a ratio of premiums written from opaque business lines to total premiums written.

Some literature suggests that information given by CRAs may improve market transparency. Myers and Majluf (1984) argue that CRAs provide objective and independent information in the market, decreasing the information cost of market participants. In addition, CRAs continuously monitor a firm's business environment by reporting and changing their watch actions and ratings. For example, AM Best's three types of outlooks diagnose firm's potential future directions as positive, negative, or stable.[5]

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[4] T&D index is suggested by Standard & Poor's (S&P) and consists of 98 questions about a firm's ownership structure, investor right, board structure, and financial transparency and information disclosures.
[5] Outlooks are typically reviewed annually, but it can be revisited during the year, depending on an insurer's financial and market conditions.

Such functions of CRAs attract the attention of the market participants, improving market transparency. However, CRAs frequently provide different ratings to identical firms. Particularly, such aspects are outstanding in the insurance market. Morgan (2002) and Pottier and Sommer (2006) suggest that rating difference is highly correlated with a degree of opacity. Prior studies also suggest that information asymmetry inherent in rating difference affects the market participants' reactions (e.g., Morgan, 2000; Pottier and Sommer, 2006; Livingston and Zhou, 2010). Livingston and Zhou (2010) find a positive relationship between bond yield and the magnitude of rating difference. Such findings imply that market participants consider the rating difference as a firm's uncertainty, hence they require higher returns to those firms.

1.2.2 Effect of Firm Transparency

Prior studies have attempted to find a relationship between firm transparency and performance or the cost of equity/debt capital. A positive impact of firm transparency is commonly is found based on the following firm performance proxies: (1) Tobin's Q, (2) Price-To-Book Ratio (PBR), and (3) Return on Asset (ROA) or Return on Equity (ROE).

Firm transparency also affects its overall cost of capital. Theoretical studies of Diamond and Verrecchia (1991) and Pagano and Volpin (2012) show that reduced asymmetric information alleviates a firm's overall cost of capital. Ashbaugh, Collins, and LaFond (2006) and Deboskey and Gillett (2013) provide empirical evidence supporting the above theoretical expectation. The negative relationship between transparency and the cost of capital can be explained by liquidity improvement and risk reduction. If a firm provides greater disclosure to the market, it reduces its overall risk (Hirtle, 2007). Pagano and Volpin

(2012) suggest that the degree of transparency affects the liquidity in the primary and secondary market. When a firm's information asymmetry increases, rational traders with less information tend to reduce transactions, reducing liquidity (Bignon and Breton, 2004).

The improved firm performance and the reduced cost of capital lead to an increase in a firm's value. If a firm's value is reflected in stock price, transparent firms' stock prices tend to be higher than those of opaque firms (e.g., Akhunianov, 2009; Pagano and Volpin, 2012). In addition, the magnitude of firm value drop is relatively small for those firms with higher transparency during the financial crisis (Akhunianov, 2009). These findings are consistent with the economic theories which predict a positive relationship between firm transparency and firm value.

Despite considerable attention to firm transparency in the finance and accounting literature, the empirical study on the effect of firm transparency in the insurance market is still in its infancy stage. Morgan (2002) and Pottier and Sommer (2006) show that the rating difference among CRAs is more frequently found in the insurance market. Zhang, Cox, and Ness (2009) provide empirical evidence that market participants expect higher bid-ask spreads when insurers have more opaque assets and liabilities. Babbel and Merrill (2005) state that insurers' complexity and opaqueness of contracts allow managers to create illusory values by understating reserve liabilities and overstating surplus. Han, Lai, and Ho (2018) examine the effect of firm transparency on P&C insurers' loss reserve error. Using the samples of publicly traded firms in the P&C insurance market, they find that opaque firms are more likely to underestimate their loss reserves. However, this study covers publicly traded firms only and the sample size is small.

1.2.3 Earnings (Reserve) Management

The main purpose of firm existence is to maximize profits and values. Therefore, firms have incentives to show positive aspects of their business activities and financial positions to the market. Earnings management is an accounting technique which makes a firm's status more plausible and attractive, by inflating earnings, revenues, and assets and by reducing expenses and liabilities. In the insurance market, such a pattern of earnings management is frequently found in an insurer's loss reserves, the largest liabilities. Colquitt, Hoyt, and McCullough (2006) demonstrate how managers of P&C insurers use greater discretion in setting loss reserves. Babbel and Merrill (2005) show that insurers understate reserve liabilities and overstate surplus to created illusory values.

The estimation of loss reserves is both directly and indirectly related to an insurer's financial position, affecting surplus, profits, tax amount, pricing, and the costs of capital. Statement of Statutory Accounting Principles No. 55 requires insurers to record the best estimate of liabilities in their statutory financial statements. However, loss reserve error (LRE), the gap between estimated losses and realized losses, occurs due to two main reasons: non-discretionary misestimating and discretionary manipulation. The non-discretionary error originates from a variety of reasons: unexpected changes in claims, delayed claim reporting, lack of accurate actuarial modeling techniques, and new regulations, etc. On the other hand, insurers may manipulate reserves by overestimating or underestimating. Prior studies have been examined to reveal the motivations of insurers' discretionary manipulation behaviors in terms of income smoothing, tax reduction, regulatory intervention avoidance, and managerial compensation. Moreover, such motivations can be changed over time (Grace, 1990).

First, in respect of the income smoothing motivation, Smith (1980) finds that insurers manage loss reserves in order to smooth underwriting results. He argues that the sign of reserve errors (positive or negative) is not randomly found. In addition, Weiss (1985) shows that loss reserve errors are significantly associated with economic development and smoothing incentives. Grace (1990) finds that an insurer's average net income over the last three years is significantly related to the degrees of loss reserve error. Beaver, McNichols, and Nelson (2003), Browne, Ma, and Wang (2009), and Grace and Leverty (2010) provide similar findings that firms with higher earnings tend to report more reserves, which supports the theory of income smoothing motivation.

Second, tax reduction is a key motivation for an insurer's reserve manipulation. By overestimating reserves and incurred losses, insurers can reduce tax liabilities in the current year. Grace (1990) finds a significant relationship between loss reserves and tax amount. Cummins and Grace (1994) demonstrate how loss reserves can be used for reducing tax liabilities. In addition, Nelson (2000) provides evidence that insurers with a higher tax rate tend to overestimate their loss reserves than insurers with a lower tax rate, supporting the tax reduction hypothesis.

Third, insurers manage loss reserves to avoid the intervention from regulators. Insurance Regulatory Information System (IRIS) consists of three reserve-related ratios and eight non-reserve-related ratios. If more than three ratios are abnormal, the insurance firm might be examined and intervened by regulators. Therefore, firms have incentives to manipulate their reserves to avoid regulatory interventions, by hiding their financial difficulties. Gaver and Peterson (2004) demonstrate empirical evidence that two-thirds of insurers avoid regulators' intervention by managing reserves when they are at risk to

violate certain ratios. This finding is consistent with the argument of Petroni (1992) who suggests that financially weak firms tend to underestimate their loss reserves.

Fourth, some studies have focused on the link between insurers' reserve management behaviors and managerial compensations. Lin and Lai (2008), Browne, Ma, and Wang (2009), and Eckles and Halek (2010) find that managers' compensation structures significantly affect an insurer's earnings management practice, showing an under-reserving practice. These studies support that managers have incentives to maximize their compensations by manipulating loss reserves.

Additionally, some studies seek the motivation of loss reserve management from regulation changes. Because regulation changes affect firms' overall business environment, insurers need to change their business strategies. Grace and Leverty (2010) show that insurers increase their tendency of over-reserving when the stringent regulation is enacted. On the other hand, Petroni and Beasley (1996), Gaver and Peterson (2001), and Grace and Leverty (2011) find the mechanism of reserve management from the relationship with auditing firms and actuarial firms.

About earnings management behaviors, prior studies in finance and accounting literature find that firm transparency is negatively related to degrees of earnings management. Henton, Libby, and Mazza (2006) suggest that more transparent reporting requirements reduce the degree of earnings management. Riahi and Arab (2011) also show that information disclosure constitutes a constraint to the proliferation of earnings management. Nonetheless, there is not enough empirical evidence how firm transparency determines an insurer's reserve management practice. To the best of my knowledge, Han, Lai, and Ho (2018) are the first to examine this issue. They find that opaque firms are more

likely to underestimate their loss reserves than transparent firms. However, their data are limited to publicly traded firms in the P&C market and the number of samples is small. In this paper, we will use a different measure of firm transparency and expand the sample to all types of insurers.

1.2.4 Ratings

Although several accounting scandals and the most recent financial crisis made market participants skeptical of the function of CRAs as gatekeepers, CRAs are still expected to contribute to the market efficiency. The U.S. Securities and Exchange Commission (SEC) designated Moody's, S&P, AM Best, DBRS, and Fitch as nationally recognized statistical rating organizations (NRSRO) until 2006. In 2006, the U.S. Congress reduced the entry barriers of CRAs in order to increase market competition and improve transparency. As of Dec 2015, ten NRSROs were registered in the SEC and eight of them provided ratings to the U.S. insurers (see Table 1.1).

Among eight CRAs who issue ratings to insurers, AM Best, S&P, Moody's and Fitch are the main players. As shown in Table 1.1, over 94% of outstanding credit ratings in the insurance market are given by these four agencies. In general, CRAs report two types of ratings, i.e., Issuer Credit Ratings (ICRs) and Financial Strength Ratings (FSRs). AM Best defines these two ratings as follows: "Issue Credit Ratings is an independent opinion of credit quality assigned to issues that gauge the ability to meet the terms of the obligation." "Financial Strength Ratings is an independent opinion of an insurer's financial strength and ability to meet its ongoing insurance policy and contract obligations." There are two key differences between ICRs and FSRs. First, ICRs reflect the default rates of issued

securities, while FSRs reflect the default risk of firms. Second, ICRs are given to firms in all industries, whereas FSRs are given to insurers only. Among these CRAs, AM Best provides FSRs to insurance firms only and other CRAs rate both insurance and non-insurance firms. Although their market share is relatively smaller than AM Best, S&P, Moody's and Fitch are also major rating agencies in the US insurance industry.

The ratings given by CRAs provide considerable benefits to the insurance market. First, ratings provide objective and independent information to the market, reducing information asymmetry (Myers and Majluf, 1984). Not only do CRAs have access to a firm's information which is not available to the public, they are also efficient at processing such information and assessing the firm's financial strength. Therefore, CRAs efficiently reduce the information gap between firms and other parties by reporting ratings to the market. Second, ratings provide firms with great access to the capital market. In general, third-parties rely heavily on outside assessments about an insurer's solvency. With a credit rating by a CRA, such reduced information asymmetry may lower the cost of capital. In addition, firms with a high-ranked rating can get entry ticket into the capital market since CRAs provide gate-keeping functions (Wolfson and Crawford, 2010). Third, CRAs provide advice to firms as well, offering feedback about the long-term effects of the firms' approach to risk (Duff and Einig, 2009). Their feedback includes potential changes of credit ratings and the cost of capital. Fourth, firms with high ratings can avoid the intervention from regulators because regulators use firm ratings to assess a firm's capital adequacy for regulatory purposes. As a result, the aforementioned benefits may improve market efficiency by reducing information costs of market participants.

Interestingly, firms with multiple ratings are frequently found in the market. Some

studies have investigated the reasons as to why some firms hold multiple ratings. Hsueh and Kidwell (1988) provide evidence that additional ratings help reduce the borrowing cost when firms issue bonds. Cantor and Packer (1995) test whether the motivation of multi-ratings is driven by regulatory considerations. Cantor and Packer (1995) test whether the motivation of multi-ratings is driven by regulatory consideration. Financial market regulators restrict investors from investing firms or securities with a speculative grade. Cantor and Packer (1995) find that the third opinion from CRAs helps firm escape the speculative grade. Later, Cantor and Packer (1997) also test the motivations of getting third-ratings with respect to information efficiency, rating shopping, and certification effects. However, they fail to find evidence that the third rating is related to such motivations.

Although many firms get multiple-ratings, CRAs commonly disagree in their assessment of credit quality and assign split credit ratings (e.g., Ederington, 1986; Jewell and Livingston, 1998; Livingston, Wei, and Zhou, 2010). Livingston, Wei, and Zhou (2010) show that disagreements of bond ratings are about 20% and 50% at the level of category and sub-ratings (notch) respectively. Ederington (1986) suggests that the disagreement of ratings is attributed to random errors since the default risk of a split-rated bond is close to the borderline between two rating categories. Therefore, CRAs might randomly assign a rating between these two categories. However, Livingston, Naranjo, and Zhou (2008) find that over two-thirds of split ratings last for four years, so they argue that if the rating splits are originated from random errors, the rating discrepancy should not last for several years. Morgan (2002) finds that the incident of split ratings is frequently found in financial institutions such as banks and insurance firms with higher degrees of opacity. Pottier and

Sommer (2006) also provide consistent findings. They show that firm transparency (rating disagreement) is significantly related to firm size, firm type, investment assets, and a degree of diversification. Haggard, Martin, and Pereira (2008) support that the information uncertainty makes risk assessment problematic when CRAs evaluate a firm's rating, increasing the possibility of the split ratings.

Prior studies also show that the split ratings affect the reactions of market participants such as investors. Kish, Hogan, Olson (1999) show that the bond spread varies depending on the magnitude of rating discrepancy. Livingston and Zhou (2010) examine the relationship between split bond ratings and bond yields at the notch level with newly issued corporate bonds. They find that the split-rated bonds have a 7-basis-point yield premium on average over non-split-rated bonds with similar credit risk. Especially, the yield premiums are 5, 15, and 20 basis points when the splits are one-notch, two-notches, and three-notches respectively. They also find that the yield premiums for split-rated bonds become higher during the period of economic recessions, indicating that investors become more averse to risk during economic downfalls.

Then, how does a rating difference affect insurers' accounting behaviors? To the best of my knowledge, this question has not been answered before in the insurance literature. By examining the relationship between insurers' rating discrepancy and loss reserve management practice, this study helps us understand how insurers recognize information inherent in rating difference and manage their loss reserve estimation accordingly. This is a different approach from the existing literature since most previous studies focus on the reactions of market participants such as investors and regulators.

Table 1.1 Number of Outstanding Credit Ratings by Rating Categories

NRSRO	Financial Institutions	Insurance Companies	Corporate Issues	Asset-Backed Securities	Government Securities
A.M. Best	N/R	7,710	1,445	18	N/R
DBRS	8,487	143	3,536	12,848	16,947
EJR	11,251	1,015	6,384	N/R	N/R
Fitch	43,798	3,077	16,734	41,517	198,375
HR Ratings	N/R	N/R	N/R	N/R	347
JCR	770	59	2,227	N/R	428
KBRA	443	4	4	4,259	55
Moody's	50,094	3,175	42,821	68,494	637,898
Morningstar	N/R	N/R	N/R	3,306	N/R
S&P	60,005	6,896	51,105	64,222	964,704

Source): Annual Report on Nationally Recognized Statistical Rating Organizations (2016)
Note) N/R indicates that the NRSRO is not registered in the applicable rating category as of the reporting date

1.3 Hypothesis Development

This study aims to examine the relationship between firm transparency and insurers' loss reserve management behaviors. We explore three main research questions: (1) whether the pattern of loss reserve management is different for firms with a rating and firms without ratings, (2) whether holding multiple ratings affects an insurer's loss reserve management practice, and (3) how an insurer views the rating difference from different rating agencies as a result of random error or a source of information asymmetry. Based on prior literature, we also include other factors which may affect insurers' loss reserve management behaviors.

Prior literature provides evidence that the degree of earnings manipulation is positively related to firm opacity (e.g., Richardson, 2000; Hunton, Libby, and Mazza, 2006). With information asymmetry, firms are more likely to engage in earnings manipulation since their financial status is not perfectly observed by market participants. In addition, managers have an incentive to maximize their private benefits through earnings management (e.g., Trueman and Titman, 1988; Hunton, Libby, and Mazza, 2006). Such opportunistic behaviors can be effectively mitigated by improving firm transparency. Lobo and Zhou (2001) argue that managerial misbehaviors can be more easily monitored and detected when firms disclose more information to the market. For P&C insurers, loss reserves are one of the channels used to conduct earnings management. Zhang and Browne (2013) show that an insurer's under-reserving is a sign of accounting manipulation.

The information provided by CRAs is expected to improve market transparency for the following reasons. First, CRAs have access to the information that is not observed by market participants. CRAs provide such information to market participants by reporting

firms' financial ratings. Second, the information given by CRAs is more objective and independent (Myers and Majluf, 1984). For a long time, CRAs have accumulated knowledge and developed their rating systems. Therefore, their rating systems have been designed to monitor a firm's overall business environments. Third, CRAs continuously monitor rated firm's business environment. When CRAs detect any events, which may affect a firm's overall business environment, CRAs promptly change the firm's rating or report new opinions such as positive, negative, or stable, estimating the effect of the events. Such actions of CRAs draw significant attentions from market participants to the firm, thus improving the monitoring function. Therefore, holding a rating is expected to help alleviate information asymmetry in the insurance market. In this respect, firms with at least one rating are expected to have fewer incentive to manipulate earnings than firms without a rating (*H1*).

Furthermore, if insurers hold multiple ratings from different CRAs, then it is more likely that more information about the firm is provided to market participants, so they can compare the firm's financial and other information from different sources. Therefore, the more ratings that one firm receives from different CRAs, the less likely it is for the firm to manipulate earnings (*H2*). If an opposite sign is found, it suggests that information given by CRAs is not effective in monitoring an insurer's loss reserve management behaviors, raising concerns about information diseconomies.

Prior studies also suggest that the disagreement on ratings given by CRAs indicates some degree of firm opacity of rated firms. Morgan (2002) finds that the incident of split ratings is frequently found for financial institutions such as banks and insurance firms with higher opacity degrees. Pottier and Sommer (2006) show that insurers have more split

ratings than other industries, using rating samples from S&P and Moody's. Livingston, Naranjo, and Zhou (2008) find that the rating splits are caused not by random errors, but by firm opacity. They provide evidence that over two-thirds of split ratings last four years. Haggard, Martin, and Pereira (2008) also support that information uncertainty makes risk assessment problematic when CRAs evaluate a firm's rating, increasing the degree of the rating split. If the rating difference can be used as a proxy of firm opacity, firms with higher rating disagreement are more likely to manipulate their loss reserve, (*H3*).

H1: Firms with at least one rating are less likely to manipulate loss reserves than firms without a rating.

H2: Firms with more ratings are less likely to manipulate loss reserves.

H3: Firms with a higher rating disagreement are more likely to manipulate loss reserves.

1.4 Data and Methodology

1.4.1 Data

For this study, we collect data on the US P&C insurers between 1996 and 2010. Samples are obtained from several databases such as S&P Global, AM Best, and National Association of Insurance Commissioners (NAIC). S&P Global provides FSRs given by rating agencies such as AM Best, S&P, Moody's, and Fitch. However, S&P Global does not have AM Best rating data before 2008. Therefore, AM Best ratings are separately collected from AM Best. Moreover, NAIC provides insurers' firm-specific data. The key variable, loss reserve error is measured with data in oSchedule P from 1996 to 2015 since the calculation of loss reserve error requires 5 years of data. The number of initial observations is 20, 335.

For consistency, we exclude some observations when (1) the net admitted asset is negative; (2) the proportion of reinsurance is larger than one or smaller than zero; (3) ROA is less than -1; and (4) an original reserve estimate differs from the revised estimate by greater than 50% in absolute value ($Reserve_{i,t} < 0.5\, Reserve_{i,t+5}$ or $Reserve_{i,t} > 1.5\, Reserve_{i,t+5}$); and (5) insurers overwrite more than 25% of premiums from each line of workers compensation, accident and health, surety, credit, and reinsurance. Further, *Growth,* a proxy of firm uncertainty, is winsorized at the 1% and 99% level since some observations have extreme values. The number of final observations is 15,166, which consists of 2,865 firms without a rating (18.89%) and 12,301 firms with a rating (81.11%) from any of the four rating agencies (Figure 1.1). It illustrates that over 80% of insurers hold at least one rating. Moreover, most ratings are given by AM Best (see Figure 1.2).

Figure 1.1 Firms with FSRs from Four CRAs (1996-2010)

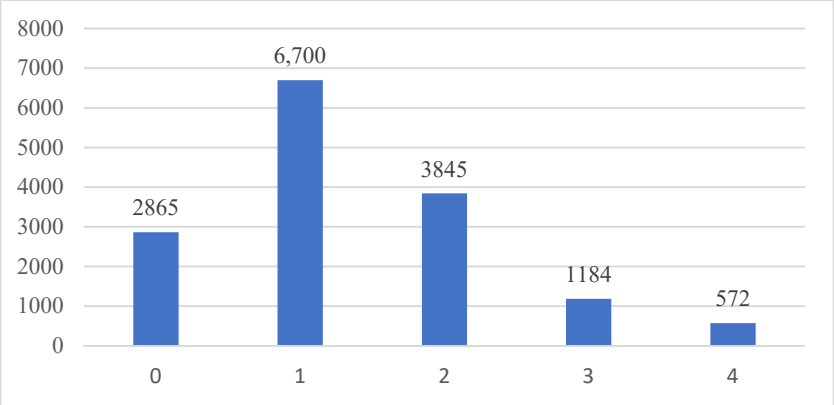
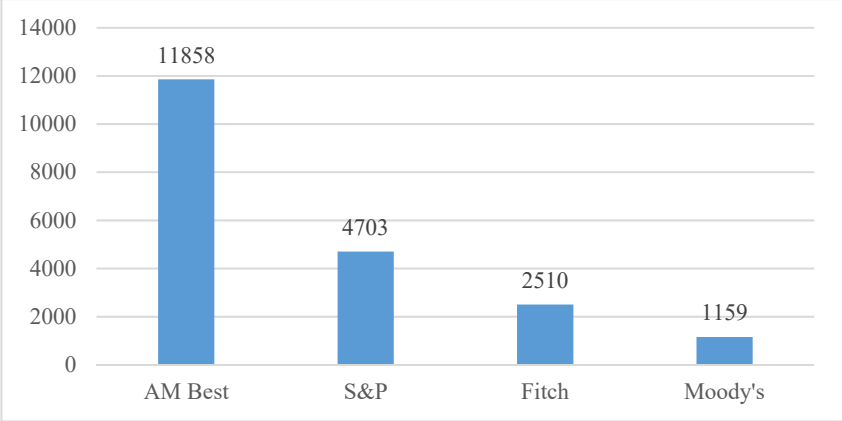


Figure 1.2 Ratings Issued by CRAs (1996-2010)



1.4.2 Methodology

To examine the effect of information embedded in FSRs on an insurer's loss reserve management behaviors, three models are used. Equation (1) investigates whether an insurer's loss reserve management behaviors are different when it holds a rating or not. Rating holding is a dummy variable which is equal to one if a firm holds at least one rating, and zero, otherwise. Equation (2) examines whether firms with more ratings are less likely to manipulate their loss reserves due to the increased information. RatingNo is the number of FSRs that a firm holds. Equation (3) tests whether the rating difference between two rating agencies affects the tendency of an insurer's loss reserve manipulation. Furthermore,

this study investigates whether rating holding, holding more ratings, and rating disagreement may affect the accuracy of loss reserve estimation as shown in Equation (4), (5), and (6).

$$LRE_t = f(Rating\ holding, Firm\ Characteristics, SOX) \quad (1)$$

$$LRE_t = f(Rating\ No,\ Firm\ Characteristics, SOX) \quad (2)$$

$$LRE_t = f(Rating\ Difference, Firm\ Characteristics, SOX) \quad (3)$$

$$AbsLRE_t = f(Rating\ holding, Firm\ Characteristics, SOX) \quad (4)$$

$$AbsLRE_t = f(Rating\ No,\ Firm\ Characteristics, SOX) \quad (5)$$

$$AbsLRE_t = f(Rating\ Difference,\ Firm\ Characteristics, SOX) \quad (6)$$

To test our hypothesis, we run regressions with Newey-West standard errors to correct for heteroscedasticity and autocorrelation. At the 1% significance level, Wthe ooldridge test rejects the null hypothesis that there is no first-order autocorrelation. White's test and Breusch-Pagan / Cook-Weisberg test also rejects the null hypothesis that the variance is constant. In this situation, ordinary least squares (OLS) regression may show a bias in the results. So, we use the Newey-West estimator to correct for autocorrelation and heteroscedasticity.

This study uses rating data from four FSR agencies: AM Best, Fitch, Moody's, and S&P. So, six types of rating disagreement combinations can be observed: (1) AM Best vs. Fitch, (2) AM Best vs. S&P, (3) AM Best vs. Moody's, (4) Fitch vs. S&P, (5) Fitch vs. Moody's, and (6) S&P vs. Moody's. Before the estimation of rating discrepancy, each financial strength ratings are sorted based on two rating categories (See Appendix A and B). Then, the absolute value of the rating difference between two CRAs is measured.

Based on prior literature, we add firm characteristics which may affect insurers' reserve management practice. First, the agency theory argues that larger firms are more likely to disclose information than smaller firms because larger firms are monitored by outside investors. Investors have a greater demand for transparency to large companies (Klein, 2002). In addition, they are more likely to have strong governance structures and regulatory scrutiny (Klein, 2002). Mckinnon and Dalimunthe (1993) point out that larger firms may take the benefit of economies of scale in information dissemination. These arguments suggest that larger firms have difficulty in manipulating their earnings due to their strong monitoring mechanisms. In this respect, larger firms are less likely to manipulate their loss reserves than smaller firms. On the other hand, Jensen and Meckling (1976) suggest a competing hypothesis. They argue that larger firms' overall operations are more complex than smaller firms. Therefore, managers in larger firms might show more opportunistic behaviors to maximize their benefits, using information asymmetry, so larger firms are more likely to manipulate their loss reserves than smaller firms. In this study, firm size is measured with the natural logarithm of net admitted assets.

Second, diversification is an effective tool used to manage firm risks. However, when a firm's business lines are more diverse, the firm could be less transparent since market participants find it difficult to monitor its misbehaviors (Bushman et al., 2004). Therefore, firms with multiple business lines or operating in multiple geographical segments are hard to scrutinize in their earnings reports (Lim, Thong, and Ding, 2008). In the insurance literature, Pottier and Sommer (2006) find that firms with more diversified activities might have greater discretion. Brendt, Ma, and Pope (2013) also point out that diversified firms are hard to be monitored and controlled by outside investors when firms

show inappropriate reserve management behaviors. These arguments suggest that more diversified firms are more likely manipulate their earnings, so we expect a positive relationship between firm diversification and reserve manipulation. In this study, the degrees of product diversification (PDHHI) and geographical diversification (GDHHI) are measured based on the following equations.

$$PDHHI_{kt} = \sum_{j=1}^{24}\left(\frac{NPW_{kjt}}{NPW_{kt}}\right)^2 \quad (7)$$

where NPW_{kjt} denotes net premiums written in line j=1, …, 24 for firm k in year t.

$$GDHHI_{kt} = \sum_{j=1}^{58}\left(\frac{NPW_{kjt}}{NPW_{kt}}\right)^2 \quad (8)$$

where NPW_{kjt} denotes net premiums written in region j=1, …, 58 for firm k in year t.

Third, when firms suffer from financial difficulties, managers might have a strong incentive to manipulate financial statements to minimize negative reactions from market participants. If firms fail to show their financial sustainability, firms may lose their market shares and current/potential customers. To alleviate such negative impacts, firms may engage in income-increasing earnings management to show their financial stability (e.g., DeAngelo et al., 1994; Sweeny, 1994; and Habib, Bhuiyan and Islam, 2013). In the insurance market, insurers with financial weakness have more incentive to show strong financial strength by manipulating earnings. Prior literature has used the number of failures in the insurance regulatory information system (IRIS) ratios as a proxy of an insurer's financial weakness and suggested that IRIS ratios are related to an insurer's loss reserve management. Gaver and Peterson (2004) provide empirical evidence that two-thirds of insurers avoid regulators' intervention by adjusting ratios through reserve management. Petroni (1992) suggests that firms with financial weakness tend to underestimate loss reserves. If insurers have several abnormal IRIS ratios, the firms are more likely to be

monitored. Therefore, firms with financial weakness are more likely to manipulate their reserves to avoid such constraints.

Fourth, reinsurance is a very common and effective risk-management tool for insurers. Primary insurers transfer their risks to reinsurers and stabilize loss experience. Such reinsurance usage effectively reduces a firm's insolvency probability and the firm′s business complexity. Therefore, firms using more reinsurance contracts have fewer incentive to estimate their loss reserve more conservatively. On the other hand, reinsurers have advanced knowledge and mechanism to monitor primary insurers. By monitoring insurance firms, reinsurers can considerably resolve problems due to the asymmetry information. Furthermore, firms who accurately estimate their loss reserves can take better terms when they contract with reinsurers (Browne, Lan, and Yu, 2012). Therefore, firms using more reinsurance have fewer incentives to manipulate earnings through loss reserves. Following the approach from prior literature, reinsurance use is measured as a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed.

Fifth, reserve errors may arise when insurers try to reduce their tax liabilities. Loss reserves are s pretax deduction from earnings and account for a substantial portion of insurers' liabilities. Therefore, by overestimating their loss reserves, insurers can postpone their tax liabilities. Prior literature provides evidence that tax reduction is one of the key motivations for insurers' reserve manipulation. Nelson (2000) finds that insurers with a high tax rate tend to discount loss reserves at a low rate. Cummins and Grace (1994) demonstrate how loss reserves can be used for reducing tax. Petroni (1992) find that insurers with a high tax rate are more likely to overstate their loss reserves than insurers with a low tax rate. In this respect, high tax rates are positively related to the likelihood of

loss reserve overestimation. Based on previous literature, the absence of net operating losses (NOL) is used as a proxy for high tax burdens. On the other hand, firms with NOL confront lower tax burdens.

Sixth, group affiliation has become one of the most common characteristics in the financial service marketplace. Prior studies provide evidence that the group structure may affect an insurer's decision makings, regarding internal capital market and diversification (e.g., Liebenberg and Sommer, 2008, Berry-Stolzle et al., 2012). Group affiliation may also affect an insurer's loss reserve management practice. Group firms are less likely to manipulate their loss reserves since each affiliated firm in the group plays as a risk buffer, supporting the theory of the internal capital market. In addition, they are monitored by affiliated firms and market participants due to the concern of systemic risk. Kim (2012) also provides evidence that they are more transparent than non-group firms due to the efficient monitoring from outsiders. On the other hand, an affiliated firm's business is more likely to be complex due to the intragroup transactions (Chen, Hsu, and Troy, 2015). In contrast, non-affiliated firms have fewer resources to cover their losses. Under these conditions, non-affiliated firms are more likely to overestimate their loss reserves than affiliated firms. Grace and Leverty (2010) fail to find any relationship between group affiliation and loss reserve error. However, Zhang (2013) and Chen, Hsu, and Troy, (2015) find a significant relationship between group structure and loss reserve errors.

Seventh, the income smoothing hypothesis suggests that an insurer's reserve management practice is affected by earning volumes. If earning volumes are unexpectedly low (high), insurers are more likely to underestimate (overestimate) their loss reserves for income smoothing. In addition, firms with high earning volumes can reduce tax burdens

by overestimating loss reserves. Beaver, McNichols, and Nelson (2003) provide evidence that loss reserve management behaviors are different depending on earnings distribution. Grace and Leverty (2010) also include earnings distribution to examine the motivations of loss reserve management. Following their approaches, we generate four indicators which identify earnings distributions to examine the effect of earnings distribution on loss reserve management practice: large loss (bottom 90% of the negative earnings distribution), small loss (top 5% of the negative earnings distribution), small profit (bottom 5% of the positive earnings distribution), and large profit (top 90% of the positive earnings distribution).

Eighth, although a strong premium growth may improve an insurer's financial health, it may also increase the firm's uncertainty. Harrington and Danzon (1994) suggest that the premium growth might be originated from underpricing or a poor underwriting standard. Especially during the soft market cycle, insurers tend to underprice to improve market shares. However, Chen, Hsu, and Troy (2015) point out that an insurer's underpricing policy during the soft market cycle may lead to high insolvency risk, increasing risk exposures. Therefore, prior literature frequently employs a premium growth as a proxy of firm uncertainty level (e.g., Sommer and Pottier, 1999; Chen, Hsu, and Troy, 2015). Based on these arguments, this study expects that firms with a high premium growth rate are more likely to overestimate their loss reserves to reduce insolvency risk.

Last, in 2002, the Sarbanes–Oxley Act (SOX) was enacted in the US as a reaction to several accounting scandals such as Enron and World.com. To protect investors from the accounting frauds, the SOX mandates strict regulatory reforms. The SOX consists of eleven main sections and SEC implements rulings on requirements to comply with the law. About the effect of the SOX on a firm's earnings management behavior, prior literature

has shown inconsistent findings. Jain and Rezaee (2006) find that the SOX improves a firm's earnings quality and reduces the tendency of earnings management. Lobo and Zhou (2006) present that a firm's financial reporting becomes more conservative after the SOX. However, Deboskey and Jiang (2012) find that US banks still manipulate earnings for income smoothing. In the insurance market, Hsu (2012) suggests that insurers' reporting quality has been improved after the SOX. However, Cohen et al. (2008) show that a firm's earnings management has significantly increased even after the SOX. Brandt, Ma, Pope (2013) fail to find any change in reserve management behaviors. They explain that the US insurance market was already highly regulated even before the SOX. Han, Lai, and Ho (2018) also argue that enactment of the SOX was redundant with existing regulations. Therefore, the SOX may not change an insurer's reserve management behaviors

Table 1.2 provides several aspects about insurer's ratings. First, AM Best and S&P have the largest matched rating samples (N=4,352), while Fitch and Moody's have the smallest matched rating samples (N=776). It is attributed to the fact that AM Best and S&P are the largest CRAs in the insurance market. Second, it confirms that rating discrepancy is very common in the insurance industry. Table 1.2 shows that the rating difference between any two CRAs is significant at the 1% level. Third, AM Best provides the most favorable ratings to insurers among all CRAs. Regardless of sorting methods, on average, AM Best grants at least one rating higher than Fitch and S&P. This finding supports the criticism that AM Best ratings are too favorable compared to other CRAs (FitchRating, 2016). Fitch (2016) argues that AM Best's rating of A- is comparable with BBB from Fitch, Moody's, and S&P. In addition, it partially explains why many insurers receive ratings from AM Best. Fourth, the rating gap is the smallest between S&P and Moody's.

The definition of each variable is provided in Table 1.3. In addition, Table 1.4 provides a statistical summary of all variables. The mean and median values of loss reserve errors are -0.0119 and -0.0134. These values indicate that insurers tend to overestimate their potential losses. In addition, over 80% of P&C insurers hold at least one FSR. On average, each insurer has 1.3 FSRs in the P&C market.

Table 1.2 Rating Difference ($\mathbf{H0}$: $\boldsymbol{\mu_{(1)} - \mu_{(2)} = 0}$)

Sorting Method One							
(1) - (2)		(2)					
		S&P		Fitch		Moody's	
(1)	AM Best	-1.2576 N=4352	***	-1.0288 N=2294	***	-0.7640 N=979	***
	S&P			0.1081 N=1462	***	0.0404 N=966	***
	Fitch					-0.0696 N=776	***

Sorting Method Two							
(1) - (2)		(2)					
		S&P		Fitch		Moody's	
(1)	AM Best	-1.4423 N=4352	***	-1.2786 N=2294	***	-1.0919 N=979	***
	S&P			0.1081 N=1462	***	0.0404 N=966	***
	Fitch					-0.0696 N=776	***

Note) Table 1.2 provides empirical evidence whether CRAs give same ratings to the identical firms. The rating difference is tested based on two different rating sorting methods in Appendix A and Appendix B.

Table 1.3 Variable Definition

Variable	Definition
Firm Transparency	
RatingHolding	1 if an insurer has at least one FSR from four CRAs. Otherwise, 0.
RatingNo	Number of FSR ratings one insurer holds from four CRAs
Difference	Absolute value of rating difference between two rating agencies
Reserve Management	
LRE	Claims loss reserve estimation error is divided by total assets. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. $\mathrm{LRE}_{i,t} = (\mathrm{Reserve}_{i,t+5} - \mathrm{Reserve}_{i,t})/\mathrm{Net\ Admitted\ Assets}_{i,t}$
AbsLRE	Absolute value of LRE
Firm Characteristics	
Size	Natural log of total net written premiums
Reinsurance	Ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed
PDHHI	Sum of squares of net premium written premiums in business line i divided by insurer's total net premium written premiums. NPW_{kjt} denotes net premiums written in line i = 1, …, 24 $\mathrm{PDHHI}_{kt} = \sum_{j=1}^{24}(\frac{\mathrm{NPW}_{kjt}}{\mathrm{NPW}_{kt}})^2$,
GDHHI	Sum of squares of net premium written premiums in state j divided by insurer's total net premium written premiums. NPW_{kjt} denotes net premiums written in state j = 1, …, 58. $\mathrm{GDHHI}_{kt} = \sum_{j=1}^{58}(\frac{\mathrm{NPW}_{kjt}}{\mathrm{NPW}_{kt}})^2$
Public	1 if the ultimate parent is publicly traded. Otherwise, 0.
Group	1 if an insurer is involved in a group. Otherwise, 0.
Growth	Growth rate of net premium written between current year and previous year.
Tax	1 if an insurer has a high tax rate
Large loss	Indicator for insurers with earnings in the bottom 90% of negative earnings distribution
Small loss	Indicator for insurers with earnings in the top 5% of negative earnings distribution
Small profit	Indicator for insurers with earnings in the bottom 5% of positive earnings distribution
Large profit	Indicator for insurers with earnings in the top 90% of positive earnings distribution
Weakness	1 if an insurer has more than four unusual insurance regulatory information system (IRIS) ratio. Otherwise, 0.
Malpractice	A percentage of net premiums written from malpractice business line.
Length	A percentage of claim loss reserve to total liabilities.
Stock	1 if insurer is a stock company. Otherwise, 0.
Regulation	
SOX	1 if firm year is after 2003. Otherwise, 0.

Table 1.4 Summary Statistics

	N	Mean	SD	p1	p5	p25	p50	p75	p95	p99	Min	Max
LRE	15166	-0.0119	0.1008	-0.2396	-0.1617	-0.0500	-0.0134	0.0114	0.1304	0.3652	-1.3647	1.1212
AbsLRE	15166	0.0613	0.0810	0.0000	0.0010	0.0127	0.0343	0.0774	0.2159	0.3884	0.0000	1.3647
RatingHolding	15166	0.8111	0.3914	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
RatingNo	15166	1.3339	0.9913	0.0000	0.0000	1.0000	1.0000	2.0000	3.0000	4.0000	0.0000	4.0000
Difference1	966	0.1563	0.4140	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	2.0000	0.0000	4.0000
Difference2	2294	1.0357	0.7515	0.0000	0.0000	1.0000	1.0000	2.0000	2.0000	3.0000	0.0000	4.0000
Difference3	979	0.7661	0.5856	0.0000	0.0000	0.0000	1.0000	1.0000	2.0000	2.0000	0.0000	2.0000
Difference4	4352	1.2727	0.8443	0.0000	0.0000	1.0000	1.0000	2.0000	3.0000	3.0000	0.0000	5.0000
Difference5	776	0.1082	0.3191	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	2.0000
Difference6	1462	0.2476	0.5089	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	2.0000	0.0000	3.0000
Size	15166	17.9229	1.8868	13.8364	15.0164	16.5994	17.8269	19.1462	21.2308	22.6960	12.2168	25.4386
Reinsurance	15166	0.3538	0.2824	0.0000	0.0000	0.1135	0.2862	0.5608	0.9000	0.9578	0.0000	1.0000
PDHHI	15166	0.6446	0.3007	0.1520	0.2171	0.3565	0.6257	0.9987	1.0000	1.0000	0.0999	1.0000
GDHHI	15166	0.6347	0.3750	0.0430	0.0610	0.2468	0.7447	1.0000	1.0000	1.0000	0.0324	1.0000
Public	15166	0.2903	0.4539	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Group	15166	0.6704	0.4701	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Growth	15166	0.1461	0.5421	-0.6366	-0.2902	-0.0411	0.0457	0.1674	0.7696	3.8876	-0.6366	3.8876
Tax	15166	0.7056	0.4558	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Large Loss	15166	0.1897	0.3921	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	1.0000
Small Loss	15166	0.0105	0.1022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000
Small Profit	15166	0.0394	0.1946	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000
Large Profit	15166	0.7099	0.4538	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
Weakness	15166	0.2314	0.4218	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	0.0000	1.0000
Malpractice	15166	0.0710	0.2483	0.0000	0.0000	0.0000	0.0000	0.0000	0.9722	1.0000	0.0000	1.0000
Length	15166	0.4620	0.2254	0.0244	0.0851	0.2899	0.4790	0.6266	0.8220	0.9553	0.0007	1.0000
Stock	15166	0.6582	0.4743	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
SOX	15166	0.6141	0.4868	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000

Note) *Difference* is an absolute value of rating difference between two CRAs: Difference1 (S&P-Moody's), Difference2 (AM Best - Fitch), Difference 3 (AM Best-Moody's), Difference4 (AM Best - S&P), Difference5 (Fitch - Moody's), and Difference6 (Fitch - S&P).

1.5 Empirical Results

This study examines whether the information given by CRAs are valid to monitor insurer's loss reserve management behaviors. It is worth noting that a negative (positive) loss reserve errors (LRE) means that insurers overestimate (underestimate) their loss reserves. In addition, a larger absolute value of loss reserve errors (AbsLRE) means that an insurer's loss reserve estimation is less accurate and more volatile.

1.5.1 Rating and LRE

This section provides empirical results of how insurers' loss reserve management behaviors are affected by whether they hold a rating and how many ratings they hold. The empirical results about the relationship between rating holding and insurers' loss reserve management behaviors are shown in Table 1.5. Table 1.6 provides empirical evidence on the relationship between the rating numbers and loss reserve errors.[6] Each of them consists of three types of regression results. Model (1) and (2) show regression results for under-reserved firms and over-reserved firms, respectively. These analyses are conducted separately because those firms may have different motivations for their loss reserve management behaviors. Model (3) provides regression results for all sample firms. Because most findings in Table 1.5 are consistent with Table 1.6, we mainly discuss the results in Table 1.5.

[6] Additionally, we tested hypothesis including business mix variables: commercial long-tail, commercial short-tail, private long-tail, and private short-tail. The business mix variables are measured based on Cummins, Weiss, and Zi (2010). The main results are consistent with those in Table 1.5 and Table 1.6. Therefore, we do not report the results in this paper.

Table 1.5 Effect of Rating Holding on LRE

	LRE					
	(1) Positive		(2) Negative		(3) All	
RatingHolding	-0.0054	-0.0044	0.0005	0.0008	0.0008	0.0013
	(0.2352)	(0.3432)	(0.7899)	(0.7024)	(0.7641)	(0.6193)
Size	0.0054***	0.0055***	0.0018***	0.0018***	0.0044***	0.0044***
	(0.0000)	(0.0000)	(0.0007)	(0.0007)	(0.0000)	(0.0000)
Reinsurance	0.0152***	0.0149***	0.0112***	0.0114***	0.0171***	0.0172***
	(0.0016)	(0.0020)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
PDHHI	-0.0119**	-0.0119**	-0.0073***	-0.0070***	-0.0105***	-0.0101***
	(0.0142)	(0.0137)	(0.0028)	(0.0041)	(0.0006)	(0.0010)
GDHHI	0.0141***	0.0141***	-0.0070***	-0.0069***	-0.0011	-0.0010
	(0.0012)	(0.0011)	(0.0005)	(0.0007)	(0.6972)	(0.7220)
Public	-0.0018	0.0080	-0.0034*	0.0044	0.0005	0.0119***
	(0.5752)	(0.1110)	(0.0597)	(0.1048)	(0.8286)	(0.0012)
Group	-0.0178***	-0.0175***	0.0075***	0.0075***	-0.0036	-0.0035
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1297)	(0.1374)
Growth	-0.0053***	-0.0051***	0.0001	0.0001	-0.0020	-0.0021
	(0.0043)	(0.0060)	(0.9400)	(0.9610)	(0.1328)	(0.1340)
Tax	-0.0068**	-0.0074**	-0.0022	-0.0020	-0.0091***	-0.0091***
	(0.0388)	(0.0234)	(0.1872)	(0.2299)	(0.0000)	(0.0000)
Small Loss	-0.0029	-0.0012	0.0014	0.0016	-0.0140*	-0.0135*
	(0.7549)	(0.8956)	(0.8461)	(0.8253)	(0.0533)	(0.0621)
Small Profit	-0.0017	-0.0014	0.0034	0.0035	0.0013	0.0015
	(0.7853)	(0.8223)	(0.3784)	(0.3641)	(0.7553)	(0.7123)
Large Profit	-0.0014	-0.0014	-0.0062***	-0.0063***	-0.0113***	-0.0114***
	(0.6803)	(0.6788)	(0.0006)	(0.0005)	(0.0000)	(0.0000)
Weakness	0.0545***	0.0544***	-0.0237***	-0.0237***	0.0296***	0.0296***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Malpractice	0.0028	0.0028	-0.0410***	-0.0414***	-0.0379***	-0.0385***
	(0.7410)	(0.7398)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 1.5: Continued

	LRE					
	(1) Positive		(2) Negative		(3) All	
Length	0.1269***	0.1264***	-0.1019***	-0.1020***	-0.0389***	-0.0391***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.0194***	0.0194***	-0.0002	-0.0003	0.0142***	0.0141***
	(0.0000)	(0.0000)	(0.9073)	(0.8328)	(0.0000)	(0.0000)
SOX	-0.0216***	-0.0153*	0.0114***	0.0147***	0.0041	0.0096**
	(0.0058)	(0.0654)	(0.0021)	(0.0001)	(0.3235)	(0.0270)
SOX_Public		-0.0204***		-0.0118***		-0.0192***
		(0.0003)		(0.0002)		(0.0000)
Constant	-0.0967***	-0.1015***	-0.0381***	-0.0410***	-0.0852***	-0.0898***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4988	4988	10178	10178	15166	15166
R-squared	0.3273	0.3293	0.2418	0.2433	0.194	0.1958

Note) The dependent variable, *LRE*, is measured with claim loss reserve error scaled by total assets. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *RatingHolding* is set equal to one if an insurer has at least one FSR. Otherwise, zero. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

Table 1.6 Effect of Rating Number on LRE

	LRE					
	(1) Positive		(2) Negative		(3) All	
RatingNo	-0.0025	-0.0021	0.0040***	0.0045***	0.0025**	0.0030**
	(0.1474)	(0.2195)	(0.0022)	(0.0005)	(0.0470)	(0.0136)
Size	0.0057***	0.0057***	0.0009	0.0008	0.0039***	0.0038***
	(0.0000)	(0.0000)	(0.1795)	(0.2240)	(0.0000)	(0.0000)
Reinsurance	0.0161***	0.0157***	0.0094***	0.0094***	0.0159***	0.0158***
	(0.0009)	(0.0012)	(0.0003)	(0.0002)	(0.0000)	(0.0000)
PDHHI	-0.0119**	-0.0120**	-0.0062**	-0.0058**	-0.0099***	-0.0093***
	(0.0131)	(0.0124)	(0.0107)	(0.0175)	(0.0013)	(0.0022)
GDHHI	0.0142***	0.0142***	-0.0067***	-0.0065***	-0.0009	-0.0008
	(0.0011)	(0.0011)	(0.0008)	(0.0012)	(0.7455)	(0.7808)
Public	-0.0014	0.0085*	-0.0041**	0.0048*	0.0000	0.0118***
	(0.6783)	(0.0935)	(0.0162)	(0.0800)	(0.9990)	(0.0013)
Group	-0.0180***	-0.0177***	0.0065***	0.0065***	-0.0041*	-0.0041*
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0839)	(0.0846)
Growth	-0.0053***	-0.0051***	0.0003	0.0002	-0.0019	-0.0019
	(0.0045)	(0.0061)	(0.8446)	(0.8592)	(0.1613)	(0.1679)
Tax	-0.0067**	-0.0074**	-0.0025	-0.0023	-0.0092***	-0.0093***
	(0.0403)	(0.0243)	(0.1236)	(0.1540)	(0.0000)	(0.0000)
Small Loss	-0.0022	-0.0006	0.0016	0.0018	-0.0140*	-0.0135*
	(0.8141)	(0.9452)	(0.8283)	(0.8070)	(0.0533)	(0.0610)
Small Profit	-0.0012	-0.0010	0.0035	0.0036	0.0013	0.0014
	(0.8472)	(0.8730)	(0.3600)	(0.3465)	(0.7602)	(0.7258)
Large Profit	-0.0016	-0.0016	-0.0063***	-0.0064***	-0.0113***	-0.0114***
	(0.6363)	(0.6429)	(0.0004)	(0.0003)	(0.0000)	(0.0000)
Weakness	0.0545***	0.0544***	-0.0227***	-0.0225***	0.0301***	0.0301***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Malpractice	0.0028	0.0028	-0.0396***	-0.0399***	-0.0371***	-0.0376***
	(0.7341)	(0.7373)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 1.6: Continued

	LRE					
	(1) Positive		(2) Negative		(3) All	
Length	0.1274***	0.1268***	-0.1033***	-0.1034***	-0.0396***	-0.0400***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.0194***	0.0194***	-0.0004	-0.0005	0.0141***	0.0140***
	(0.0000)	(0.0000)	(0.8161)	(0.7236)	(0.0000)	(0.0000)
SOX	-0.0206***	-0.0144*	0.0099***	0.0136***	0.0034	0.0089**
	(0.0073)	(0.0741)	(0.0058)	(0.0002)	(0.4142)	(0.0389)
SOX_Public		-0.0204***		-0.0136***		-0.0201***
		(0.0003)		(0.0000)		(0.0000)
Constant	-0.1044***	-0.1081***	-0.0240**	-0.0257**	-0.0766***	-0.0795***
	(0.0000)	(0.0000)	(0.0376)	(0.0269)	(0.0000)	(0.0000)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4988	4988	10178	10178	15166	15166
R-squared	0.3273	0.3293	0.2438	0.2458	0.1943	0.1962

Note) The dependent variable, *LRE*, is measured with claim loss reserve error scaled by total assets. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *RatingNo* is the number of FSR ratings one insurer holds. Otherwise, zero. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

Model (1) and (2) in Table 1.5 show positive and negative signs on *RatingHolding* respectively. Such opposite signs imply that insurers' reserve estimation can be affected by firms' reserving status. For example, under-reserving insurers with at least one rating tend to estimate their loss reserves more conservatively. LRE are encouraged to estimate their loss reserves more conservatively. In addition, firms with negative LRE are required to reduce the magnitude of overestimated loss reserves by CRAs. Those opposite directions depending on reserving status shows a possibility of the intervention of CRAs. That is, CRAs might encourage insurers to estimate their loss reserves more accurately. Nevertheless, all coefficients of *RatingHolding* in Table 1.5 are not significant. Therefore, it suggests that the effect of rating holding itself is limited to control insurers' loss reserve management behaviors.

On the other hand, Table 1.6 provides more interesting evidence on the effect of multi-ratings. Although the effect of rating holding itself is not significant in Table 1.5, holding multi-ratings seems to be more effective in monitoring insurers' reserve management behavior. When insurers have negative LRE (over-reserved), they seem to be required to reduce the degree of reserve overestimation, showing a significant and positive coefficient in Model (2). On the other hand, the coefficient of *RatingNo* in Model (1) is negative but still insignificant. Such limited impact to under-reserved firms indicates that CRAs need additional attention to those firms with positive LRE to control their reserve management behaviors.

Table 1.5 and Table 1.6 provide similar empirical findings regarding the impacts of other factors on insurers' reserve management behaviors. First, there is a significant and positive relationship between firm size and loss reserve error. It means that larger firms

tend to underestimate their loss reserves than smaller firms. Such results can be originated from two main reasons: (1) when firms are larger and complex, managers are more likely to be opportunistic to maximize their private benefits through information asymmetry (Jensen and Meckling, 1976). In addition, the effect of a manager's opportunistic behavior dominates the benefits of monitoring from outside market participants and governance. (2) In general, larger firms tend to have enough risk buffer than smaller firms. In this case, firms have fewer incentives to overestimate their loss reserves.

Second, similar to larger firms, firms using more reinsurance contracts tend to underestimate their loss reserves because reinsurance contracts provide a sufficient risk buffer to insurers. The empirical results in Table 1.5 and Table 1.6 show that all coefficients of *reinsurance* are positive and significant at the 1% level. Such results imply that insurers believe that they can reduce risk and stabilize loss experience by transferring risk to reinsurers. Moreover, the above finding suggests that the monitoring function of reinsurers or possible discount benefit does not give a considerable incentive to manage their loss reserves more conservatively.

Third, the degree of diversification also affects insurers' reserve management practice. Table 1.5 and Table1.6 provide evidence that firms are more likely to overestimate their loss reserves when they have concentrated business lines, showing positive and significant signs in all models. However, the effect of geographical diversification (*GDHHI)* is different depending on an insurer's reserving status. Although firms with negative LRE still show a negative and significant sign, firms with positive LRE show a positive and significant sign, so overall the impact of *GDHHI* is insignificant when we study all sample firms.

Fourth, being a group member seems to an effectively way to manage an insurer's reserve management behavior. The empirical results in Table 1.5 and Table 1.6 show that firms with positive (negative) LRE have a negative (positive) and significant coefficient. These results suggest that under-reserved firms are asked to estimate their reserves more conservatively at a group level. Moreover, over-reserved firms are required to reduce the degree of overestimation. Therefore, group firms are more likely to accurately estimate their loss reserves than non-group firms because of internal monitoring at the group level.

Fifth, to manage their financial weakness and potential risk from specific business lines, firms seem to manipulate their loss reserves. However, the management approaches are different depending on reserving status. Table 1.5 and Table 1.6 show that all coefficients of *Weakness*, *Malpractice*, and *Length* are negative and significant for those firms with negative LRE. However, most coefficients of *Weakness*, *Malpractice*, and *Length* are positive and significant for those firms with positive LRE. Such findings implicate that firms with enough reserves tend to actively manage financial weakness and potential risks by reserving more conservatively. On the other hand, under-reserved firms tend to underestimate their loss reserves to hide their financial weakness.

Sixth, although stock firms are expected to have strong governance structure and monitoring function, the empirical results in Table 1.5 and Table 1.6 show that *Stock* is positively associated with loss reserve error for those firms with positive LRE. It means that stock firms tend to underestimate their loss reserves when firms are under-reserved. On the other hand, there is no significant difference for over-reserved firms between stock firms and non-stock firms.

Last, although the SOX is enacted to regulate publicly traded firms, the enactment

of the SOX seems to improve the accuracy of reserve estimation over the market. The empirical results in Table 1.5 and Table 1.6 show that under-reserved firms begin to estimate their loss reserves more conservatively after the SOX. In addition, SOX encourages over-reserved firms to reduce the degree of overestimation. On the other hand, the interaction term with *Public* shows that public firms with positive LRE estimate their loss reserves more conservatively. The coefficients of the interaction term are negative and significant for those firms with negative LRE.

1.5.2 Rating and AbsLRE

In this section, we investigate the impacts of rating holding and multiple-ratings on the accuracy of insurers' loss reserve estimation. The relationship between rating holding and accuracy of reserve estimation is shown in Table 1.7. Table 1.8 provides the empirical evidence on the relationship between the number of ratings and the accuracy of reserve estimation. Because the most findings shown in Table 1.7 are consistent with findings in Table 1.8, we mainly describe the results in Table 1.7.

Consistent with findings in Table 1.5, the empirical results in Table 1.7 illustrate that rating holding itself does not have a significant impact on insurers' loss reserve estimation accuracy. However, we find that all coefficients of *RatingHolding* are negative. Although holding a rating itself does not encourage insurers to estimate their loss reserves more accurately, multi-ratings seem to help improve the accuracy of LRE, particularly for over-reserved firms. Such findings suggest that insurers are motivated to accurately estimate loss reserves if they are monitored by several CRAs.

Table 1.7 and Table 1.8 also provide empirical evidence on how other factors

affect an insurer's reserve forecast accuracy. Most implications from the results in Table 1.7 are consistent with those in Table 1.8. Therefore, we mainly describe the results in Table 1.7. First, the effects of firm size and reinsurance on the variance of LRE are different by reserving status. The empirical results of Model (1) in Table 1.7 show that the variance is significantly increased when firms are larger. On the other hand, the volatility of LRE is reduced for those firms with over-reserving. We also find that under-reserved (over-reserved) firms using more reinsurance tend to have larger (smaller) variance of LRE than under-reserved firms using less. Because of such different directions between over-reserved firms and under-reserved firms, the impacts of firm size and reinsurance use on the reserve accuracy are diluted in the overall market as shown in Model (3).

Second, diversified business activities also affect the degree of LRE volatility. The concentrated business of firms with positive LRE deteriorates the accuracy of reserve estimation. However, over-reserved firms tend to have more accurate estimation when they concentrate on specific business lines. Moreover, doing business in the less diversified insurance market worsens the estimation accuracy for all firms.

Third, consistent with findings in Table 1.5 and Table 1.6, we find that group firm's reserve estimation is more accurate than non-group firms. Table 1.7 and Table 1.8 show that all coefficients of *Group* are negative and significant at the 1% level. These results indicate that group members are required to estimate their loss reserve more conservatively. Over-reserved (under-reserved) group firms are encouraged to reduce the magnitude of over-reserves (under-reserves). Therefore, *group* seems to internally monitor insurers' loss reserve management behaviors, encouraging insurers to improve the accuracy of the reserve estimation.

Fourth, insurers' behavior to deal with financial weakness and potential risk from specific business lines seem to deteriorate the accuracy of loss reserve estimation. Both Table 1.5 and Table 1.6 show that firms with positive (negative) LRE tend to underestimate (overestimate) their loss reserves. However, the empirical results in Table 1.7 and Table 1.8 provide evidence that most coefficients of *Weakness*, *Malpractice*, and *Length* are positive and significant regardless of reserving status. Therefore, insurers' risk management activities through loss reserve management increase the variance of LRE.

Fifth, the monitoring function of stock firms seems ineffective in improving the accuracy of loss reserve estimation, especially for firms with positive LRE. Table 1.7 shows that stock firms with positive LRE have positive and significant signs, whereas stock firms with negative LRE have positive but insignificant signs. In addition, stock firms are more likely to have a higher variance of LRE than non-stock firms over the market. Such results implicate that stock firms should be more effectively monitored to improve the accuracy of reserve estimation.

Sixth, we also find that the enactment of the SOX is effective in alleviating the volatility of loss reserve error over the market. All coefficients of the SOX in Table 1.7 and Table 1.8 are negative and significant. Such findings indicate the impact of the SOX spreads over the market, despite the regulatory intervention is aiming at publicly traded firms. In addition, the effect of the SOX to publicly traded firms is different depending on reserving status. Firms with positive LRE show the additional improvement of the accuracy of reserve forecast. However, the accuracy is deteriorated to firms with negative LRE. Nevertheless, the enactment of the SOX seems effective in improving overall insurers' reserve forecast accuracy.

Table 1.7 Effect of Rating Holding on AbsLRE

	AbsLRE					
	(1) Positive		(2) Negative		(3) All	
RatingHolding	-0.0054	-0.0044	-0.0005	-0.0008	-0.0011	-0.0011
	(0.2352)	(0.3432)	(0.7899)	(0.7024)	(0.5786)	(0.5975)
Size	0.0054***	0.0055***	-0.0018***	-0.0018***	0.0010*	0.0010*
	(0.0000)	(0.0000)	(0.0007)	(0.0007)	(0.0707)	(0.0701)
Reinsurance	0.0152***	0.0149***	-0.0112***	-0.0114***	-0.0014	-0.0014
	(0.0016)	(0.0020)	(0.0000)	(0.0000)	(0.5678)	(0.5723)
PDHHI	-0.0119**	-0.0119**	0.0073***	0.0070***	0.0009	0.0009
	(0.0142)	(0.0137)	(0.0028)	(0.0041)	(0.7240)	(0.7093)
GDHHI	0.0141***	0.0141***	0.0070***	0.0069***	0.0095***	0.0095***
	(0.0012)	(0.0011)	(0.0005)	(0.0007)	(0.0000)	(0.0000)
Public	-0.0018	0.0080	0.0034*	-0.0044	0.0011	0.0023
	(0.5752)	(0.1110)	(0.0597)	(0.1048)	(0.5255)	(0.4289)
Group	-0.0178***	-0.0175***	-0.0075***	-0.0075***	-0.0115***	-0.0115***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Growth	-0.0053***	-0.0051***	-0.0001	-0.0001	-0.0021*	-0.0021*
	(0.0043)	(0.0060)	(0.9400)	(0.9610)	(0.0630)	(0.0629)
Tax	-0.0068**	-0.0074**	0.0022	0.0020	-0.0011	-0.0011
	(0.0388)	(0.0234)	(0.1872)	(0.2299)	(0.5157)	(0.5152)
Small Loss	-0.0029	-0.0012	-0.0014	-0.0016	-0.0026	-0.0025
	(0.7549)	(0.8956)	(0.8461)	(0.8253)	(0.6707)	(0.6770)
Small Profit	-0.0017	-0.0014	-0.0034	-0.0035	-0.0034	-0.0034
	(0.7853)	(0.8223)	(0.3784)	(0.3641)	(0.3150)	(0.3181)
Large Profit	-0.0014	-0.0014	0.0062***	0.0063***	0.0026	0.0026
	(0.6803)	(0.6788)	(0.0006)	(0.0005)	(0.1441)	(0.1456)
Weakness	0.0545***	0.0544***	0.0237***	0.0237***	0.0382***	0.0382***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Malpractice	0.0028	0.0028	0.0410***	0.0414***	0.0318***	0.0318***
	(0.7410)	(0.7398)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 1.7: Continued

	AbsLRE					
	(1) Positive		(2) Negative		(3) All	
Length	0.1269***	0.1264***	0.1019***	0.1020***	0.1102***	0.1102***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.0194***	0.0194***	0.0002	0.0003	0.0066***	0.0066***
	(0.0000)	(0.0000)	(0.9073)	(0.8328)	(0.0000)	(0.0000)
SOX	-0.0216***	-0.0153*	-0.0114***	-0.0147***	-0.0134***	-0.0129***
	(0.0058)	(0.0654)	(0.0021)	(0.0001)	(0.0001)	(0.0003)
SOX_Public		-0.0204***		0.0118***		-0.0020
		(0.0003)		(0.0002)		(0.5328)
Constant	-0.0967***	-0.1015***	0.0381***	0.0410***	-0.0131	-0.0135
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1676)	(0.1567)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4988	4988	10178	10178	15166	15166
R-squared	0.3273	0.3293	0.2418	0.2433	0.2703	0.2704

Note) The dependent variable, *AbsLRE*, is measured with absolute value of *LRE*. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *RatingHolding* is set equal to one if an insurer has at least one FSR. Otherwise, zero. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

Table 1.8 Effect of Rating Number on AbsLRE

	AbsLRE					
	(1) Positive		(2) Negative		(3) All	
RatingNo	-0.0025	-0.0021	-0.0040***	-0.0045***	-0.0029***	-0.0028***
	(0.1474)	(0.2195)	(0.0022)	(0.0005)	(0.0074)	(0.0076)
Size	0.0057***	0.0057***	-0.0009	-0.0008	0.0016**	0.0016**
	(0.0000)	(0.0000)	(0.1795)	(0.2240)	(0.0115)	(0.0116)
Reinsurance	0.0161***	0.0157***	-0.0094***	-0.0094***	-0.0001	-0.0001
	(0.0009)	(0.0012)	(0.0003)	(0.0002)	(0.9744)	(0.9727)
PDHHI	-0.0119**	-0.0120**	0.0062**	0.0058**	0.0001	0.0001
	(0.0131)	(0.0124)	(0.0107)	(0.0175)	(0.9656)	(0.9551)
GDHHI	0.0142***	0.0142***	0.0067***	0.0065***	0.0093***	0.0093***
	(0.0011)	(0.0011)	(0.0008)	(0.0012)	(0.0000)	(0.0000)
Public	-0.0014	0.0085*	0.0041**	-0.0048*	0.0017	0.0023
	(0.6783)	(0.0935)	(0.0162)	(0.0800)	(0.3307)	(0.4115)
Group	-0.0180***	-0.0177***	-0.0065***	-0.0065***	-0.0109***	-0.0109***
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
Growth	-0.0053***	-0.0051***	-0.0003	-0.0002	-0.0023**	-0.0023**
	(0.0045)	(0.0061)	(0.8446)	(0.8592)	(0.0455)	(0.0456)
Tax	-0.0067**	-0.0074**	0.0025	0.0023	-0.0009	-0.0009
	(0.0403)	(0.0243)	(0.1236)	(0.1540)	(0.5950)	(0.5937)
Small Loss	-0.0022	-0.0006	-0.0016	-0.0018	-0.0025	-0.0025
	(0.8141)	(0.9452)	(0.8283)	(0.8070)	(0.6779)	(0.6811)
Small Profit	-0.0012	-0.0010	-0.0035	-0.0036	-0.0034	-0.0034
	(0.8472)	(0.8730)	(0.3600)	(0.3465)	(0.3254)	(0.3267)
Large Profit	-0.0016	-0.0016	0.0063***	0.0064***	0.0026	0.0026
	(0.6363)	(0.6429)	(0.0004)	(0.0003)	(0.1399)	(0.1406)
Weakness	0.0545***	0.0544***	0.0227***	0.0225***	0.0376***	0.0376***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Malpractice	0.0028	0.0028	0.0396***	0.0399***	0.0310***	0.0309***
	(0.7341)	(0.7373)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 1.8: Continued

	AbsLRE					
	(1) Positive		(2) Negative		(3) All	
Length	0.1274***	0.1268***	0.1033***	0.1034***	0.1110***	0.1110***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.0194***	0.0194***	0.0004	0.0005	0.0068***	0.0068***
	(0.0000)	(0.0000)	(0.8161)	(0.7236)	(0.0000)	(0.0000)
SOX	-0.0206***	-0.0144*	-0.0099***	-0.0136***	-0.0126***	-0.0122***
	(0.0073)	(0.0741)	(0.0058)	(0.0002)	(0.0002)	(0.0004)
SOX_Public		-0.0204***		0.0136***		-0.0012
		(0.0003)		(0.0000)		(0.7071)
Constant	-0.1044***	-0.1081***	0.0240**	0.0257**	-0.0229**	-0.0231**
	(0.0000)	(0.0000)	(0.0376)	(0.0269)	(0.0326)	(0.0323)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	4988	4988	10178	10178	15166	15166
R-squared	0.3273	0.3293	0.2438	0.2458	0.2710	0.2710

Note) The dependent variable, *AbsLRE*, is measured with absolute value of *LRE*. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *RatingNo* is the number of FSR ratings one insurer holds. Otherwise, zero. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

1.5.3 Rating Discrepancy

Previously we examine how holding a rating and rating number may affect insurers' loss reserve management behaviors. This section shows how insurers' loss reserve management behaviors are affected by the rating difference given by different CRAs. If insurers consider the rating difference as a result of random error, they have no incentives to manipulate loss reserves. However, if insurers consider the rating disagreement as a source of information asymmetry, they are more likely to manipulate their loss reserves.

The empirical results in Table 1.9 provide marginal evidence that firms with a larger rating difference tend to more underestimate their loss reserves than firms with a smaller rating difference over the market.[7] Although both coefficients of *Difference* for firms with positive LRE and firms with negative LRE are not significant, they are positive as shown in Model (1) and Model (2). In addition, the coefficient in Model (3) is positive and marginally significant at the 10% level. In respect to the effect of the SOX, the SOX seems to encourage insurers to estimate their loss reserves more conservatively, showing a negative sign.[8] The interaction term with *Public* is significant only for those firms with positive LRE and the interaction term with *Difference* is significant only for those firms with negative LRE, showing negative signs.

Table 1.10 shows how the rating difference has an insignificant impact on accuracy

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[7] We also tested hypothesis including business mix variables. The empirical results provide stronger evidence that firms with larger rating difference tend to underestimate their loss reserves regardless of reserving status. Therefore, firms with a rating difference seems to recognize the rating difference as a source of hidden information.

[8] For better understanding, we conducted the joint F-test (Difference and SOX_Difference). The results of the joint F test suggest that before SOX, insurers with a larger rating difference tend to under-reserve more, but after SOX, the rating difference does not matter, probably because insurers report more accurate financial information due to the impact of SOX. Then the rating difference now is more of a random error instead of asymmetric information.

of loss reserve estimation. Moreover, the enactment of the SOX does not considerably improve the accuracy of loss reserve estimation for those firms with rating difference. Even, the variance increases after the SOX for firms with negative LRE as shown in Model (2).

Table 1.9 Effect of Rating Difference (S&P and Moody's) on LRE

	LRE		
	(1) Positive	(2) Negative	(3) All
Difference1	0.0232	0.0174	0.0325*
	(0.2340)	(0.1444)	(0.0569)
Size	0.0151***	0.0078	0.0118***
	(0.0004)	(0.1667)	(0.0049)
Reinsurance	0.0686**	0.0592**	0.0702***
	(0.0255)	(0.0383)	(0.0012)
PDHHI	-0.0211	0.0127	-0.0014
	(0.2742)	(0.4253)	(0.9217)
GDHHI	0.0306	0.0121	0.0306**
	(0.1469)	(0.3051)	(0.0240)
Public	0.0223	-0.0137	0.0010
	(0.5784)	(0.3324)	(0.9726)
Group	-0.0510	-0.0045	-0.0407
	(0.4008)	(0.8499)	(0.3850)
Growth	-0.0048	0.0082*	0.0077*
	(0.6557)	(0.0605)	(0.0842)
Tax	-0.0234*	-0.0004	-0.0296***
	(0.0751)	(0.9590)	(0.0038)
Weakness	0.0439**	-0.0353***	0.0133
	(0.0108)	(0.0026)	(0.3623)
Malpractice	-0.1785	0.0570	-0.0284
	(0.1198)	(0.1957)	(0.4540)
Length	0.1258***	-0.0258**	0.0346*
	(0.0001)	(0.0380)	(0.0655)
Stock	0.0647**	0.0048	0.0251
	(0.0234)	(0.7170)	(0.1054)
SOX	-0.0165	-0.0034	-0.0766**
	(0.7195)	(0.8928)	(0.0333)
SOX_Public	-0.0654*	-0.0072	-0.0224
	(0.0559)	(0.6453)	(0.4056)
SOX_Difference1	-0.0049	-0.0431*	-0.0256
	(0.8308)	(0.0577)	(0.2479)
Constant	-0.3063***	-0.2172	-0.2011**
	(0.0038)	(0.1074)	(0.0483)
Year-Fixed Effect	Yes	Yes	Yes
N	369	597	966
R-squared	0.4575	0.0845	0.2778

Table 1.9: Continued

Note) The dependent variable, *LRE*, is measured with claim loss reserve error scaled by total assets. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *Difference1* measures the absolute value of rating difference from two rating agencies, S&P and Moody's. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

Table 1.10 Effect of Rating Difference (S&P and Moody's) on AbsLRE

	AbsLRE		
	(1) Positive	(2) Negative	(3) All
Difference1	0.0232	-0.0174	0.0104
	(0.2340)	(0.1444)	(0.4883)
Size	0.0151***	-0.0078	0.0013
	(0.0004)	(0.1667)	(0.7517)
Reinsurance	0.0686**	-0.0592**	-0.0037
	(0.0255)	(0.0383)	(0.8587)
PDHHI	-0.0211	-0.0127	-0.0145
	(0.2742)	(0.4253)	(0.2584)
GDHHI	0.0306	-0.0121	0.0075
	(0.1469)	(0.3051)	(0.5006)
Public	0.0223	0.0137	0.0193
	(0.5784)	(0.3324)	(0.4753)
Group	-0.0510	0.0045	-0.0418
	(0.4008)	(0.8499)	(0.3647)
Growth	-0.0048	-0.0082*	-0.0055
	(0.6557)	(0.0605)	(0.1737)
Tax	-0.0234*	0.0004	-0.0188**
	(0.0751)	(0.9590)	(0.0189)
Weakness	0.0439**	0.0353***	0.0402***
	(0.0108)	(0.0026)	(0.0003)
Malpractice	-0.1785	-0.0570	-0.0496
	(0.1198)	(0.1957)	(0.2203)
Length	0.1258***	0.0258**	0.0637***
	(0.0001)	(0.0380)	(0.0000)
Stock	0.0647**	-0.0048	0.0171
	(0.0234)	(0.7170)	(0.2252)
SOX	-0.0165	0.0034	0.0278
	(0.7195)	(0.8928)	(0.4238)
SOX_Public	-0.0654*	0.0072	-0.0158
	(0.0559)	(0.6453)	(0.5282)

Table 1.10: Continued

	AbsLRE		
	(1) Positive	(2) Negative	(3) All
SOX_Difference1	-0.0049	0.0431*	0.0074
	(0.8308)	(0.0577)	(0.7015)
Constant	-0.3063***	0.2172	0.0152
	(0.0038)	(0.1074)	(0.8761)
Year-Fixed Effect	Yes	Yes	Yes
N	369	597	966
R-squared	0.4575	0.0845	0.2456

Note) The dependent variable, *AbsLRE*, is measured with absolute value of *LRE*. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *Difference1* measures the absolute value of rating difference from two rating agencies, S&P and Moody's. *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is one if firm year is after 2003. Otherwise, zero.

For the robustness check, we tested same hypothesis with rating difference data from other CRAs. Table 1.11 shows marginal evidence that the insurers with larger rating difference are more likely to underestimate their reserves than firms with smaller rating difference. Among the six types of *Difference*, four coefficients are positive and significant. Although the remaining two coefficients show negative signs, they are not significant. Despite the above findings in Table 1.11, Table 1.12 show that rating difference does not affect the accuracy of estimation significantly. Table 1.11 and Table 1.12 also illustrate the effect of the SOX on insurers' reserve management. Table 1.11 provides evidence that the SOX helps alleviate under-reserving behaviors over the market, improving overall accuracy. Moreover, the SOX encourages insurers with rating difference to estimate their loss reserves more conservatively. However, there is no evidence that the SOX effectively improves the accuracy of reserve estimation for those firms with rating difference.

Table 1.11 Robustness Check: Effect of Rating Disagreement from Other CRAs on LRE

	LRE					
	(1) Difference 1	(2) Difference 2	(3) Difference 3	(4) Difference 4	(5) Difference 5	(6) Difference 6
Difference #	0.0325*	0.0523**	0.0236**	-0.0056	0.1250***	-0.0163
	(0.0569)	(0.0181)	(0.0421)	(0.1659)	(0.0011)	(0.4963)
Size	0.0118***	0.0052***	0.0117***	0.0041***	0.0155***	0.0067**
	(0.0049)	(0.0064)	(0.0043)	(0.0037)	(0.0014)	(0.0111)
Reinsurance	0.0702***	0.0255***	0.0762***	0.0292***	0.1027***	0.0342***
	(0.0012)	(0.0010)	(0.0004)	(0.0000)	(0.0000)	(0.0038)
PDHHI	-0.0014	-0.0037	-0.0039	-0.0239***	0.0029	-0.0071
	(0.9217)	(0.5908)	(0.7787)	(0.0002)	(0.8379)	(0.4635)
GDHHI	0.0306**	0.0032	0.0151	-0.0077	0.0355***	0.0120*
	(0.0240)	(0.5079)	(0.2349)	(0.1180)	(0.0085)	(0.0789)
Public	0.0010	-0.0692	-0.0123	0.0103	-0.0696	-0.0543
	(0.9726)	(0.1265)	(0.6561)	(0.1726)	(0.3728)	(0.2953)
Group	-0.0407	-0.0011	-0.0149	-0.0023	0.0092	-0.0247
	(0.3850)	(0.8196)	(0.6984)	(0.7435)	(0.7718)	(0.2911)
Growth	0.0077*	0.0048	0.0091*	0.0069**	0.0142***	0.0081**
	(0.0842)	(0.1278)	(0.0664)	(0.0109)	(0.0047)	(0.0458)
Tax	-0.0296***	-0.0094**	-0.0171*	-0.0153***	-0.0298***	-0.0257***
	(0.0038)	(0.0340)	(0.0821)	(0.0001)	(0.0043)	(0.0001)
Weakness	0.0133	0.0216**	0.0125	0.0334***	0.0082	0.0290**
	(0.3623)	(0.0387)	(0.5092)	(0.0010)	(0.6026)	(0.0148)
Malpractice	-0.0284	-0.1287***	-0.2100***	-0.0490***	-0.1924**	-0.1204***
	(0.4540)	(0.0000)	(0.0072)	(0.0000)	(0.0191)	(0.0000)
Length	0.0346*	-0.0381***	-0.0047	-0.0037	-0.0070	0.0074
	(0.0655)	(0.0001)	(0.8547)	(0.7070)	(0.6893)	(0.6053)
Stock	0.0251	0.0040	0.0213	0.0163***	0.0344**	0.0139**
	(0.1054)	(0.2868)	(0.1543)	(0.0001)	(0.0401)	(0.0433)
SOX	-0.0766**	-0.0785*	0.0201	0.0919**	-0.2424***	-0.1920***
	(0.0333)	(0.0558)	(0.4975)	(0.0470)	(0.0032)	(0.0006)

Table 1.11: Continued

	LRE					
	(1) Difference 1	(2) Difference 2	(3) Difference 3	(4) Difference 4	(5) Difference 5	(6) Difference 6
SOX_Public	-0.0224	0.0619	-0.0062	0.0218***	.0546	0.0409
	(0.4056)	(0.1705)	(0.8083)	(0.0058)	(0.4789)	(0.4309)
SOX_Difference1	-0.0256					
	(0.2479)					
SOX_Difference2		-0.0506**				
		(0.0219)				
SOX_Difference3			-0.0215			
			(0.1036)			
SOX_Difference4				0.0021		
				(0.6262)		
SOX_Difference5					-0.1209***	
					(0.0053)	
SOX_Difference6						0.0166
						(0.4951)
Constant	-0.2011**	-0.0421	-0.3214***	-0.1856***	-0.1837	0.0542
	(0.0483)	(0.4328)	(0.0017)	(0.0006)	(0.1635)	(0.4946)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	966	2294	979	4352	776	1462
R-squared	0.2778	0.2186	0.3195	0.2838	0.2211	0.1773

Note) The dependent variable, *LRE*, is measured with claim loss reserve error scaled by total assets. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *Difference* measures the absolute value of rating difference from two rating agencies, *Difference1* (S&P vs. Moody's), *Difference2* (AM Best vs. Fitch), *Difference 3* (AM Best vs. Moody's), *Difference4* (AM Best vs. S&P), *Difference5* (Fitch vs. Moody's), and *Difference6* (Fitch vs. S&P). *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

Table 1.12 Robustness Check: Effect of Rating Disagreement from Other CRAs on AbsLRE

	AbsLRE					
	(1) Difference 1	(2) Difference 2	(3) Difference 3	(4) Difference 4	(5) Difference 5	(6) Difference 6
Difference #	0.0104	0.0226	-0.0034	0.0013	0.0342	-0.0156
	(0.4883)	(0.2609)	(0.7161)	(0.6928)	(0.4173)	(0.3220)
Size	0.0013	-0.0009	0.0008	0.0035***	-0.0048	-0.0017
	(0.7517)	(0.6247)	(0.8401)	(0.0056)	(0.3236)	(0.5013)
Reinsurance	-0.0037	-0.0065	-0.0034	0.0052	-0.0297	-0.0178*
	(0.8587)	(0.3463)	(0.8677)	(0.3396)	(0.2402)	(0.0978)
PDHHI	-0.0145	-0.0053	-0.0149	-0.0005	-0.0175	-0.0069
	(0.2584)	(0.3770)	(0.2263)	(0.9234)	(0.1643)	(0.4202)
GDHHI	0.0075	-0.0067*	0.0024	0.0023	-0.0126	-0.0073
	(0.5006)	(0.0858)	(0.8211)	(0.5514)	(0.2831)	(0.1832)
Public	0.0193	-0.0607	0.0049	0.0037	-0.0746	-0.0803*
	(0.4753)	(0.1233)	(0.8464)	(0.5454)	(0.3922)	(0.0534)
Group	-0.0418	-0.0063*	-0.0017	-0.0209***	-0.0154	-0.0364**
	(0.3647)	(0.0938)	(0.9658)	(0.0003)	(0.5593)	(0.0453)
Growth	-0.0055	-0.0022	-0.0058	-0.0013	-0.0104**	-0.0046
	(0.1737)	(0.3585)	(0.1771)	(0.5910)	(0.0245)	(0.1558)
Tax	-0.0188**	-0.0019	-0.0107	-0.0001	-0.0148*	-0.0062
	(0.0189)	(0.5956)	(0.1908)	(0.9659)	(0.0804)	(0.2198)
Weakness	0.0402***	0.0265***	0.0417***	0.0448***	0.0362***	0.0305***
	(0.0003)	(0.0006)	(0.0059)	(0.0000)	(0.0028)	(0.0013)
Malpractice	-0.0496	0.1104***	0.1697**	0.0206***	0.1815**	0.0847***
	(0.2203)	(0.0000)	(0.0145)	(0.0008)	(0.0145)	(0.0000)
Length	0.0637***	0.0892***	0.0636***	0.1072***	0.0526***	0.0852***
	(0.0000)	(0.0000)	(0.0027)	(0.0000)	(0.0001)	(0.0000)
Stock	0.0171	0.0018	0.0128	0.0063**	0.0236	0.0048
	(0.2252)	(0.5713)	(0.3120)	(0.0466)	(0.1136)	(0.3869)
SOX	0.0278	-0.0353	-0.0042	-0.0677**	-0.1418	-0.1620***
	(0.4238)	(0.2880)	(0.8701)	(0.0399)	(0.1220)	(0.0004)

Table 1.12: Continued

	AbsLRE					
	(1) Difference 1	(2) Difference 2	(3) Difference 3	(4) Difference 4	(5) Difference 5	(6) Difference 6
SOX_Public	-0.0158	0.0717*	0.0069	0.0024	0.0836	0.0904**
	(0.5282)	(0.0686)	(0.7596)	(0.7091)	(0.3318)	(0.0308)
SOX_Difference1	0.0074					
	(0.7015)					
SOX_Difference2		-0.0163				
		(0.4164)				
SOX_Difference3			0.0142			
			(0.1899)			
SOX_Difference4				0.0078**		
				(0.0247)		
SOX_Difference5					-0.0186	
					(0.6874)	
SOX_Difference6						0.0166
						(0.3049)
Constant	0.0152	0.0591	-0.0078	-0.0161	0.2958**	0.2462***
	(0.8761)	(0.1851)	(0.9341)	(0.6913)	(0.0271)	(0.0004)
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	966	2294	979	4352	776	1462
R-squared	0.2456	0.2264	0.2536	0.3298	0.1474	0.1865

Note) The dependent variable, *AbsLRE*, is measured with absolute value of *LRE*. Claims loss reserve error is measured as the difference between loss reserve estimation at t and the developed loss reserve in t+5. Total net admitted assets are used as total assets. *Difference* measures the absolute value of rating difference from two rating agencies, *Difference1* (S&P vs. Moody's), *Difference2* (AM Best vs. Fitch), *Difference 3* (AM Best vs. Moody's), *Difference4* (AM Best vs. S&P), *Difference5* (Fitch vs. Moody's), and *Difference6* (Fitch vs. S&P). *Size* is the natural log of total net written premium. Reinsurance is a ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *PD* and *GD* are measured with one minus product HHI and one minus geographical HHI respectively. Three types of organizational structures are measured depending on stock, group, and publicly traded firms. *Growth* indicates a growth rate of net premium written between current year and previous year. *Tax* is a dummy variable set equal to one if an insurer has a high tax rate, zero otherwise. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Small loss* is an indicator for insurers with earnings in the top 5% of negative earnings distribution. *Large profit* is an indicator for insurers with earnings in the top 90% of positive earnings distribution. *Weakness* is set equal to one if an insurer has more than four unusual IRIS ratios. Otherwise, 0. *Malpractice* is a percentage of net premiums written from malpractice business line. *Length* is a percentage of claim loss reserve to total liabilities. *SOX* is set equal to one if firm year is after 2003. Otherwise, zero.

1.6 Conclusion

Existing insurance literature has examined several motivations for loss reserve management in terms of income smoothing, tax reduction, avoidance of regulatory intervention, regulation change, and managerial compensations. However, most of these studies do not pay attention to the effect of firm transparency on insurers' loss reserve management behaviors despite the concerns that the insurance market has severe information asymmetry compared to other markets. In addition, the scandals of financial statement fraud and financial crisis over the 2000s make market participants skeptical of the function of CRAs as gatekeepers. Therefore, it is doubtful whether CRAs give useful information to the market participants in the insurance industry.

This study attempts to figure out the relationship between loss reserve management behavior and firm transparency in the US P&C industry. Specifically, it tries to measure degrees of firm transparency with data from FSRs. Using 15,166 samples between 1996 and 2015, this study investigates three main research questions: 1) whether insurers' loss reserve management behaviors are affected by rating holding, 2) whether insurers evaluate their loss reserves more conservatively if they hold more ratings, and 3) whether insurers regard the rating difference as random error or information asymmetry inherent in firms.

From this study, we find the following implications. First, holding a rating itself does not have a significant impact on insurers' reserve management behaviors. However, when firms hold more ratings, loss reserve estimation becomes more accurate. Such findings suggest that multiple CRAs require insurers to estimate their reserves more accurately. Second, there is a marginal impact of rating difference on insurers' LRE. The empirical results show that firms with rating difference are more likely to underestimate loss reserves

over the market. However, such under-reserving behavior seems to not critically diminish the accuracy of reserve forecast. Third, the enactment of SOX seems to help improve the accuracy of reserve estimation over the market. In addition, the impact to public firms differs depending on s firm's reserving status. We also find marginal evidence that SOX alleviates over-reserving behaviors of firms with rating difference. However, we fail to find any evidence that the reserve accuracy of those firms is improved after SOX.

In spite of the above findings, this study has several limitations. First, it does not account for the various motivations of multi-ratings. Prior studies describe possible reasons for multi-ratings in terms of reduction of the cost of capital, avoidance of the regulatory intervention, and rating shopping. Although these motivations may affect insurers' loss reserve management behaviors, this study does not consider the effect of these motivations. Second, the number of samples with the rating difference is relatively small compared to the number of all samples. Table 1.2 and Table 1.3 show that most insurers get rated by AM Best and the rating given by AM Best is significantly different from other CRAs. If the bias can be adjusted, additional tests can be conducted. One method to remove such discrepancy is to adjust AM Best's rating category. For example, Fitch (2016) suggests that that AM Best's rating of A- is comparable with BBB from Fitch, Moody's, and S&P. Third, we need to consider how the degree of rating difference is affected by regulation changes in nationally recognized statistical rating organizations (NRSRO). In 2006, the US Congress reduced barriers to entry to increase market competition and improve transparency. Such increased competition may affect the rating itself and rating difference. Last, some empirical findings are inconsistent with theoretical expectations. However, this study fails to provide reasonable explanations.

CHAPTER 2

DETERMINANTS OF DERIVATIVE USE AND THE IMPACTS OF THE FINANCIAL CRISIS AND THE DODD-FRANK ACT: EVIDENCE FROM THE U.S. LIFE INSURANCE INDUSTRY

2.1 Introduction

The primary functions of insurance companies in the economy can be divided into two categories: (1) risk-pooling and sharing and (2) financial intermediation (Cummins, Phillips, and Smith, 1997). These two main activities cause several types of risks to insurers. Some types of risks can be effectively managed by using certain risk management techniques such as natural hedging or reinsurance. However, other types of risks such as interest risk and currency risk are not easily transferable or diversifiable, so derivative hedging becomes popular when dealing with such risks (Raturi, 2004).

Over the last two decades, insurers have utilized derivatives to hedge risky positions on their balance sheets. Although derivatives are cost-effective instruments against insurers' risks (Hodgson, 1999; Shiu, 2007), the practice of derivative use in the U.S. insurance market has not been well examined in prior literature.[9] This is quite surprising because the derivative transaction volume and its potential risk are huge. The National Association of Insurance Commissioners (NAIC, 2016) reports that the notional value of derivative transactions used by U.S. insurers in 2015 was approximately $2,000 billion, about 15% of the U.S. GDP. In addition, the most recent U.S. financial crisis over 2007-2008 was

[9] Most prior studies on derivative use have focused on non-financial companies (see Section 2 for more details).

partly attributed to the misuse of derivatives. Therefore, regulators and market participants began to pay attention to insurers' practice of derivative use. Moreover, insurers regularly report their derivative transactions due to the strict regulatory requirements. Some new regulatory requirements in the Title VII of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) were also introduced in 2010. The Dodd-Frank Act changes the environment of both the derivative market and the insurance market.

In this study, we focus on the determinants of derivative participation and its extent in the U.S. life insurance market because life insurers are active users of derivatives, accounting for over 95% risk exposures in the insurance market (NAIC, 2016). In prior literature, some efforts have been made to understand the determinants of derivative engagement and its extent in the insurance market around the world.[10] Nevertheless, several limitations exist to prevent us from fully understanding the derivative practice of the U.S. life insurers. First, the practical use of derivatives varies by countries (De Ceuster et al., 2000) and industry sectors (Cummins, Phillips, and Smith, 2001). The implications from other countries or other industry sectors cannot be directly applied to the U.S. insurance market since they have different market environments and market cycles.[11] Second, there are only a few studies that examine the U.S. insurance market with one year and outdated samples (see, e.g., Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith,

[10] U.S. (e.g., Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 1997, 2001), U.K. (e.g., Hardwick and Adams, 1999; Shiu, 2011), Australia (De Ceuster et al., 2003), Taiwan (Shiu et al., 2014), and Japan (Lantara and Takao, 2014).

[11] For example, the derivative participation rates are over 50% in Australia and the UK (e.g., De Ceuster et al., 2003; Hardwick and Adams, 1999), whereas less than 20% of the U.S. insurers use derivatives. Even, Cummins, Phillips, and Smith (2001) provide evidence that insurers' practical use of derivatives is different by industry sub-sector (between the life & health insurance market and the property & casualty insurance market).

1997, 2001).[12] These studies with single-year samples may lead to biased results due to their overlook of the market cycle. In addition, their data (back in the year of 1992 or 1994) do not reflect the recent market conditions. Third, each type of derivatives has different characteristics and transaction purposes. Nevertheless, prior literature examines the determinants of derivative participation and transaction volumes using aggregated data. Fourth, except for Song and Cummins (2008) and Shiu (2016), prior literature does not capture the endogeneity caused by the reverse relationship between derivative use and reinsurance. Fifth, the impacts of the financial crisis and the Dodd-Frank Act on derivative use by insurers have not yet been examined, although such events/policy regulations may affect derivative use in the U.S. life insurance market significantly. Last, the notional amount is a key proxy to measure the degree of derivative usage, however, the notional amount estimated in prior literature is inaccurate because (1) insurers report the notional amount and the number of contracts in the same blank cell. Therefore, it is not clear whether the figure reported there represents the notional amount or the number of contracts; (2) even after 2010, there are many insurers who report the number of contracts only. Such missing information leads to the underestimation of the notional transaction volumes[13]; and (3) when a firm reports the number of contracts only, we can estimate the transaction volumes by using multipliers. The multiplier varies across the type of transaction and the traded market. However, prior literature applies the same multiplier regardless of the

[12] Cummins, Phillips, and Smith (1997) use samples of 1,207 L&H insurers and 2,063 P&C insurers in 1994 only. Cummins, Phillips, and Smith (2001) examine the derivative practice with samples of 1,216 L&H insurers and 1,668 P&C insurers in 1994 again. Colquitt and Hoyt (1997) use 571 samples of life insurers in 1992.

[13] We find that NAIC also reports the sum of reported notional amounts as a market transaction volume. When firms report the number of contracts only, the transactions are not included in a total.

underlying asset type and the exchange market.

This paper contributes to the extant literature in several aspects. First, we use the latest data collected between 2001 and 2015. Since the sample period include both soft and hard markets, it provides more consistent and reliable results. In addition, using the latest data helps us understand the recent derivative practice of the U.S. life insurers. Second, we estimate the notional amounts more accurately. When it is unclear whether the firm reports the notional amount or the number of contracts, we compare the data before and after 2010 since most firms continue to report their transactions in the same manner. Moreover, when a firm only reports the number of contracts, we calculate the notional amount by applying different multipliers depending on the underlying asset and the traded market. Third, we examine the determinants of derivative participation and its extent, controlling for the reverse relationship between derivative use and reinsurance via the instrumental variable approach. Fourth, this paper also fills the gap by investigating the impacts of the financial crisis and the Dodd-Frank Act on derivative use, which prior literature does not account for. In addition to the total derivative usage, we separately analyze swap participation and transaction volume to test the impact of the Dodd-Frank Act which mainly regulates swaps.

As a preview of our results, we find that the determinants of derivative/swap participation are totally different from those of derivative/swap transaction volumes. Although some factors such as *firm size* affect the likelihood of participation and the amount of transaction volumes in the same direction, many other determinants show opposing effects on participation and extent. We also find that the U.S. life insurance sector is not highly sensitive to the changes in the macroeconomic market environment. It supports the perspective that the insurance sector is fundamentally different from the

banking sector. Our results show that the impact of the financial crisis on derivative usage is not significant in the U.S. life insurance market. The Dodd-Frank Act not only reduces the likelihood of swap participation but also stagnates the growth of swap transaction volumes, while the total derivative transaction volumes are significantly increased. Such findings indicate that the costs of the new regulation outweigh the benefits due to the inefficient and inadequate regulatory changes, supporting the criticism in prior literature.

The remainder of this paper is organized as follows. Section 2.2 reviews existing literature and Section 2.3 develops hypotheses based on theoretical background. Section 2.4 describes our sample data and discusses the methodologies for the empirical analysis. Empirical findings are provided in section 2.5. The last section concludes results and discusses limitations of this study.

2.2 Literature Review

Although the motivations of derivative use have been widely examined around the world, most existing studies have focused on the derivative practice of non-financial firms.[14][15] However, there is a dearth of studies into the motivations of derivative use for financial institutions such as bank and insurance sectors (Shiu, 2010). The practical use of derivatives varies across countries and industry sectors (De Ceuster et al., 2000). Even the determinants are different from the industry sub-sector (Cummins, Phillips, and Smith, 2001). In existing insurance literature on derivatives usage, there are three main research streams: (1) motivations of derivative use (participation and its extent), (2) relationship between reinsurance and derivatives, and (3) effects of derivatives on firm value and risk.

Regarding the motivations of derivative use, there are a few papers examining the U.S. insurance market. Colquitt and Hoyt (1997) investigate the determinants of derivative use of the U.S. life insurers. With samples of 571 life insurers in 1992, they find that firm size, leverage, stock, and asset-liability duration mismatch are positively related to the likelihood of life insurers' derivative use. However, except for stock, these factors do not affect the decision of the derivative transaction amount. Such inconsistent aspects implicate that the motivations of derivative participation are different from those of derivative transaction outstanding. Using data collected in year 1994, Cummins, Phillips, and Smith (1997) find that P&C insurers are more likely to be active in trading equity options and

[14] e.g., Bodnar, Hyat, and Marston (1995), Phillips (1995), and Dolde (1993) in the US; Jalilvand and Tang (1996) in Canada; Grant and Marshal (1997) in the UK; Mallin, Ow-yong, and Reynalds (2001) in Germany; Nguyen and Paff (2002) and Batten, Mellor, Wan (1994) in Australia; Heaney et al. (1999) in Japan.

[15] The motivations of derivative use have been well examined for non-financial firms (e.g., Brown, 2001; Geczy, Minton; and Schrand, 1997; Hentschel and Kothari, 2001; Mian, 1996; Nanse, Smith and Smithson, 1993).

foreign exchange contracts, whereas U.S. life insurers use more derivatives for hedging risks originated from interest rate and foreign exchange. However, the determinants of transaction volumes (extent) are not investigated. Cummins, Phillips, and Smith (2001) reexamine the U.S. insurers' derivative transaction practice in 1994. They find that derivative participation is positively associated with the risk exposure and liquidity, while the estimated risk exposure is negatively related to the derivative volume.

Hardwick and Adams (1999) examine the U.K. life insurance market. With samples from 88 life insurers in 1995, they show that firm size, leverage, and international link are the determinant factors which increase the usage of derivatives. In confront to findings of Colquitt and Hoyt (1997), they find that mutual firms are more likely to use derivatives than stock firms. Moreover, larger firms and stock firms have larger transaction volumes than smaller firms and mutual firms respectively. De Ceuster et al. (2003) examine the insurance market in Australia from 1997 to 1999. The empirical results indicate that firm size (+), leverage (+), and reinsurance (-) are key determinants of derivative use in the life insurance industry. Meanwhile, firm size (+), reinsurance (-), and long-tailed business lines (+) determine the use of derivatives for non-life insurers. Moreover, firm size and asset and liability mismatch affect life insurers' derivative transaction volumes, however, firm size is only significant for non-life insurers. Shiu et al. (2012) investigate the Taiwan insurance market between 2001 and 2003. They provide evidence that firm size, asset and liability duration gap, and risk exposures to foreign exchange and interest rates are key factors which lead insurers to participate more in the derivative transactions. However, the reinsurance use does not stimulate insurers to engage in derivative transactions. Shiu et al. (2012) also show that foreign exposure is an influential factor to increase transaction

volumes. Although the substitutional relationship between reinsurance and derivative transaction volumes is found for non-life insurers, there is no significant relationship for life insurers. Lantara and Takao (2014) investigate the Japanese insurance market. They find that firm size, leverage, proportion of invested stocks and bonds are positively associated with derivative use for both life and non-life insurers. However, reinsurance and solvency margin are not significant factors. The asset and liability mismatch is significant for life insurers only. They also show that the global business increases the likelihood of derivative use and transaction volumes. These results suggest that the motivations of derivative participation and extent vary by countries and industry sub-sectors.

With respect to the relationship between derivatives and reinsurance in the insurance market, the empirical studies have shown inconsistent findings. Some studies suggest that these two risk management tools are used as substitutes. Cummins, Phillips, and Smith (1997) find that there is an inverse relationship between reinsurance and writing options in the U.S P&C insurers. Hardwick and Adams (1999) suggest that the use of reinsurance reduces their propensity to use derivatives of life insurers. In addition, Cummins and Song (2008) provide theoretical interactions between reinsurance and derivative contract with a mean-variance optimization model. Shiu (2014) finds that firms with higher dependence of reinsurance exhibit less reliance on derivatives. On the other hand, other studies support the complementary relationship between derivative instruments and reinsurance. Cummins, Phillips, and Smith (1997, 2001) find that the use of reinsurance contracts by U.S. life insurers is positively associated with the writing of options. Colquitt and Hoyt (1997) find that life insurers using reinsurance tend to participate more in the derivative contract, but there is not a significant relationship

between reinsurance usage and derivative transaction volumes.

Modigliani and Miller (1958) state that firm value cannot be added through hedging activities. However, in the presence of market frictions, risk management has a positive impact on firm values (e.g., Smith and Stulz, 1985; Froot et al., 1993). Nevertheless, the effect of derivative use on firm risk is ambiguous.[16] Although Batram et al. (2011) find that derivative use significantly reduces a firm's overall risk and systematic risk, many other studies fail to find any relationship between derivative use and firm risk (i.e., Graham and Rogers, 2002; Allayannis and Weston, 2001). Trapp and Weib (2016) find that the use of derivatives increases systemic risk in the banking industry. Bierth, Irresberger, Weiss (2016) examine the relationship between derivative use and default risk in the U.S. insurance sector. Using samples of publicly traded 171 U.S. insurers from 1994 to 2011, they find that derivative use significantly increases insurer's exposure to systemic market shocks. It supports the views of insurance regulators that derivative use has a negative impact on firm's financial stability. Batram (2015) suggests that derivative users tend to have higher gross exposures to financial risk than non-users. In addition, risk reduction through derivatives is more effective when shareholder rights are strong and creditor rights are weak. In respect to the effect of derivative use on firm values, Guay and Kothari (2003) and Jin and Jorion (2006) provide evidence that a firm's market value is not affected by hedging activities.

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[16] In the banking sector, Choi and Elyasiani (1997) show that derivative use further exposes exchange rate risk. Similarly, Hirtle (1997) and Li and Yu (2010) suggest that banks using more interest rate derivatives are more likely to have higher systematic interest risk. Li and Marinč (2014) find that financial derivative use increases the degree of systematic risk exposures. However, Yong, Faff, and Chalmers (2009) suggest that the relationship between derivative use and firm risk varies by managed risk types in the banking sector. They find a positive (negative) relationship between derivatives and long-term (short-term) interest rate risk. However, there is no significant impact of financial derivative on exchange rate risk.

2.3 Hypothesis Development

2.3.1 Effect of the Financial Crisis

The financial crisis that occurred between 2007 and 2009 is known as an episode showing significant systemic risk in the market (Cummins and Weiss, 2014). The systemic risk originated from the banking sector and derivatives, spread to other sectors and led to an economic recession, decreasing asset values and real economic activities. However, the impact of the financial crisis seems limited in the insurance industry (e.g., OECD, 2009; SwissRe, 2010). Insurers not only remarkably survived, but also displayed resilience in the adverse market conditions. Even insurers seem to absorb the market volatility as institutional investors (SwissRe, 2010).

OECD (2010) states that the competitive advantages of insurance companies during the financial crisis are attribute to the following unique characteristics. First, even in the depths of the crisis, insurers operate as usual as a shock absorber to the real market. Through the stable premium earnings, insurers can sustain the adequate capacity even when other sources of the capital were unavailable. Second, the nature of insurance business provides stability to their ongoing operations. Insurers' losses are triggered by pre-defined loss events. In addition, insured risks are well diversified and have a low correlation with market conditions. Third, insurers do not lend to others. Therefore, it makes insurers less vulnerable to contagion. Fourth, insurers have major investors in the capital market. Since insurers have widely diversified investment portfolios with high quality, they could avoid losses for the initial crisis period, when the asset value decline was concentrated in lower-quality and higher-risk assets. Most these characteristics make the insurance sector fundamentally different from the banking sector, which primarily led to the financial crisis

(Tyler and Hoenig, 2009; Harrington, 2009, 2010, 2013; Cummins and Weiss, 2014).

Nevertheless, the financial crisis may have changed insurers' practices of derivative use for the following reasons. First, derivatives such as mortgage-backed securities deepened the financial crisis. As a result, the financial crisis spread the pessimistic perception to derivatives in the market. Second, market participants have paid attention to the systemic risk of insurance firms after the financial crisis. The Geneva Association (2010) suggests that there is no relationship between insurers' noncore activities and the financial crisis. However, many other studies still raise concerns about systemic risk in the insurance industry. Bell and Keller (2009) show that traditional insurers do not have systemic risk, but their noncore activities can lead to systemic risk. Cummins and Weiss (2014) also suggest that noncore activities such as financial guarantees and derivatives trading may cause systemic risk. In this respect, insurers might have felt pressure to reduce derivative use, one of noncore activities which increase the systemic risk.

H1: The financial crisis decreases insurers' derivative participation and volume (−).

2.3.2 Effect of the Dodd-Frank Act

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) is the financial reform legislation which was signed by the Obama administration on July 21, 2010 as a response to the financial crisis of 2007-2008. Especially, the Title VII of the Dodd-Frank Act covers swaps and derivative transactions which exacerbated the crisis.[17] The Title VII has three primary goals: 1) minimize systemic risk from derivative

[17] The Congress regards that 2007-2008 financial crisis is exacerbated due to the lack of regulations of OTC derivatives.

contracts, 2) improve transparency in derivative markets, and 3) prohibit entities holding customer deposits from engaging in speculative derivative activity. The Title VII of the Dodd-Frank Act authorizes Securities and Exchange Commission (SEC) and Commodity Futures Trading Commission (CFTC) to jointly regulate derivative transactions.[18] SEC and CFTC regulate security-based-swaps and non-security-based swaps respectively. In addition, some types of derivative transactions such as equity options, commodity futures, and physically settled forwards are excluded from the Title VII.

To achieve these goals, the Dodd-Frank Act includes three major changes. First, it requires that swap contracts be traded on either designated contract market or swap execution facility. Second, it mandates that all relevant swap transactions be submitted and stored at a swap data repository. Third, it requires more capital and liquid collateral to back derivative trades. Fourth, swap contracts should be cleared by a central counterparty.

These new regimes are expected to pose several potential costs for life insurers who actively engage in derivative transactions. According to the report of NAIC (2016), $1.88 Trillion is traded in the insurance industry through the OTC derivative market, which accounts for 93.7% of the total notional value. In addition, swap contracts account for about 49.6% of the total notional value. Therefore, these changes may affect insurers' derivative practices (participation and transaction volumes). For example, insurers need to adjust operations and corporate structures to meet the new clearing and collateralization requirement. Insurers also face ongoing expenses associated with trading, collateral

[18] The Title VII of the Dodd-Frank Act authorizes the Securities and Exchange Commission (SEC) to regulate security-based swaps, instruments on security futures, and credit default swaps based on single names, loans, and narrow-based security indexes. The Commodity Futures Trading Commission (CFTC) regulates all other swaps such as interest swaps, currency swaps, forward rate agreement and basis swap. The SEC and CFTC have joint jurisdiction over mixed swaps.

optimization, and back-office functions. One way to alleviate such costs from the new regimes is to reduce the derivative positions (*H2A*).

Nevertheless, the enactment of the Dodd-Frank Act may give more incentive to engage in derivative contracts and have high transaction volumes. Once new regulations are enacted, market transparency might be improved. In addition, more capital and liquid collateral requirements may reduce the default risk from counter-parties. Therefore, insurers have incentives to increase the likelihood of derivative participation and its transaction outstanding (*H2B*).

H2A: The enactment of the Dodd-Frank Act decreases insurers' derivative participation and transaction volume (−).

H2B: The enactment of the Dodd-Frank Act increases insurers' derivative participation and transaction volume (+).

2.4 Methodology and Data

2.4.1 Methodology

The purpose of this study is to examine the determinants of derivative use and its extent. Berry-Stolzle et al. (2012) suggest that Cragg's two-part model is more appropriate to studies of participation (status) and volume (extent) than ordinary least squares (OLS) or Tobit model. Under the condition with many zero-values, the estimation with the OLS approach on the full samples may provide biased and inconsistent estimators. In addition, the determinants of derivative participation and derivative volumes cannot be separately analyzed with the Tobit model. If the determinants of derivative participation are different from those of derivative volumes, Tobit model can be mis-specified (Berry-Stolzle et al., 2012). In this study, we follow the approach of Berry-Stolzle et al. (2012).

At the first stage of the Cragg two-part model, the determinants of derivatives/swap participation are investigated with a probit model. In prior insurance literature, a probit regression analysis has been commonly conducted to investigate the decision of insurers' derivative engagement (e.g., Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 2001; De Ceuster et al., 2003; Shiu et al., 2012; Lantara and Takao, 2014). In the probit model, firm characteristics, the financial crisis, the Dodd-Frank Act, and macroeconomic variables are included as shown in Equation (3) and Equation (4).

$$Derivative\ Participation = \beta_0 + \beta_i \sum X_{it} + \gamma_1 FS_{it} + \gamma_2 DF_{it} + \sum M_{it} + \varepsilon_{it} \quad (3)$$

$$Swap\ Participation = \beta_0 + \beta_i \sum X_{it} + \gamma_1 FS_{it} + \gamma_2 DF_{it} + \sum M_{it} + \varepsilon_{it} \quad (4)$$

where

Derivative Participation is an indicator whether insurers engage in derivative transactions,
Swap Participation is an indicator whether insurers engage in swap transactions,
X is a vector of explanatory variables,
FS is a dummy of the financial crisis,
DF is a dummy of the Dodd-Frank Act, and
M indicates the macroeconomic factors.

On the other hand, reinsurance may increase (decrease) the likelihood of derivative participation as a supplement (substitute) of derivatives. This may cause a reverse causality relationship between reinsurance and derivative participation, which raises a concern about the endogenous problem. Therefore, we additionally analyze the determinants of the derivative engagement with an IV probit model. To control the endogeneity issue, the degree of reinsurance dependency of the previous year and IRIS violation are employed as instrument variables.

At the second stage, we examine the determinants of derivatives/swap volumes. Equation (5) and Equation (6) are truncated regression models for derivative/swap extent which applies only for derivative users. Similar to Equation (3) and Equation (4), firm characteristics, the financial crisis, the Dodd-Frank Act, and macroeconomic variables are included.

$$Derivative\ Volume = \beta_0 + \beta_i \sum X_{it} + \gamma_1 FS_{it} + \gamma_2 DF_{it} + \sum M_{it} + \varepsilon_{it} \quad (5)$$

$$Swap\ Volume = \beta_0 + \beta_i \sum X_{it} + \gamma_1 FS_{it} + \gamma_2 DF_{it} + \sum M_{it} + \varepsilon_{it} \quad (6)$$

where
Derivative Volume is the notional amount of derivative transactions,
Swap Volume is the amount of swap transactions,
X is a vector of explanatory variables,
FS is a dummy of the financial crisis
DF is a dummy of the enactment of the Dodd-Frank Act, and
M indicates the macroeconomic factors.

We also examine determinants of extent with two-stage least squares (2SLS) approaches. The 2SLS model can avoid simultaneity bias which brings inconsistent estimators. In prior literature, Shiu (2016) uses the 2SLS approach to control the simultaneous decisions on the use of derivative and reinsurance. We use the degree of

reinsurance dependency of the previous year and IRIS violation as instrument variables.[19]

Based on prior literature, we add several firm characteristics which may affect an insurer's derivative use. First, the firm size is frequently used as a proxy to measure firm risk. Warner (1977) states that larger firms have lower bankruptcy costs than smaller firms. Shiu (2011) contends that larger firms are less likely to utilize derivative since they have diversified activities and sufficient capacity to deal with adverse market conditions. On the other hand, the theory of economies of scale points out that larger firms tend to have more experts with knowledge about derivatives and infrastructures for derivative trading (Nance, Smith, and Smithson, 1993). Therefore, larger firms are more likely to engage in derivative transaction and have high volumes (+). In this study, firm size is measured with the natural logarithm of total admitted assets.

Second, leverage is also usually used as a proxy to measure the firm's financial distress (e.g., Colquitt and Hoyt, 1997; De Ceuster et al., 2003). Highly leveraged firms are more likely to face financial distress. Therefore, highly leveraged firms are motivated to engage in derivative transactions to reduce their risks (+). In this study, firm leverage is measured as total liabilities scaled by total net admitted assets.

Third, prior literature shows that the agency costs vary by firm type (e.g., Fama and Jenson, 1983; Mayers and Smith, 1988 and 1990; Liebenberg and Sommer, 2008). The managerial risk aversion hypothesis suggests that mutual insurers are largely controlled by

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[19] To examine the relevance and the validity of the instrumental variables, we check under-identification (Kleibergen-Paap rk LM test), IV weakness (Cragg-Donald Wald test, Kleibergen-Paap rk Wald test, and Stock-Yogo weak ID test), and over-identification (Hansen J test). Kleibergen-Paap rk Wald test rejects the null hypothesis that the instruments are jointly insignificant. All Cragg-Donald Wald test, Kleibergen-Paap rk Wald test, and Stock-Yogo weak ID test reject the null hypothesis the instruments are weak. In addition, the Hansen J statistics is insignificant, thus, the over-identifying restrictions are valid. As a result, two instruments are valid.

risk-averse managers. In addition, mutual firms do not have a strong mechanism to effectively control managers' behaviors (Hardwick and Adams, 1999). In this situation, hedging can alleviate such principal-agent problems (e.g., Froot, Scharfstein, and Stein, 1993, Nance, Smith, and Smithson, 1993, Cummins, Phillips, and Smith, 1997). Therefore, mutual firms can be more motivated to engage in derivative activities than stock firms (−). On the other hand, stock firms tend to be involved in more complex and risky business due to such a strong mechanism (Hodgson, 1999). In this respect, stock firms have more incentives to engage in derivative transaction and have higher volumes than non-stock firms (+).

Fourth, the taxation status is known as one of the important determinants of derivative use (Colquitt and Hoyt, 1997). Prior literature shows that taxation rules affect a firm's decision of derivative use (e.g., Smith and Stulz, 1985, Froot et al., 1993). Particularly, firms with a convex tax schedule can minimize tax liabilities by reducing the volatility of annual reported taxable earnings and using derivatives helps to reduce the variance of taxable earnings (e.g., Hoyt and Khang, 1997; Kleffner and Doherty, 1996). Therefore, firms with higher taxation liabilities are more likely to engage in derivative activities and have higher derivative transaction volumes than firms with lower or non-taxation liabilities (+).

Fifth, conventionally, reinsurance has been an important mechanism for mitigating insurer's risks (Adams, 1996). Through the reinsurance contracts, insurers can alleviate their financing constraint and volatilities in operational cash flows (Hardwick and Adams, 1999). Cummins, Phillips, and Smith (1997) state that reinsurance can be used as a substitute of derivatives to reduce underwriting risk and improve the rate of returns (−).

However, reinsurance can also be used as a complementary tool for risk hedging. Colquitt and Hoyt (1997) argue that the use of reinsurance might be associated with management's predisposition and experience of hedging techniques (+). On the other hand, insurers assume or cede certain types of risks to affiliated firms and/or non-affiliated firms. If insurers highly use the affiliated reinsurance, they could reduce the cost by mitigating the uncertainty from the information asymmetry. However, high dependency on the reinsurance transactions from affiliated firms may not diversify risks at the group level, and thus increases the level of systemic risk. In this study, we expect that firms with high dependency on reinsurance contracts from affiliated firms are more motivated to manage risks through derivative transactions (+).

Last, insurance firms have a different portfolio of assets and liabilities. As a result, insurers face different risks depending on their portfolio structures. This study considers three possible risks imposed in their portfolios: investment risk, currency risk, and interest risk: (1) life insurance contracts are long-term based and insurers invest their assets in securities. However, the value of invested securities fluctuates and this change increases investment risk. Therefore, insurers with highly invested assets in securities have more incentives to hedge their investment risk through derivative contracts (e.g., Shiu, 2007; Cummins, Phillips, and Smith, 1997). (2) insurers are frequently exposed to foreign currency (FX) risk from foreign investment and foreign underwriting activities. Firms with high exposure to FX risk from foreign investment have an incentive to use derivatives to mitigate such risk since the change of FX affects the net values of assets and liabilities (+). Insurers operating overseas business earn premiums from foreign countries. These firms also face FX risk when exchange rate changes are significant during the policy-term. As a

result, the multinational insurance firms are motivated to use more derivatives for hedging currency risk than domestic firms (+). In this study, FX risk from the investment side is measured as a ratio of foreign-invested assets in bonds and equities to total admitted assets. FX risk from underwriting is measured as a dummy variable. If firms earn premiums from foreign countries except for Canada, the value is noted as one. Otherwise, it is zero. (3) prior literature states that life insurers need to match the actuarial value and maturity of liabilities with those of the underlying assets (e.g., Hoyt, 1989; Colquitt and Hoyt, 1997; Santomero and Babbel, 1997). If firms fail to manage the asset-liability duration mismatch, it leads to liquidity risk and interest risk (De Ceuster et al., 2003), decreasing a firm's net value (Hodgson, 1999). Life insurers are more exposed to interest risk than P&C insurers. Moreover, it is harder to match assets and liabilities since 1) life insurance policies are long-term based contracts compared to non-life insurance policies, 2) many life contracts include investment components, 3) policyholders are very sensitive to interest rates (Cummins, Phillips, and Smith, 1997), and 4) life insurers provide various options to policyholders (e.g., guaranteed returns or flexible premium terms). As a result, life insurers need to hedge a balance sheet duration gap through derivative contracts. This study measures the degree of asset and liability mismatch based on the approaches of De Ceuster et al. (2003) and Lantara and Takao (2014). Each value in Equation (1) and (2) is computed again as a value of the natural logarithm.

ALM Mismatch Assets
= Max [0, (current assets - non-current liabilities) / total admitted assets] (1)

ALM Mismatch Liabilities
= Max [0, (non-current liabilities - current assets) / total admitted assets] (2)

2.4.2 Changes in Schedule DB

The derivative data obtained from NAIC are used as key dependent variables in this study. Therefore, it is necessary to explain the structure of Schedule DB and how it has changed. Insurers are required to report information related to derivative transactions to Schedule DB in their statuary statement (see Table 2.1). Before 2010, Schedule DB was composed of six parts by derivatives types. Part A through Part D in Schedule DB include derivative transactions across four categories: Part A - acquired options, caps, floors, and insurance future options, Part B - written options, caps, floors, and insurance future options, Part C - collar, swap, and forward agreements, and Part D - futures contract and insurance futures contracts. Part A through Part D in Schedule DB report the open positions at the end of the current year, which are acquired, written, and terminated during the current year. Part E reports the counterparty exposures open December 31 of the current year. Part F provides data related to replicated (synthetic) assets.

Since 2010, new changes were made in derivatives reporting. First, the significant modification of Schedule DB was undertaken to reduce the number of Parts and Sections. Derivative transactions across four categories from Part A to Part D were newly combined into Part A and Part B. The previous Part A, B, and C were aggregated into the new Part A. The prior Part D was reported in the new Part B. The counterparty exposures in prior Part E were reported in the new Part D. In addition, the prior Part F shifted to the new Part C. Particularly, Schedule DB was modified to completely exclude the report of acquired holdings since 2010. Second, before 2010, the purposes of derivative transactions were simply categorized into (1) hedging and (2) other. Since 2010, the purposes have been classified into five groups: (1) hedging, (2) hedge effective, (3) replication, (4) generate

income, and (5) other. In this study, we regard transactions from (1) hedging and (2) hedge effective as transactions with hedging purpose. (3) Replication, (4) generate income, and (5) other are regarded as transactions with non-hedging purposes, Third, the value of the derivative transactions is reported on the sheets of assets and liabilities. Distinctively, the debit balances in the new Part A and credit balances in the new Part B are reported as assets and liabilities respectively. Fourth, in previous reports, the number of derivative contracts and the nominal value of derivative contracts were reported in one column in an obscure fashion. Therefore, there was confusion whether each number indicates the number of contracts or nominal amount. Since 2010, those numbers have been reported separately.

Table 2.1. Changes of Schedule DB in 2010

Before	Information	After
Part A	Acquired options, caps, floors, and insurance future options	
Part B	Written options, caps, floors, and insurance future options	Part A
Part C	Collar, swap, and forwards	
Part D	Futures contracts and insurance futures contracts	Part B
Part E	Counterparty exposure for derivatives instruments	Part D
Part F	Replicated (Synthetic) Assets	Part C

2.4.3 Data

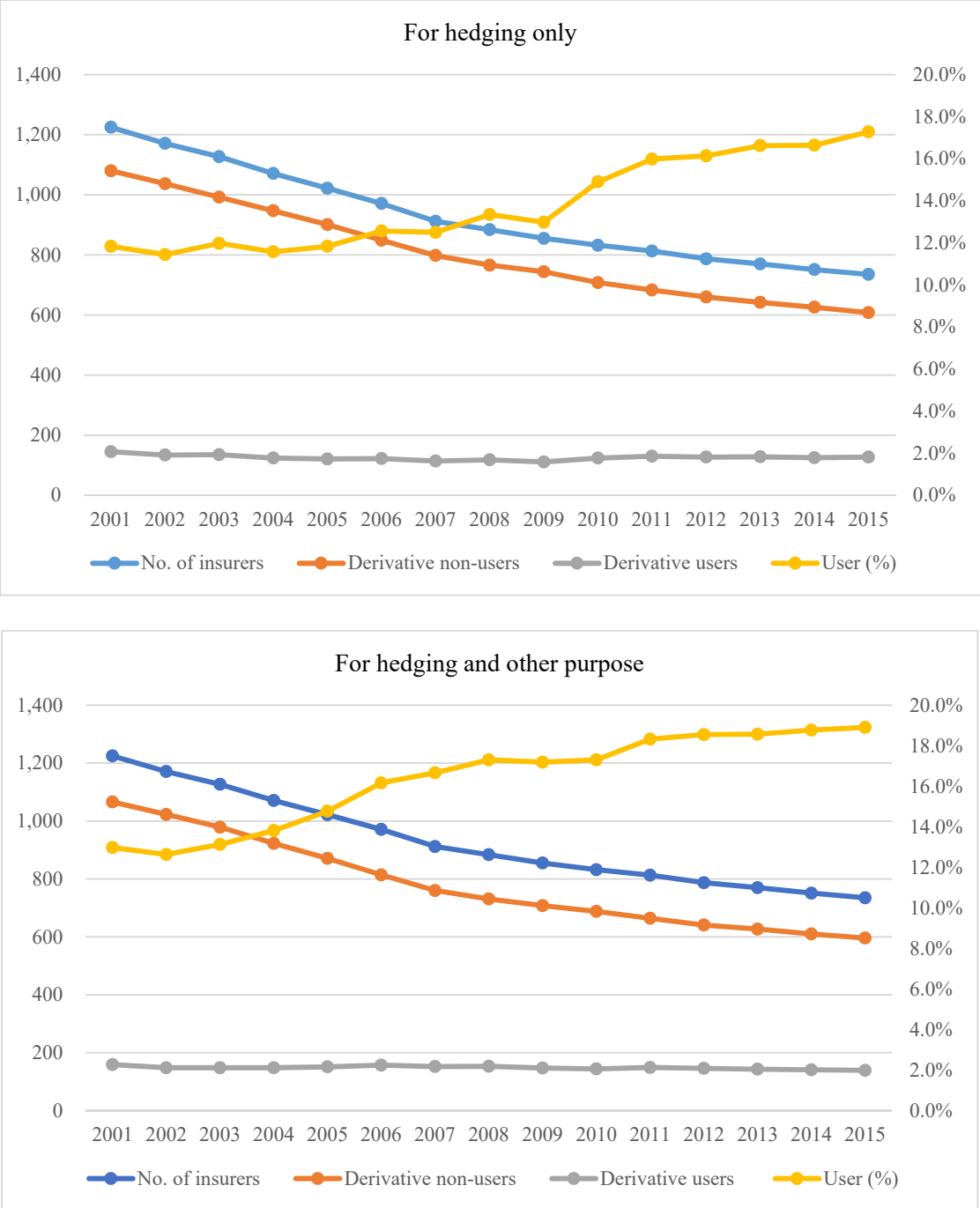
To examine the determinants of derivative participation and its extents (volume), we collect the data from NAIC between 2001 and 2015. We also obtain the macroeconomic data from the websites of the Federal Reserve Bank of St. Luis and Yahoo Finance. The initial samples cover all life insurers who operate business in the US. The initial number of firm-year samples is 13,926. Table 2.2 shows the trend of derivative use in the life insurance market. In 2015, 735 life insurance firms operated business. Among 735 life

insurers, 139 firms used derivatives in the market: 127 firms and 12 firms used derivatives for hedging and other purposes respectively. In 2001, there were 1,225 life insurers. Of 159 life insurers, 145 firms used derivatives for risk hedging and 14 firms used derivatives for other purposes. Although the number of derivative users has decreased, the participation rate has gradually increased (See Figure 2.1).

Table 2.2. Number of Derivative Users by Purpose

User: Hedging Purpose Only				
	No. of insurers	Derivative non-users	Derivative users	User (%)
2001	1,225	1,080	145	0.118
2002	1,171	1,037	134	0.114
2003	1,127	992	135	0.120
2004	1,071	947	124	0.116
2005	1,022	901	121	0.118
2006	971	849	122	0.126
2007	912	798	114	0.125
2008	884	766	118	0.133
2009	855	744	111	0.130
2010	832	708	124	0.149
2011	813	683	130	0.160
2012	787	660	127	0.161
2013	770	642	128	0.166
2014	751	626	125	0.166
2015	735	608	127	0.173
User: Hedging & Non-Hedging Purpose				
	No. of insurers	Derivative non-users	Derivative users	User (%)
2001	1,225	1,066	159	0.130
2002	1,171	1,023	148	0.126
2003	1,127	979	148	0.131
2004	1,071	923	148	0.138
2005	1,022	871	151	0.148
2006	971	814	157	0.162
2007	912	760	152	0.167
2008	884	731	153	0.173
2009	855	708	147	0.172
2010	832	688	144	0.173
2011	813	664	149	0.183
2012	787	641	146	0.186
2013	770	627	143	0.186
2014	751	610	141	0.188
2015	735	596	139	0.189

Figure 2.1. Derivative Use Trend



Data) NAIC (2001-2015)

For the consistent research approach, we exclude the observations if data meet any following criteria: (1) net admitted assets are zero or negative, (2) liabilities are zero or

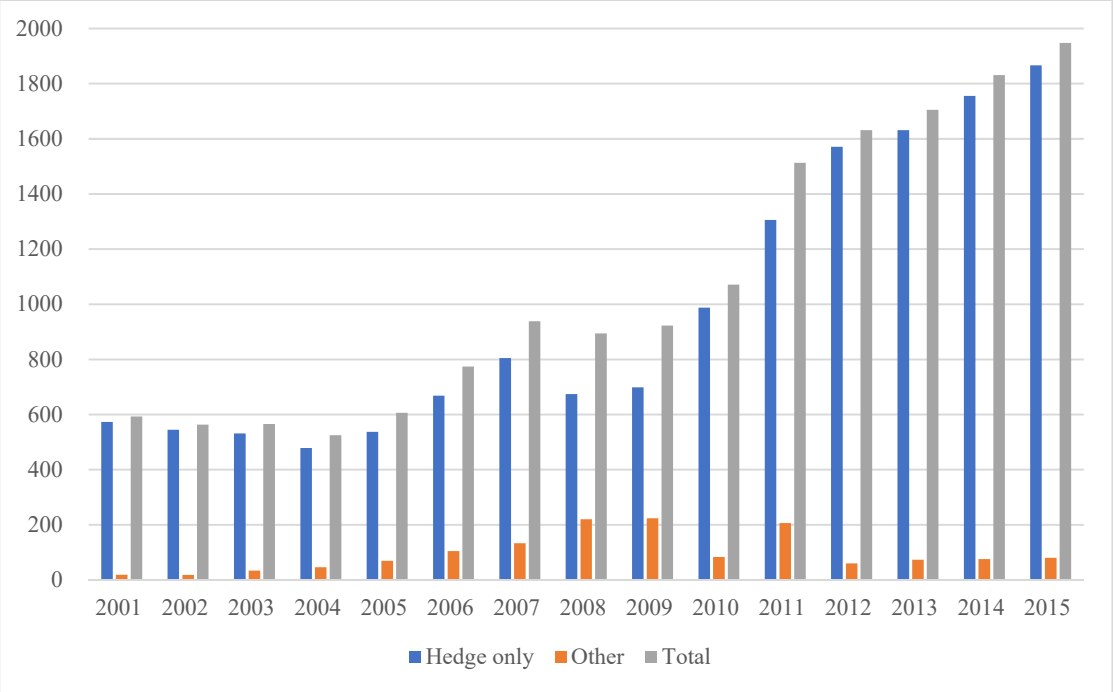
negative, (3) policyholder surplus is zero or negative, (4) total invested assets are zero or negative, (5) the proportion of reinsurance is smaller than zero or larger than one. After screening samples, the final sample consists of 13,042 firm-year observations.

The definition of variables and summary statistics on each variable are presented in Table 2.3 and Table 2.4 respectively. As shown in Table 2.4, about 16% (10%) of insurers in our sample participate in derivatives (swap) transactions. Interestingly, life insurance markets are dominated by stock firms and group firms, accounting for 92.7% and 74.9% respectively. In addition, over 30% of insurers operate accident and health business and over 30% of insurers earned premiums from other countries except for Canada. However, the proportions of foreign investment and bond investment with speculative grade are relatively small. Table 2.4 also provides separate statistics for both derivative users and non-derivative users. The results of the mean and median tests show that derivative users and non-users have significantly different characteristics. Derivative users tend to be larger than non-derivative users. Group members and highly leveraged firms seem to participate more in derivative transactions. Firms who depend more on affiliated reinsurance, operate accident health, and foreign business are more likely to use derivatives. ALM mismatch seems to affect insurers' derivative participation. If a firm's ALM mismatch comes from huge current assets, firms use less derivatives. However, if a firm's ALM mismatch is due to huge liabilities, firms use more derivatives. Firms who invest in highly risky bonds and firms with long business history tend to participate more in derivative transactions.

Additionally, Figure 2.2 shows the total notional amount of derivatives used by life insurance firms between 2001 and 2015. As shown in Figure 2.2, most derivative transactions are for risk hedging. Although the amounts were slightly reduced after the

financial crisis, it recovered very quickly. Therefore, the impact of the financial crisis seems not considerable. Especially, the notional amounts soared after 2010, in which year the Dodd-Frank Act was enacted. Such an aspect implicates that life insurers' derivatives practice has changed after 2010.

Figure 2.2 Transaction Volume (Notional Amount) (Unit: $B)



Data) NAIC (2001-2015)

Table 2.3 Variables Definition

Variables	Definition
Participation	1 if derivative transaction>0, 0 otherwise.
Volume	ln (derivative transactions)
Reinsurance	Ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed
Size	ln (net admitted asset)
Stock	1 if stock firms, 0, otherwise.
Group	1 if group, 0, otherwise.
Leverage	liabilities/net admitted assets
Tax	1 if firm pays tax at the current year, 0, otherwise
Reinsurance Affiliation	Total transaction amount with affiliated firms over total reinsurance transactions
AH Business	1 if firm operates accident/health business, 0, otherwise.
Foreign Business	1 if firm earns premiums from foreign countries except Canada, 0, otherwise.
Foreign Investment	(Total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets
Investment Portion	(Bond + Preferred Stock + common Stock) / total invested assets
Speculative Bonds	Total amounts invested in speculative bond / total invested bonds
ALM Mismatch (Assets)	ln (ALM Mismatch Assets). Here, ALM Mismatch (Assets)=Max [0, (current assets - non-current liabilities) / total admitted assets]
ALM Mismatch (Liabilities)	ln (ALM Mismatch Liabilities). Here, ALM Mismatch (Liabilities)=Max [0, (non-current liabilities - current assets) / total admitted assets]
FS (Financial Crisis)	1 if year>=2007, 0, otherwise
DF (Dodd-Frank Act)	1 if year>=2010, 0, otherwise
Δ 3M Yield	Change in the three-month Treasury bill rate
Δ Yield curve	Change in the slope of the yield curve. Spread between 10-year Treasury bill and the three- month Treasury bill
Δ Credit Spread	Change in the credit spread between Moody's Baa-rated bonds and the 10-year Treasury rate
Index Return	Return of S&P 500 Index
VIX	Average VIX

Table 2.4 Descriptive Statistics

Variables	All samples (N=13,042)			Non-users				Users				Difference	
	Mean	Median	SD	N	Mean	Median	SD	N	Mean	Median	SD	Mean	Midian
Derivative Participation	0.1636	0.0000	0.3699	10908	0.0000	0.0000	0.0000	2134	1.0000	1.0000	0.0000	-	-
Derivative Volume	3.2262	0.0000	7.4362	10908	0.0000	0.0000	0.0000	2134	19.7172	20.1887	3.5748	-	-
Swap Participation	0.1091	0.0000	0.3118	11619	0.0000	0.0000	0.0000	1423	1.0000	1.0000	0.0000	-	-
Swap Volume	2.18437	0.0000	6.3084	11619	0.0000	0.0000	0.0000	1423	20.0201	20.0553	2.7646	-	-
Size	18.8244	18.5775	2.9315	10908	18.0210	17.8574	2.3908	2134	22.9313	23.0174	1.7713	***	***
Stock	0.9271	1.0000	0.2600	10908	0.9306	1.0000	0.2541	2134	0.9091	1.0000	0.2875	***	***
Group	0.7485	1.0000	0.4339	10908	0.7098	1.0000	0.4539	2134	0.9461	1.0000	0.2259	***	***
Leverage	0.6541	0.7779	0.3037	10908	0.6050	0.6968	0.3061	2134	0.9049	0.9330	0.0970	***	***
Tax	0.6586	1.0000	0.4742	10908	0.6535	1.0000	0.4759	2134	0.6846	1.0000	0.4648	***	***
Reinsurance	0.181	0.0540	0.2568	10908	0.1789	0.0419	0.2629	2134	0.1913	0.1057	0.2227	**	***
Reinsurance Affiliation	0.181	0.0000	0.3754	10908	0.2376	0.0000	0.3783	2134	0.3322	0.2099	0.3498	***	***
AH Business	0.3125	0.0000	0.4635	10908	0.2975	0.0000	0.4572	2134	0.3894	0.0000	0.4877	***	***
Foreign Business	0.3143	0.0000	0.4643	10908	0.2264	0.0000	0.4185	2134	0.7634	1.0000	0.4251	***	***
Foreign Investment	0.042	0.0087	0.0687	10908	0.0292	0.0000	0.0591	2134	0.1076	0.1017	0.0762	***	***
Invested Assets	0.8676	0.9481	0.1952	10908	0.8939	0.9544	0.1674	2134	0.7330	0.8449	0.2605	***	***
Speculative Bonds	0.0333	0.0117	0.0672	10908	0.0281	0.0035	0.0709	2134	0.0596	0.0583	0.0322	***	***
ALM Mismatch (Assets)	6.2819	0.0000	7.8797	10908	7.3222	0.0000	8.0162	2134	0.9642	0.0000	4.1466	***	***
ALM Mismatch (Liabilities)	11.4402	16.0040	9.5471	10908	9.5932	13.9194	9.1042	2134	20.8808	22.0605	5.1789	***	***
FS (Financial Crisis)	0.5228	1.0000	0.4995	10908	0.5107	1.0000	0.4999	2134	0.5843	1.0000	0.4929	-	-
DF (Dodd-Frank Act)	0.3321	0.0000	0.4710	10908	0.3228	0.0000	0.4676	2134	0.3796	0.0000	0.4854	-	-
Δ 3M Yield	-45.330	-8.5833	136.3708	10908	-46.123	-8.5833	136.9481	2134	-41.281	-3.0833	133.3389	-	-
Δ Yield curve	18.0239	4.2500	106.4428	10908	18.6502	4.2500	106.7258	2134	14.8226	4.2500	104.9509	-	-
Δ Credit Spread	3.3720	-0.4167	67.4885	10908	3.1629	-0.4167	67.1380	2134	4.4408	-0.4167	69.2585	-	-
Index Return	0.0379	0.0899	0.1806	10908	0.0369	0.0899	0.1809	2134	0.0427	0.0899	0.1792	-	-
VIX	20.7228	17.7989	6.3855	10908	20.7490	21.9829	6.3744	2134	20.5889	17.7989	6.4416	-	-

2.5 Empirical Results

2.5.1 Total Derivative Participation

The empirical results on the determinants of derivative participation are shown in Table 2.5. Table 2.5 shows that the impacts of the financial crisis and the Dodd-Frank Act on the derivative entry are limited. Both coefficients of the financial crisis and the Dodd-Frank Act are not significant at the 10% level. These findings indicate that insurers did not significantly reduce the entry to the derivative market even after the financial crisis and the Dodd-Frank Act.

Table 2.5 also presents which firm characteristics affect a life insurer's derivative participation decision. Overall, *Firm Size*, *Stock*, *Reinsurance Affiliation*, *Foreign Business*, *Speculative Bonds*, *ALM Mismatch (Liabilities)* and *Age* are positively correlated with insurers' derivative engagement. On the other hand, *Group*, *Tax*, *AH Business,* and *ALM Mismatch (Assets)* are reversely correlated with derivative participation. However, all coefficients of the macroeconomic variables are not significant. Therefore, the macroeconomic factors seem not to affect the decisions of insurers' derivative participation. More details are explained as follows.

First, the significant and positive signs of *Size* indicate that larger firms are more likely to engage in derivative transactions than smaller firms. Such results support the theory of economies of scale that larger firms tend to have experts with knowledge about derivatives and infrastructures for derivative trading (Nance, Smith, and Smithson, 1993). It also supports the argument that risk hedging through derivative transactions is an effective way to mitigate the principal-agent problem of firms with complex business environment. However, it rejects the perspectives of Warner (1977) and Shiu (2011), who

expect that larger firms are less likely to use derivatives since they have diversified activities and enough capacity to deal with adverse market conditions.

Second, coefficients of *Stock* are positive and significant at the 1% level. It indicates that stock firms are more likely to engage in derivative transactions than non-stock firms. It is not surprising in that stock firms tend to operate more complex and risky business than non-stock firms. However, it rejects the managerial risk aversion hypothesis that mutual firms, managed by risk-averse managers, are more likely to engage in derivative activities (Hardwick and Adams, 1999).

Third, group firms are less likely to participate in derivative transactions. All coefficients in Table 2.5 are negative and significant at the 1% level. These results imply that group firms have fewer incentive to use derivatives to manage their risk than non-group firms since they have sufficient risk buffers or subsidy from other members in a group.

Fourth, Table 2.5 shows that reinsurance use does not affect the decision of derivative participation. Although the coefficients are positive, they are not significant at the 10% level. On the other hand, dependence on the reinsurance contracts with affiliated firms positively affects insurers' participation decisions at the 1% of significance level. It suggests that life insurers try to reduce firm risk and systemic risk through derivative contracts when they highly depend on the reinsurance transactions with affiliated firms.

Fifth, operating an accident and health (A&H) business seems to reduce the likelihood of derivative participation. The coefficients in Table 2.5 are negative and significant at the 5% level. These empirical findings suggest that life insurers regard A&H business as a source of diversification activities. In general, risk reduction through

diversification is effective when the risks are not highly correlated. If life insurers operate A&H business, the risk from A&H business is not highly correlated with the risk from life insurance business since the insured risk types are completely different. Therefore, life insurers operating A&H business have fewer incentives to manage their risk through derivative participation.

Sixth, despite the diversification effect, operating an overseas business shows a different aspect. Firms with foreign business have a higher likelihood of derivative participation than firms without foreign business. One of the possible reasons for this is that the inherent risks from foreign business are more complex and various. Particularly, firms doing overseas business need to manage another type of risk such as FX risk. Therefore, firms operating a business in other countries have incentives to reduce such risk through derivative transactions. On the other hand, firms seem to not actively manage risk from their foreign investment through derivatives. Although the coefficients are positive, they are not significant. In addition, firms investing more speculative bonds are more likely to participate in derivative transactions, showing positive and significant signs. Such results suggest that firms with high risk from speculative bonds try to show a signal to the market that they manage such risk through diverse risk management activities.

Seventh, firms with ALM mismatch due to the large current assets are less likely to participate in derivative transaction. However, firms with ALM mismatch due to the large non-current liabilities are more likely to participate in derivative transactions. The coefficients of *ALM Mismatch (Assets)* and *ALM Mismatch (Liabilities)* in Table 2.5 are negative and positive respectively and both signs are significant at the 1% level. Therefore, insurers seem to more seriously consider the risk from mismatch from the large non-current

liabilities than risk from the mismatch from the large current assets.

Eighth, firms with a long business history tend to participate in more derivative transactions. All coefficients of *Age* in Table 2.5 are positive and significant at the 1% level. Older firms are more likely to experience the derivative transactions and have knowledge about the mechanism. Therefore, firms with a long business history have more chances and incentives to participate in derivative transactions than firms with a shorter business history.

As noted earlier, the empirical results in Table 2.5 are analyzed without considering the endogeneity issue from the reverse-causal relationship between reinsurance and derivative participation. We additionally analyze the same research question with an IV probit model. The empirical results in Table 2.6 show that reinsurance is an endogenous variable. All coefficients of *lnsigma* are negative and significant at the 1% level, rejecting a hypothesis that the variable is exogenous. Nevertheless, the empirical results and implications in Table 2.6 are consistent with those in Table 2.5. Therefore, we do not explain the results in Table 2.6.

Table 2.5 and Table 2.6 provide evidence that the Dodd-Frank Act has little impact on the insurers' decisions of derivative participation. However, these results might absorb the different impacts of determinant factors before and after the enactment of the Dodd-Frank Act. Therefore, we separately investigate the determinant factors to see whether any determinants have changed after the new regulatory intervention. Table 2.7 shows that most factors such as firm size, firm type, taxation, foreign business, ALM mismatch due to large current assets or non-current liabilities, a portion of speculative bonds, and age are still significant factors regardless of the enactment of the Dodd-Frank Act. Therefore, those are key factors which affect the decisions of life insurers' derivative participation.

On the other hand, significant changes are observed in some variables: *group*, *leverage*, *reinsurance affiliation*, *A&H business*, and *invested assets*. First, *group* is not considered as a significant factor before the Dodd-Frank Act, but it becomes a significant factor after the Dodd-Frank Act, showing negative signs. Second, *reinsurance affiliation* increases the likelihood of derivative use before the Dodd-Frank Act. However, it is no longer significant after the Dodd-Frank Act. Third, the coefficients of *AH business* are negative and significant before the act, whereas it becomes insignificant after. Lastly, considerable changes are found in leverage and invested asset portion. These two factors are positively related to the likelihood of derivative use before the new regulation. However, these two variables show negative and significant signs after the enactment of the Dodd-Frank Act. Such findings implicate that life insurers' participation motivations can be changed when their business environment changes.

Table 2.5. Determinants of Derivative Participation with Probit Model

	Derivative Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.5381***	0.5381***	0.5382***	0.5156***	0.5158***	0.5159***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.4062***	0.4160***	0.4184***	0.4081***	0.4179***	0.4203***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Group	-0.2139***	-0.2210***	-0.2224***	-0.2110***	-0.2181***	-0.2195***
	(0.0045)	(0.0033)	(0.0031)	(0.0052)	(0.0038)	(0.0036)
Leverage	0.1580	0.1468	0.1468	0.1576	0.1466	0.1464
	(0.4310)	(0.4619)	(0.4620)	(0.4356)	(0.4659)	(0.4666)
Tax	-0.2213***	-0.2213***	-0.2224***	-0.2202***	-0.2202***	-0.2212***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Reinsurance	0.0462	0.0503	0.0524	0.0533	0.0573	0.0595
	(0.5805)	(0.5468)	(0.5302)	(0.5253)	(0.4936)	(0.4777)
Reinsurance Affiliation	0.2215***	0.2248***	0.2250***	0.2204***	0.2238***	0.2240***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AH Business	-0.0937**	-0.0960**	-0.0968**	-0.0938**	-0.0961**	-0.0969**
	(0.0178)	(0.0152)	(0.0144)	(0.0175)	(0.0150)	(0.0142)
Foreign Business	0.1760***	0.1801***	0.1762***	0.1755***	0.1796***	0.1757***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Foreign Investment	0.2970	0.3598	0.3828	0.3076	0.3703	0.3934
	(0.4002)	(0.3214)	(0.2959)	(0.3836)	(0.3075)	(0.2827)
ALM Mismatch (Assets)	-0.0217***	-0.0215***	-0.0215***			
	(0.0000)	(0.0000)	(0.0000)			
ALM Mismatch (Liabilities)				0.0205***	0.0204***	0.0204***
				(0.0000)	(0.0000)	(0.0000)
Invested Assets	0.1818*	0.1832*	0.1847**	0.1291	0.1308	0.1323
	(0.0523)	(0.0510)	(0.0495)	(0.1840)	(0.1793)	(0.1753)
Speculative Bonds	1.7388***	1.7106***	1.7262***	1.7145***	1.6862***	1.7018***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 2.5: Continued

	Derivative Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.0023***	0.0024***	0.0024***	0.0023***	0.0024***	0.0024***
	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
FS		-0.0729	0.0021		-0.0730	0.0025
		(0.1073)	(0.9775)		(0.1068)	(0.9732)
DF			-0.0930			-0.0936
			(0.2172)			(0.2143)
Δ 3M Yield	-0.0005	-0.0004	-0.0007	-0.0005	-0.0004	-0.0007
	(0.4754)	(0.5246)	(0.3059)	(0.4755)	(0.5247)	(0.3046)
Δ Yield curve	-0.0002	-0.0002	-0.0005	-0.0002	-0.0002	-0.0005
	(0.7032)	(0.7612)	(0.4830)	(0.7041)	(0.7621)	(0.4820)
Δ Credit Spread	-0.0000	0.0003	-0.0001	-0.0000	0.0003	-0.0001
	(0.9695)	(0.5743)	(0.8985)	(0.9624)	(0.5794)	(0.8901)
Index Return	-0.0794	0.0412	-0.0299	-0.0826	0.0382	-0.0334
	(0.6583)	(0.8305)	(0.8813)	(0.6454)	(0.8426)	(0.8677)
VIX	-0.0007	0.0004	-0.0029	-0.0007	0.0004	-0.0029
	(0.9105)	(0.9419)	(0.6600)	(0.9121)	(0.9402)	(0.6588)
Constant	-12.6611***	-12.6534***	-12.6019***	-12.5639***	-12.5569***	-12.5050***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	13042	13042	13042	13042	13042	13042
R-squared	0.5523	0.5526	0.5527	0.5522	0.5525	0.5526

Note) *Derivative Participation* is 1 if derivative transaction>0, 0 otherwise. *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

Table 2.6 Determinants of Derivative Participation with IV Probit Model

	Derivative Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.5369***	0.5370***	0.5370***	0.5149***	0.5151***	0.5152***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.4094***	0.4193***	0.4217***	0.4113***	0.4212***	0.4236***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Group	-0.2107***	-0.2179***	-0.2193***	-0.2078***	-0.2150***	-0.2164***
	(0.0012)	(0.0008)	(0.0007)	(0.0014)	(0.0009)	(0.0009)
Leverage	0.1711	0.1599	0.1600	0.1717	0.1607	0.1605
	(0.3388)	(0.3712)	(0.3711)	(0.3412)	(0.3732)	(0.3736)
Tax	-0.2224***	-0.2224***	-0.2234***	-0.2213***	-0.2213***	-0.2223***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Reinsurance	-0.0232	-0.0195	-0.0178	-0.0162	-0.0126	-0.0108
	(0.8005)	(0.8315)	(0.8465)	(0.8600)	(0.8910)	(0.9063)
Reinsurance Affiliation	0.2269***	0.2302***	0.2304***	0.2258***	0.2292***	0.2294***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AH Business	-0.0935**	-0.0958**	-0.0966**	-0.0936**	-0.0959**	-0.0967**
	(0.0232)	(0.0201)	(0.0192)	(0.0230)	(0.0200)	(0.0190)
Foreign Business	0.1803***	0.1844***	0.1805***	0.1799***	0.1840***	0.1801***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Foreign Investment	0.2975	0.3603	0.3829	0.3083	0.3709	0.3937
	(0.2547)	(0.1716)	(0.1470)	(0.2375)	(0.1588)	(0.1355)
ALM Mismatch (Assets)	-0.0213***	-0.0211***	-0.0211***			
	(0.0000)	(0.0000)	(0.0000)			
ALM Mismatch (Liabilities)				0.0201***	0.0200***	0.0200***
				(0.0000)	(0.0000)	(0.0000)
Invested Assets	0.1841*	0.1855**	0.1870**	0.1327	0.1344	0.1359
	(0.0518)	(0.0500)	(0.0482)	(0.1760)	(0.1702)	(0.1656)
Speculative Bonds	1.7213***	1.6928***	1.7084***	1.6974***	1.6690***	1.6845***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 2.6: Continued

	Derivative Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.0023***	0.0024***	0.0024***	0.0024***	0.0024***	0.0024***
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
FS		-0.0729	0.0018		-0.0730	0.0022
		(0.1045)	(0.9810)		(0.1040)	(0.9769)
DF			-0.0926			-0.0932
			(0.2111)			(0.2080)
Δ 3M Yield	-0.0005	-0.0004	-0.0007	-0.0005	-0.0004	-0.0007
	(0.4732)	(0.5228)	(0.3021)	(0.4736)	(0.5232)	(0.3010)
Δ Yield curve	-0.0002	-0.0002	-0.0005	-0.0002	-0.0002	-0.0005
	(0.6968)	(0.7537)	(0.4748)	(0.6980)	(0.7549)	(0.4740)
Δ Credit Spread	0.0000	0.0003	-0.0001	0.0000	0.0003	-0.0001
	(0.9930)	(0.5503)	(0.9326)	(0.9999)	(0.5550)	(0.9244)
Index Return	-0.0741	0.0467	-0.0240	-0.0772	0.0438	-0.0274
	(0.6745)	(0.8072)	(0.9041)	(0.6615)	(0.8190)	(0.8907)
VIX	-0.0009	0.0002	-0.0031	-0.0008	0.0002	-0.0031
	(0.8833)	(0.9688)	(0.6334)	(0.8851)	(0.9669)	(0.6325)
Constant	-12.6429***	-12.6351***	-12.5838***	-12.5487***	-12.5416***	-12.4898***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
athrho2_1						
Constant	0.0353*	0.0355*	0.0357*	0.0352*	0.0355*	0.0357*
	(0.0933)	(0.0912)	(0.0895)	(0.0937)	(0.0915)	(0.0898)
lnsigma2						
Constant	-2.2512***	-2.2512***	-2.2513***	-2.2513***	-2.2513***	-2.2513***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	13042	13042	13042	13042	13042	13042

Table 2.7 Impact of the Dodd-Frank Act on Insurers' Derivative Participation

	Derivative Participation			
	Before		After	
	(1)	(2)	(3)	(4)
Size	0.5518***	0.5396***	0.5275***	0.4870***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	0.2949***	0.2965***	0.7210***	0.7238***
	(0.0008)	(0.0008)	(0.0000)	(0.0000)
Group	-0.1284	-0.1270	-0.3540***	-0.3480***
	(0.1875)	(0.1927)	(0.0038)	(0.0045)
Leverage	0.4992**	0.5171**	-0.5387	-0.5666*
	(0.0306)	(0.0274)	(0.1158)	(0.0971)
Tax	-0.2082***	-0.2066***	-0.2862***	-0.2880***
	(0.0001)	(0.0002)	(0.0001)	(0.0000)
Reinsurance	0.0725	0.0738	0.0489	0.0706
	(0.5118)	(0.5062)	(0.7035)	(0.5845)
Reinsurance Affiliation	0.3444***	0.3439***	0.0208	0.0165
	(0.0000)	(0.0000)	(0.8066)	(0.8454)
AH Business	-0.1040**	-0.1035**	-0.0994	-0.1020
	(0.0359)	(0.0368)	(0.1350)	(0.1242)
Foreign Business	0.1281**	0.1295**	0.2681***	0.2614***
	(0.0144)	(0.0133)	(0.0001)	(0.0001)
Foreign Investment	0.2257	0.2347	0.9201	0.9357
	(0.6044)	(0.5905)	(0.2237)	(0.2155)
ALM Mismatch (Assets)	-0.0122**		-0.0389***	
	(0.0286)		(0.0000)	
ALM Mismatch (Liabilities)		0.0109**		0.0381***
		(0.0445)		(0.0000)
Invested Assets	0.4545***	0.4299***	-0.2924*	-0.3940**
	(0.0001)	(0.0004)	(0.0587)	(0.0151)
Speculative Bonds	2.1790***	2.1592***	1.1064**	1.1079**
	(0.0000)	(0.0000)	(0.0363)	(0.0342)
Age	0.0026***	0.0027***	0.0017*	0.0017*
	(0.0006)	(0.0006)	(0.0642)	(0.0616)
Δ 3M Yield	-0.0009	-0.0009	-0.0126	-0.0128
	(0.3686)	(0.3655)	(0.3872)	(0.3794)
Δ Yield curve	-0.0005	-0.0005	-0.0011	-0.0011
	(0.6661)	(0.6645)	(0.4199)	(0.4102)
Δ Credit Spread	0.0007	0.0007	-0.0002	-0.0003
	(0.3431)	(0.3482)	(0.8169)	(0.8083)
Index Return	0.1507	0.1483	0.3374	0.3352
	(0.5422)	(0.5485)	(0.5185)	(0.5210)
VIX	-0.0102	-0.0102	0.0014	0.0013
	(0.2446)	(0.2428)	(0.9383)	(0.9430)
Constant	-13.3125***	-13.2754***	-11.6982***	-11.5062***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	8711	8711	4331	4331
R-squared	0.5563	0.5561	0.5557	0.5557

2.5.2 Swap Participation

The Dodd-Frank Act mainly focuses on regulating swap contracts. Therefore, we additionally examine the determinants of swap participation. The empirical results in Table 2.8 suggest that the impact of the financial crisis on the swap use is still limited, showing negative and insignificant coefficients. On the other hand, the likelihood of swap participation is reduced after the Dodd-Frank Act. Those changes can be originated from the new regulatory requirement. After the Dodd-Frank Act, the regulatory changes increased the overall costs for swap contracts, overwhelming the benefits. Therefore, insurers have fewer incentive to participate in swaps contract, showing a reduced entry.

In general, most key determinants in swap participation are consistent with those in derivative participation. Table 2.8 shows that the impacts of *size*, *reinsurance affiliation*, *AH business*, *foreign business*, *ALM mismatch*, and *speculative bond* are the same. However, coefficients of *stock* and *tax* are no longer significant. In addition, we find that swap contracts are used as a supplement of reinsurance. Table 2.9 provides empirical results analyzed with IV probit models. Once again, all coefficients of *lnsigma* are negative and significant at the 1% level, rejecting a hypothesis that the variable is exogenous. Nevertheless, the empirical results are consistent with those in Table 2.9.

We also examine whether the determinants of the swap participation decision were changed after the enactment of the Dodd-Frank Act. Table 2.10 shows most of determinants do not show considerable changes even after the Dodd-Frank Act. Except for *invested assets,* the impacts of most factors such as *size*, *leverage*, *reinsurance*, *reinsurance affiliation*, and *AH business* in column (3) and (4) are consistent with those in column (1) and (2).

Table 2.8 Determinants of Swap Participation with Probit Model

	Swap Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.6675***	0.6684***	0.6689***	0.6485***	0.6498***	0.6503***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.0906	-0.0715	-0.0673	-0.0896	-0.0705	-0.0664
	(0.3472)	(0.4549)	(0.4821)	(0.3524)	(0.4607)	(0.4881)
Group	0.0974	0.0782	0.0743	0.1006	0.0814	0.0775
	(0.5011)	(0.5874)	(0.6061)	(0.4886)	(0.5736)	(0.5920)
Leverage	0.1590	0.1243	0.1204	0.1113	0.0769	0.0731
	(0.5205)	(0.6079)	(0.6185)	(0.6544)	(0.7520)	(0.7633)
Tax	-0.0502	-0.0498	-0.0513	-0.0506	-0.0501	-0.0516
	(0.3322)	(0.3369)	(0.3228)	(0.3279)	(0.3331)	(0.3193)
Reinsurance	0.3739***	0.3864***	0.3901***	0.3843***	0.3966***	0.4002***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Reinsurance Affiliation	0.3522***	0.3602***	0.3618***	0.3513***	0.3593***	0.3608***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AH Business	-0.2314***	-0.2353***	-0.2363***	-0.2325***	-0.2363***	-0.2373***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Foreign Business	0.3083***	0.3215***	0.3127***	0.3055***	0.3187***	0.3100***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Foreign Investment	-0.2412	-0.1171	-0.0796	-0.2398	-0.1162	-0.0787
	(0.4993)	(0.7471)	(0.8274)	(0.5010)	(0.7485)	(0.8289)
ALM Mismatch (Assets)	-0.0178***	-0.0174***	-0.0175***			
	(0.0014)	(0.0018)	(0.0018)			
ALM Mismatch (Liabilities)				0.0184***	0.0179***	0.0180***
				(0.0007)	(0.0009)	(0.0009)
Invested Assets	-0.0905	-0.0916	-0.0894	-0.1461	-0.1461	-0.1440
	(0.4236)	(0.4188)	(0.4302)	(0.2109)	(0.2113)	(0.2184)
Speculative Bonds	3.2738***	3.2231***	3.2444***	3.2431***	3.1926***	3.2139***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 2.8: Continued

	Swap Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	0.0002	0.0002	0.0003	0.0002	0.0003	0.0003
	(0.8225)	(0.7215)	(0.6756)	(0.8150)	(0.7142)	(0.6686)
FS		-0.1474***	-0.0234		-0.1471***	-0.0231
		(0.0079)	(0.7941)		(0.0080)	(0.7965)
DF			-0.1543*			-0.1542*
			(0.0848)			(0.0849)
Δ 3M Yield	-0.0012	-0.0011	-0.0016*	-0.0012	-0.0011	-0.0016*
	(0.1235)	(0.1444)	(0.0526)	(0.1248)	(0.1459)	(0.0532)
Δ Yield curve	-0.0007	-0.0006	-0.0010	-0.0007	-0.0006	-0.0010
	(0.3796)	(0.4419)	(0.1991)	(0.3836)	(0.4461)	(0.2016)
Δ Credit Spread	0.0000	0.0007	0.0001	0.0000	0.0007	0.0001
	(0.9640)	(0.3053)	(0.9426)	(0.9611)	(0.3046)	(0.9413)
Index Return	-0.0917	0.1507	0.0339	-0.0921	0.1498	0.0330
	(0.6705)	(0.5193)	(0.8892)	(0.6693)	(0.5219)	(0.8920)
VIX	-0.0065	-0.0046	-0.0101	-0.0065	-0.0046	-0.0100
	(0.3671)	(0.5280)	(0.2060)	(0.3696)	(0.5306)	(0.2073)
Constant	-15.8122***	-15.7964***	-15.7151***	-15.6941***	-15.6802***	-15.5991***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	13042	13042	13042	13042	13042	13042
R-squared	0.6129	0.6137	0.614	0.6131	0.6139	0.6142

Note) *Swap Participation*=1 if swap transaction>0, 0 otherwise. *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group*= 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax*= 1 if firm pays tax at t, 0, otherwise. *Reinsurance*= ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business*=1 if a firm operates accident/health business, 0, otherwise. *Foreign Business*= 1 if a firm earns premiums from foreign countries, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS*= 1 if year>=2007, 0, otherwise. *DF*= 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX is the volatility of S&P 500 index options.

Table 2.9 Determinants of Swap Participation with IV Probit Model

	Swap Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.6684***	0.6693***	0.6699***	0.6491***	0.6504***	0.6509***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.0930	-0.0740	-0.0698	-0.0921	-0.0731	-0.0689
	(0.3005)	(0.4121)	(0.4392)	(0.3054)	(0.4178)	(0.4452)
Group	0.0940	0.0749	0.0710	0.0972	0.0781	0.0742
	(0.3653)	(0.4719)	(0.4953)	(0.3490)	(0.4531)	(0.4760)
Leverage	0.1459	0.1113	0.1074	0.0974	0.0631	0.0594
	(0.5866)	(0.6777)	(0.6880)	(0.7173)	(0.8143)	(0.8248)
Tax	-0.0483	-0.0479	-0.0494	-0.0487	-0.0483	-0.0498
	(0.3741)	(0.3782)	(0.3634)	(0.3703)	(0.3748)	(0.3603)
Reinsurance	0.4286***	0.4413***	0.4451***	0.4400***	0.4524***	0.4563***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Reinsurance Affiliation	0.3480***	0.3559***	0.3575***	0.3469***	0.3549***	0.3565***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AH Business	-0.2310***	-0.2349***	-0.2359***	-0.2321***	-0.2359***	-0.2369***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Foreign Business	0.3060***	0.3191***	0.3103***	0.3030***	0.3162***	0.3075***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Foreign Investment	-0.2406	-0.1159	-0.0780	-0.2393	-0.1151	-0.0772
	(0.4156)	(0.6957)	(0.7925)	(0.4183)	(0.6979)	(0.7947)
ALM Mismatch (Assets)	-0.0182***	-0.0177***	-0.0178***			
	(0.0009)	(0.0012)	(0.0011)			
ALM Mismatch (Liabilities)				0.0187***	0.0183***	0.0183***
				(0.0004)	(0.0005)	(0.0005)
Invested Assets	-0.0934	-0.0946	-0.0925	-0.1501	-0.1502	-0.1480
	(0.3827)	(0.3764)	(0.3874)	(0.1787)	(0.1782)	(0.1845)
Speculative Bonds	3.2859***	3.2351***	3.2567***	3.2549***	3.2043***	3.2258***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003
	(0.8503)	(0.7498)	(0.7044)	(0.8431)	(0.7428)	(0.6977)

Table 2.9: Continued

	Swap Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
FS		-0.1478***	-0.0229		-0.1474***	-0.0227
		(0.0077)	(0.8018)		(0.0079)	(0.8042)
DF			-0.1554*			-0.1553*
			(0.0865)			(0.0868)
Δ 3M Yield	-0.0012	-0.0011	-0.0016*	-0.0012	-0.0011	-0.0016*
	(0.1218)	(0.1462)	(0.0520)	(0.1229)	(0.1475)	(0.0526)
Δ Yield curve	-0.0007	-0.0006	-0.0010	-0.0007	-0.0006	-0.0010
	(0.3778)	(0.4409)	(0.1954)	(0.3816)	(0.4449)	(0.1977)
Δ Credit Spread	-0.0000	0.0007	0.0000	0.0000	0.0007	0.0000
	(0.9984)	(0.3308)	(0.9763)	(0.9992)	(0.3305)	(0.9755)
Index Return	-0.0982	0.1446	0.0269	-0.0988	0.1436	0.0259
	(0.6512)	(0.5388)	(0.9126)	(0.6494)	(0.5419)	(0.9160)
VIX	-0.0065	-0.0046	-0.0100	-0.0064	-0.0045	-0.0100
	(0.3765)	(0.5369)	(0.2113)	(0.3790)	(0.5394)	(0.2127)
Constant	-15.8243***	-15.8080***	-15.7263***	-15.7043***	-15.6900***	-15.6085***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
athrho2_1						
Constant	-0.0259	-0.0260	-0.0260	-0.0263	-0.0264	-0.0264
	(0.2963)	(0.2946)	(0.2935)	(0.2893)	(0.2878)	(0.2868)
lnsigma2						
Constant	-2.2512***	-2.2512***	-2.2513***	-2.2513***	-2.2513***	-2.2513***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	13042	13042	13042	13042	13042	13042

Table 2.10 Impact of the Dodd-Frank Act on insurers' Swap Participation

	Swap Participation			
	Before		After	
	(1)	(2)	(3)	(4)
Size	0.7064***	0.6945***	0.6443***	0.6124***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.0861	-0.0855	-0.0377	-0.0381
	(0.4746)	(0.4777)	(0.8077)	(0.8055)
Group	0.1255	0.1268	0.0195	0.0253
	(0.4952)	(0.4925)	(0.9328)	(0.9131)
Leverage	0.5608*	0.4807	-0.8626***	-0.7946**
	(0.0797)	(0.1418)	(0.0096)	(0.0156)
Tax	-0.0918	-0.0918	-0.0422	-0.0427
	(0.1702)	(0.1696)	(0.6168)	(0.6126)
Reinsurance	0.4192***	0.4267***	0.4397***	0.4535***
	(0.0023)	(0.0019)	(0.0035)	(0.0026)
Reinsurance Affiliation	0.4331***	0.4339***	0.2154*	0.2112*
	(0.0000)	(0.0000)	(0.0502)	(0.0550)
AH Business	-0.3187***	-0.3191***	-0.1393*	-0.1403*
	(0.0000)	(0.0000)	(0.0650)	(0.0629)
Foreign Business	0.3077***	0.3052***	0.3825***	0.3785***
	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Foreign Investment	0.1225	0.1149	-0.4613	-0.4496
	(0.7805)	(0.7930)	(0.4876)	(0.4987)
ALM Mismatch	-0.0094		-0.0325***	
(Assets)	(0.1905)		(0.0006)	
ALM Mismatch		0.0115		0.0293***
(Liabilities)		(0.1029)		(0.0012)
Invested Assets	0.3969***	0.3536**	-0.8791***	-0.9418***
	(0.0091)	(0.0253)	(0.0000)	(0.0000)
Speculative Bonds	4.0288***	4.0013***	2.3187***	2.3187***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age	0.0008	0.0008	-0.0010	-0.0010
	(0.3747)	(0.3751)	(0.3705)	(0.3762)
Δ 3M Yield	-0.0028**	-0.0028**	-0.0018	-0.0020
	(0.0190)	(0.0200)	(0.9210)	(0.9126)
Δ Yield curve	-0.0019	-0.0018	-0.0001	-0.0001
	(0.1961)	(0.2017)	(0.9535)	(0.9403)
Δ Credit Spread	0.0011	0.0011	0.0004	0.0004
	(0.2394)	(0.2353)	(0.7619)	(0.7702)
Index Return	0.3443	0.3460	0.2448	0.2424
	(0.2504)	(0.2482)	(0.7061)	(0.7089)
VIX	-0.0286***	-0.0285**	0.0104	0.0101
	(0.0099)	(0.0102)	(0.6500)	(0.6605)
Constant	-17.0835***	-16.9554***	-14.0701***	-13.9956***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	8711	8711	4331	4331
R-squared	0.6223	0.6225	0.6146	0.6142

2.5.3 Total Derivative Transaction Volumes (Extent)

Consistent with prior findings, Table 2.11 presents that the impact of the financial crisis on life insurers' derivative transaction volumes is insignificant. Although the results in column (2) and (5) show positive and significant coefficients on *FS*, the coefficients become negative and insignificant when the impact of the Dodd-Frank Act (*DF*) is controlled as shown in column (3) and (6). The coefficients of *DF* are positive and significant at the 5% level. Such findings suggest that life insurers considerably increase the derivative transaction volumes after the Act.

Table 2.11 also provides evidence that the determinants of derivative volumes are wholly different from those of derivative participation. Although *size* in Table 2.11 is still a significant factor, the impacts of other factors are different. First, Table 2.5 shows that stock firms engage more in derivative participation, whereas Table 2.11 illustrates that their transaction volumes are smaller than non-stock firms. Second, in Table 2.5, group firms are less likely to participate in derivative transactions than non-group firms. However, they tend to have larger contract volumes once they decide to enter the derivative market. Third, life insurers do not use derivative for the tax reduction. Although the coefficients of *Tax* are positive, they are insignificant. Fourth, Table 2.5 shows that the reinsurance use itself is not associated with the decision of derivative participation. Nevertheless, if we consider derivative users only, a supplemental relationship is found between reinsurance and derivative volumes. Table 2.11 provides evidence that firms using more reinsurance tend to have higher derivative transaction volume than firms using less reinsurance. Fifth, life insurers seem to use more derivatives (extent) to manage their risks from foreign investment and invested assets. The coefficients of *Foreign Investment* and *Invested Assets*

are positive and significant at the 1% level. However, life insurers do not actively manage the risk from the large ALM mismatch through derivative transactions. Although both coefficients of *ALM Mismatch (Assets)* and *ALM Mismatch (Liabilities)* are positive, they are not statistically significant. These results can be interpreted as life insurers participate in derivative transactions only for signaling to the market that they actively manage their risks from the ALM mismatch. In addition, investment risk from speculative bonds are no longer significant in Table 2.11. Such results are reasonable in that the purpose of speculative bonds investment is completely different from the purpose of hedging. Moreover, we find that firms with a long business history tend to use less derivatives. Therefore, firms with a long business history are more likely to participate in derivative transactions, whereas relatively young firms more aggressively use derivatives. As discussed earlier, we also run 2SLS regressions for the robustness check. Particularly, it controls the endogeneity issue between reinsurance and derivatives. Despite this, the signs and implications in Table 2.12 are consistent with previous findings in Table 2.11.

To see the changes in the mechanism of the derivative transaction volumes after the enactment of the Dodd-Frank Act, we separately examine our research questions. Table 2.13 shows that *firm size*, *reinsurance*, *reinvested assets* are still valid factors which affect the extent of derivative transaction. However, we find that some other factors have changed after the enactment of the Dodd-Frank Act. First, stock firms' transaction volumes are not significantly larger than non-stock firms after the regulation. Although the coefficients are negative, they are no longer significant. Second, after the Dodd-Frank Act, the motivation of tax reduction becomes more important. The signs of coefficients become positive and significant. Third, the dependence on the reinsurance contracts with affiliated firms

significantly reduce the transaction volumes after the Dodd-Frank Act. Fourth, firms operating A&H business tend to have smaller transaction volumes before the act. However, the coefficients of *AH Business* become insignificant. Fifth, life insurers actively manage the risk from foreign investment before the new regulatory intervention, while they reduce the transaction volumes, showing negative and marginally significant signs. Lastly, after the Dodd-Frank Act, life insurers seem to avoid managing the risk from speculative bonds through derivative transactions. Such results implicate that the decision mechanism might be changed when the market conditions change.

Table 2.11 Determinant of Derivative Extent (Notional Amount) – Cragg's Two-Part Model

	Derivative Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	1.5532***	1.5505***	1.5486***	1.5519***	1.5505***	1.5480***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.7462***	-0.7903***	-0.8071***	-0.7464***	-0.7905***	-0.8073***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Group	1.1218**	1.1637**	1.1874***	1.1213**	1.1628**	1.1866***
	(0.0128)	(0.0102)	(0.0090)	(0.0129)	(0.0103)	(0.0090)
Leverage	0.0535	0.1757	0.1948	-0.0393	0.0813	0.0995
	(0.9553)	(0.8541)	(0.8383)	(0.9688)	(0.9356)	(0.9211)
Tax	0.0819	0.0931	0.1056	0.0806	0.0917	0.1043
	(0.5041)	(0.4463)	(0.3872)	(0.5102)	(0.4522)	(0.3925)
Reinsurance	1.0882***	1.0524***	1.0490***	1.0942***	1.0583***	1.0551***
	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0001)
Reinsurance Affiliation	-0.3124*	-0.3209*	-0.3112*	-0.3118*	-0.3203*	-0.3106*
	(0.0732)	(0.0657)	(0.0744)	(0.0738)	(0.0662)	(0.0750)
AH Business	-0.1713	-0.1624	-0.1615	-0.1726	-0.1638	-0.1628
	(0.1055)	(0.1227)	(0.1239)	(0.1022)	(0.1189)	(0.1200)
Foreign Business	-0.1595	-0.2097	-0.1837	-0.1608	-0.2108	-0.1849
	(0.2994)	(0.1829)	(0.2420)	(0.2955)	(0.1805)	(0.2391)
Foreign Investment	2.0144***	1.6305**	1.4753**	2.0046***	1.6207**	1.4655**
	(0.0047)	(0.0186)	(0.0326)	(0.0049)	(0.0193)	(0.0338)
ALM Mismatch (Assets)	0.0014	0.0030	0.0024			
	(0.9472)	(0.8919)	(0.9113)			
ALM Mismatch (Liabilities)				0.0018	0.0005	0.0011
				(0.9308)	(0.9793)	(0.9601)
Invested Assets	2.1510***	2.1646***	2.1663***	2.1382***	2.1545***	2.1549***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Speculative Bonds	-2.4779	-1.8204	-2.0195	-2.5125	-1.8572	-2.0569
	(0.1407)	(0.2788)	(0.2315)	(0.1349)	(0.2687)	(0.2225)

Table 2.11: Continued

	Derivative Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.0051***	-0.0053***	-0.0054***	-0.0051***	-0.0053***	-0.0054***
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
FS		0.3378***	-0.0196		0.3369***	-0.0211
		(0.0079)	(0.9255)		(0.0081)	(0.9201)
DF			0.4414**			0.4420**
			(0.0282)			(0.0280)
Δ 3M Yield	-0.0012	-0.0012	0.0001	-0.0012	-0.0012	0.0001
	(0.4853)	(0.4879)	(0.9423)	(0.4838)	(0.4861)	(0.9432)
Δ Yield curve	-0.0001	-0.0001	0.0011	-0.0001	-0.0001	0.0011
	(0.9614)	(0.9262)	(0.5014)	(0.9618)	(0.9264)	(0.5004)
Δ Credit Spread	0.0009	-0.0004	0.0014	0.0009	-0.0004	0.0014
	(0.5404)	(0.8060)	(0.4131)	(0.5412)	(0.8066)	(0.4119)
Index Return	0.4337	-0.0899	0.2389	0.4325	-0.0895	0.2397
	(0.3730)	(0.8665)	(0.6638)	(0.3744)	(0.8671)	(0.6629)
VIX	-0.0269	-0.0317*	-0.0162	-0.0268	-0.0317*	-0.0161
	(0.1031)	(0.0523)	(0.3810)	(0.1039)	(0.0528)	(0.3841)
Constant	-17.1051***	-17.1806***	-17.4211***	-17.0133***	-17.0919***	-17.3301***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	2134	2134	2134	2134	2134	2134
R-squared	0.535	0.537	0.538	0.535	0.537	0.538

Note) *Derivative Volume* = ln (derivative transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

Table 2.12 Determinant of Derivative Extent (Notional Amount) – 2SLS

	Derivative Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	1.5611***	1.5584***	1.5564***	1.5573***	1.5559***	1.5534***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.7719***	-0.8148***	-0.8315***	-0.7721***	-0.8150***	-0.8317***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Group	1.0959**	1.1369**	1.1606**	1.0953**	1.1360**	1.1598**
	(0.0149)	(0.0119)	(0.0105)	(0.0150)	(0.0120)	(0.0106)
Leverage	-0.0352	0.0845	0.1038	-0.1474	-0.0292	-0.0107
	(0.9707)	(0.9297)	(0.9136)	(0.8840)	(0.9770)	(0.9915)
Tax	0.0922	0.1031	0.1156	0.0907	0.1015	0.1141
	(0.4507)	(0.3977)	(0.3428)	(0.4573)	(0.4040)	(0.3484)
Reinsurance	1.3980***	1.3613***	1.3572***	1.4077***	1.3708***	1.3669***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Reinsurance Affiliation	-0.3492**	-0.3574**	-0.3476**	-0.3487**	-0.3569**	-0.3470**
	(0.0445)	(0.0397)	(0.0455)	(0.0448)	(0.0400)	(0.0458)
AH Business	-0.1733*	-0.1646	-0.1636	-0.1749*	-0.1662	-0.1653
	(0.0999)	(0.1160)	(0.1170)	(0.0961)	(0.1116)	(0.1126)
Foreign Business	-0.1726	-0.2215	-0.1956	-0.1742	-0.2230	-0.1970
	(0.2588)	(0.1568)	(0.2100)	(0.2543)	(0.1541)	(0.2066)
Foreign Investment	2.0026***	1.6280**	1.4733**	1.9923***	1.6178**	1.4631**
	(0.0045)	(0.0178)	(0.0313)	(0.0047)	(0.0185)	(0.0326)
ALM Mismatch (Assets)	-0.0006	0.0009	0.0004			
	(0.9787)	(0.9670)	(0.9863)			
ALM Mismatch (Liabilities)				0.0043	0.0030	0.0035
				(0.8423)	(0.8892)	(0.8704)
Invested Assets	2.1242***	2.1377***	2.1394***	2.1040***	2.1201***	2.1207***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Speculative Bonds	-2.4798	-1.8381	-2.0365	-2.5214	-1.8821	-2.0811
	(0.1368)	(0.2696)	(0.2232)	(0.1299)	(0.2577)	(0.2126)
Age	-0.0053***	-0.0054***	-0.0055***	-0.0053***	-0.0054***	-0.0055***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)

Table 2.12: Continued

	Derivative Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
FS		0.3297***	-0.0265		0.3286***	-0.0282
		(0.0092)	(0.8988)		(0.0094)	(0.8927)
DF			0.4399**			0.4406**
			(0.0278)			(0.0275)
Δ 3M Yield	-0.0012	-0.0012	0.0001	-0.0012	-0.0012	0.0001
	(0.4881)	(0.4905)	(0.9381)	(0.4868)	(0.4889)	(0.9387)
Δ Yield curve	-0.0001	-0.0001	0.0012	-0.0001	-0.0001	0.0012
	(0.9686)	(0.9340)	(0.4945)	(0.9695)	(0.9347)	(0.4930)
Δ Credit Spread	0.0008	-0.0004	0.0014	0.0008	-0.0004	0.0014
	(0.5674)	(0.7894)	(0.4227)	(0.5682)	(0.7902)	(0.4212)
Index Return	0.4036	-0.1072	0.2206	0.4019	-0.1072	0.2210
	(0.4063)	(0.8406)	(0.6871)	(0.4083)	(0.8406)	(0.6866)
VIX	-0.0265	-0.0313*	-0.0158	-0.0264	-0.0312*	-0.0156
	(0.1060)	(0.0546)	(0.3911)	(0.1071)	(0.0553)	(0.3949)
Constant	-17.1707***	-17.2441***	-17.4836***	-17.0539***	-17.1303***	-17.3677***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	2134	2134	2134	2134	2134	2134
R-squared	0.535	0.537	0.538	0.535	0.537	0.538

Note) *Derivative Volume* = ln (derivative transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

Table 2.13 Determinant of Derivative Extent (Notional Amount) Before and After the Dodd-Frank Act

	Derivative Volume (Extent)			
	Before		After	
	(1)	(2)	(3)	(4)
Size	1.5484***	1.5533***	1.5981***	1.6087***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.9489***	-0.9511***	-0.2960	-0.2958
	(0.0001)	(0.0001)	(0.2595)	(0.2598)
Group	0.9733	0.9736	1.3354**	1.3323**
	(0.1347)	(0.1349)	(0.0338)	(0.0342)
Leverage	-0.5362	-0.6450	1.9295	1.9159
	(0.6055)	(0.5578)	(0.3046)	(0.3233)
Tax	-0.2327	-0.2333	0.5760***	0.5752***
	(0.1134)	(0.1121)	(0.0060)	(0.0060)
Reinsurance	0.8097**	0.8171**	1.5156***	1.5114***
	(0.0114)	(0.0110)	(0.0003)	(0.0004)
Reinsurance Affiliation	-0.1015	-0.1009	-0.7800***	-0.7804***
	(0.6316)	(0.6337)	(0.0091)	(0.0090)
AH Business	-0.3768***	-0.3776***	0.2371	0.2371
	(0.0063)	(0.0060)	(0.1377)	(0.1373)
Foreign Business	-0.2490	-0.2508	-0.1628	-0.1626
	(0.1860)	(0.1827)	(0.5439)	(0.5448)
Foreign Investment	2.9650***	2.9504***	-1.8272*	-1.8345**
	(0.0017)	(0.0017)	(0.0503)	(0.0495)
ALM Mismatch (Assets)	0.0089		0.0124	
	(0.7102)		(0.7586)	
ALM Mismatch (Liabilities)		-0.0042		-0.0102
		(0.8575)		(0.7962)
Invested Assets	3.0258***	3.0219***	1.0287**	1.0519**
	(0.0000)	(0.0000)	(0.0108)	(0.0144)
Speculative Bonds	-0.2253	-0.2922	-4.7777*	-4.7914*
	(0.9216)	(0.8986)	(0.0894)	(0.0887)

Table 2.13: Continued

	Derivative Volume (Extent)			
	Before		After	
	(1)	(2)	(3)	(4)
Age	-0.0045**	-0.0045**	-0.0062***	-0.0062***
	(0.0161)	(0.0154)	(0.0011)	(0.0012)
Δ 3M Yield	0.0002	0.0002	-0.0107	-0.0108
	(0.9385)	(0.9404)	(0.7660)	(0.7653)
Δ Yield curve	-0.0005	-0.0005	0.0003	0.0003
	(0.8883)	(0.8882)	(0.9346)	(0.9340)
Δ Credit Spread	-0.0003	-0.0003	-0.0005	-0.0005
	(0.8898)	(0.8799)	(0.8426)	(0.8444)
Index Return	-0.1524	-0.1582	-1.8260	-1.8237
	(0.8208)	(0.8142)	(0.1226)	(0.1231)
VIX	0.0160	0.0161	-0.0928**	-0.0928**
	(0.5169)	(0.5121)	(0.0277)	(0.0278)
Constant	-17.6591***	-17.5704***	-17.7281***	-17.7465***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	1324	1324	810	810
R-squared	0.509	0.509	0.604	0.604

Note) *Derivative Volume* = ln (derivative transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

2.5.4 Swap Transaction Volumes (Extent)

The Dodd-Frank act mainly regulates the swaps contracts. Therefore, we additionally examine the determinants of swap transaction volumes (extent), using data of swap users. The empirical results in Table 2.14 confirms again that the effect of the financial crisis is little. In addition, the enactment of the Dodd-Frank Act is insignificant. It indicates that the swap transaction volumes are not considerably changed. Such results are inconsistent with our expectation since the life insurers' total derivative transaction volumes are significantly increased after the Dodd-Frank Act as shown in Table 2.11 and Table 2.12.

About these inconsistent aspects, it is doubtful whether the enactment of the Dodd-Frank Act improves market transparency and efficiency. In prior literature, there are many criticisms about the effect of the Dodd-Frank Act. Smith and Muniz-Fracticelli (2013) state that the act fails to fundamentally address the systemic design questions in the current financial market. Barr (2012) suggests that the act omits some key legislation.[20] Polk (2016) shows that the regulatory provisions are not settled down on time, providing evidence that as of the beginning of July 2013, 279 rule-making requirement deadlines had passed, but only 104 rule-making requirements (37.3%) were met with finalized rules. Khademian (2013) and Nwogugu (2015) conclude that the Dodd-Frank Act is not only inefficient and inadequate as a response to the financial crisis, but also has not resulted in significant economic growth. Further, they show that the new regulatory intervention increases costs for the transactions and compliance. Under such conditions, the benefits from the

[20] e.g., failure to consolidate government regulatory agencies, inadequate regulation of money market funds, inadequate regulation of government-sponsored entities, capital and liquidity requirements and regulation

regulatory changes in the swap market will be limited and the costs are more likely to overwhelm the benefits, deteriorating the market efficiency. Our empirical findings support that the costs of the new regulation overwhelm the benefits, due to the inefficient and inadequate regulatory changes. The Dodd-Frank Act reduces the likelihood of swap participation. In addition, swap volumes are not significantly increased after the new regulatory intervention even when the total derivative volumes are considerably increased.

Table 2.14 also shows that firm size, firm type, leverage, reinsurance, reinsurance affiliation, and age have the same impacts on the decision of transaction participation and transaction volumes. On the other hand, highly leverage firms tend to use less swaps, while firms operating A&H Business are more likely to have high transaction volumes. Moreover, the risk from foreign investment is not actively managed through swap contracts. Such different aspects indicate that certain types of risks are managed with specific types of derivatives. We also run 2SLS regressions for the robustness check. The implications in Table 2.15 are consistent with those in Table 2.14.

Consistent with Table 2.13, we additionally investigate whether the determinants of swap transaction volumes have changed after the enactment of the Dodd-Frank Act (see Table 2.16). In general, *firm size*, *reinsurance*, and *A&H Business* consistently increase the swap transaction volumes, and *firm age* decreases the volumes, regardless of the new regulatory intervention. Particularly, *reinsurance affiliation*, *firm type*, *reinsurance affiliation*, and *invested asset* are no longer effective after the act. However, leverage becomes a crucial factor. Last, there is a considerable change in *speculative bonds*. Before the enactment of Dodd-Frank Act, life insurers actively manage the risk from speculative bonds through swap contracts, but they reduce the volumes after the act.

Table 2.14 Determinant of Swap Extent (Notional Amount) – Cragg's Two-Part Model

	Swap Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	1.4882***	1.4877***	1.4850***	1.4972***	1.4968***	1.4935***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.3444*	-0.3460*	-0.3505*	-0.3423*	-0.3438*	-0.3482*
	(0.0831)	(0.0817)	(0.0787)	(0.0855)	(0.0841)	(0.0810)
Group	-0.2175	-0.2153	-0.1994	-0.2520	-0.2500	-0.2341
	(0.6879)	(0.6911)	(0.7121)	(0.6448)	(0.6476)	(0.6678)
Leverage	-2.3338**	-2.3214**	-2.2606**	-2.7434**	-2.7330**	-2.6794**
	(0.0439)	(0.0434)	(0.0482)	(0.0222)	(0.0219)	(0.0240)
Tax	-0.0116	-0.0111	-0.0023	-0.0145	-0.0140	-0.0052
	(0.9191)	(0.9223)	(0.9842)	(0.8991)	(0.9019)	(0.9637)
Reinsurance	1.4428***	1.4406***	1.4404***	1.4424***	1.4403***	1.4404***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Reinsurance Affiliation	-0.4014**	-0.4022**	-0.3960**	-0.3988**	-0.3995**	-0.3932**
	(0.0123)	(0.0124)	(0.0139)	(0.0130)	(0.0131)	(0.0147)
AH Business	0.3785***	0.3786***	0.3757***	0.3757***	0.3758***	0.3729***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Foreign Business	0.0537	0.0490	0.0733	0.0497	0.0453	0.0697
	(0.7493)	(0.7772)	(0.6724)	(0.7680)	(0.7939)	(0.6884)
Foreign Investment	0.1380	0.0937	-0.0260	0.0770	0.0361	-0.0847
	(0.9181)	(0.9449)	(0.9847)	(0.9543)	(0.9787)	(0.9501)
ALM Mismatch (Assets)	0.0204	0.0205	0.0201			
	(0.3889)	(0.3864)	(0.3946)			
ALM Mismatch (Liabilities)				-0.0071	-0.0071	-0.0066
				(0.7466)	(0.7455)	(0.7635)
Invested Assets	0.6714**	0.6734**	0.6808***	0.6535**	0.6554**	0.6609**
	(0.0113)	(0.0105)	(0.0094)	(0.0172)	(0.0161)	(0.0150)
Speculative Bonds	1.7441	1.8025	1.6352	1.5471	1.6002	1.4302
	(0.3699)	(0.3489)	(0.3965)	(0.4217)	(0.4014)	(0.4542)
Age	-0.0071***	-0.0071***	-0.0071***	-0.0071***	-0.0071***	-0.0071***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 2.14: Continued

	Swap Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
FS		0.0238	-0.2232		0.0219	-0.2262
		(0.8537)	(0.2426)		(0.8659)	(0.2367)
DF			0.3065			0.3078
			(0.1017)			(0.1004)
Δ 3M Yield	-0.0024	-0.0024	-0.0015	-0.0024	-0.0024	-0.0014
	(0.1771)	(0.1782)	(0.4283)	(0.1785)	(0.1796)	(0.4322)
Δ Yield curve	-0.0019	-0.0019	-0.0010	-0.0018	-0.0018	-0.0009
	(0.2798)	(0.2794)	(0.5876)	(0.2824)	(0.2820)	(0.5932)
Δ Credit Spread	-0.0001	-0.0002	0.0010	-0.0001	-0.0002	0.0010
	(0.9148)	(0.8766)	(0.5466)	(0.9169)	(0.8823)	(0.5408)
Index Return	0.0810	0.0462	0.2720	0.0808	0.0489	0.2756
	(0.8664)	(0.9297)	(0.6103)	(0.8668)	(0.9258)	(0.6062)
VIX	-0.0207	-0.0210	-0.0107	-0.0204	-0.0207	-0.0103
	(0.2072)	(0.2000)	(0.5504)	(0.2146)	(0.2079)	(0.5659)
Constant	-12.3865***	-12.3871***	-12.5718***	-11.9910***	-11.9906***	-12.1675***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	1423	1423	1423	1423	1423	1423
R-squared	0.502	0.502	0.502	0.501	0.501	0.502

Note) *Swap Volume* = ln (swap transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

Table 2.15 Determinant of Swap Extent (Notional Amount) – 2SLS

	Swap Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	1.5019***	1.5016***	1.4990***	1.5099***	1.5097***	1.5065***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.3808*	-0.3817*	-0.3865*	-0.3790*	-0.3798*	-0.3845*
	(0.0534)	(0.0527)	(0.0504)	(0.0549)	(0.0542)	(0.0518)
Group	-0.2702	-0.2689	-0.2534	-0.3068	-0.3057	-0.2903
	(0.6178)	(0.6199)	(0.6392)	(0.5748)	(0.5765)	(0.5948)
Leverage	-2.3410**	-2.3338**	-2.2731**	-2.7855**	-2.7799**	-2.7266**
	(0.0448)	(0.0438)	(0.0486)	(0.0212)	(0.0207)	(0.0226)
Tax	0.0036	0.0039	0.0128	0.0007	0.0009	0.0099
	(0.9748)	(0.9730)	(0.9104)	(0.9950)	(0.9935)	(0.9308)
Reinsurance	1.8965***	1.8945***	1.8977***	1.9034***	1.9017***	1.9053***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Reinsurance Affiliation	-0.4539***	-0.4543***	-0.4485***	-0.4518***	-0.4521***	-0.4462***
	(0.0045)	(0.0045)	(0.0051)	(0.0047)	(0.0048)	(0.0054)
AH Business	0.3775***	0.3776***	0.3747***	0.3745***	0.3745***	0.3716***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Foreign Business	0.0339	0.0311	0.0553	0.0291	0.0268	0.0510
	(0.8391)	(0.8560)	(0.7476)	(0.8617)	(0.8761)	(0.7671)
Foreign Investment	0.0401	0.0144	-0.1058	-0.0260	-0.0479	-0.1694
	(0.9759)	(0.9914)	(0.9369)	(0.9844)	(0.9714)	(0.8991)
ALM Mismatch (Assets)	0.0199	0.0200	0.0196			
	(0.4063)	(0.4043)	(0.4129)			
ALM Mismatch (Liabilities)				-0.0058	-0.0058	-0.0053
				(0.7944)	(0.7936)	(0.8123)
Invested Assets	0.6349**	0.6362**	0.6433**	0.6106**	0.6117**	0.6169**
	(0.0162)	(0.0152)	(0.0137)	(0.0258)	(0.0243)	(0.0228)
Speculative Bonds	1.6325	1.6668	1.4986	1.4214	1.4502	1.2790
	(0.3953)	(0.3799)	(0.4309)	(0.4545)	(0.4405)	(0.4972)
Age	-0.0072***	-0.0072***	-0.0072***	-0.0072***	-0.0072***	-0.0072***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 2.15: Continued

	Swap Volume (Extent)					
	(1)	(2)	(3)	(4)	(5)	(6)
FS		0.0139	-0.2331		0.0118	-0.2364
		(0.9139)	(0.2181)		(0.9271)	(0.2120)
DF			0.3063*			0.3078*
			(0.0984)			(0.0968)
Δ 3M Yield	-0.0024	-0.0024	-0.0015	-0.0024	-0.0024	-0.0015
	(0.1662)	(0.1668)	(0.4092)	(0.1676)	(0.1682)	(0.4131)
Δ Yield curve	-0.0018	-0.0018	-0.0009	-0.0018	-0.0018	-0.0009
	(0.2812)	(0.2809)	(0.5913)	(0.2841)	(0.2839)	(0.5977)
Δ Credit Spread	-0.0003	-0.0003	0.0009	-0.0003	-0.0003	0.0009
	(0.8390)	(0.8240)	(0.5821)	(0.8407)	(0.8296)	(0.5759)
Index Return	0.0361	0.0159	0.2413	0.0353	0.0181	0.2447
	(0.9396)	(0.9756)	(0.6481)	(0.9410)	(0.9722)	(0.6442)
VIX	-0.0207	-0.0209	-0.0106	-0.0204	-0.0205	-0.0101
	(0.2032)	(0.1989)	(0.5512)	(0.2112)	(0.2074)	(0.5681)
Constant	-12.6263***	-12.6263***	-12.8127***	-12.1967***	-12.1963***	-12.3748***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	1423	1423	1423	1423	1423	1423
R-squared	0.501	0.501	0.501	0.500	0.500	0.501

Note) *Swap Volume* = ln (swap transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

Table 2.16 Determinant of Swap Extent (Notional Amount) Before and After the Dodd-Frank Act

	Swap Volume (Extent)			
	Before		After	
	(1)	(2)	(3)	(4)
Size	1.4296***	1.4449***	1.6316***	1.6349***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock	-0.5661**	-0.5670**	0.2286	0.2412
	(0.0242)	(0.0243)	(0.5100)	(0.4863)
Group	0.2994	0.2660	-1.3886	-1.4203
	(0.6259)	(0.6692)	(0.2673)	(0.2578)
Leverage	-1.0335	-1.3504	-5.0763**	-5.7974**
	(0.4242)	(0.3162)	(0.0431)	(0.0267)
Tax	-0.0097	-0.0110	-0.0670	-0.0713
	(0.9415)	(0.9343)	(0.7509)	(0.7348)
Reinsurance	1.3182***	1.3112***	1.6707***	1.6891***
	(0.0000)	(0.0000)	(0.0009)	(0.0007)
Reinsurance Affiliation	-0.3319*	-0.3286*	-0.4580	-0.4548
	(0.0529)	(0.0552)	(0.1582)	(0.1608)
AH Business	0.2069*	0.2051*	0.7347***	0.7309***
	(0.0896)	(0.0933)	(0.0000)	(0.0000)
Foreign Business	0.0408	0.0366	0.1581	0.1539
	(0.8098)	(0.8293)	(0.6799)	(0.6900)
Foreign Investment	-0.0869	-0.1519	1.8426	1.8070
	(0.9466)	(0.9065)	(0.5536)	(0.5611)
ALM Mismatch (Assets)	0.0265		0.0152	
	(0.3408)		(0.7132)	
ALM Mismatch (Liabilities)		-0.0141		0.0023
		(0.5862)		(0.9547)
Invested Assets	1.4360***	1.4355***	-0.4338	-0.4831
	(0.0000)	(0.0000)	(0.3728)	(0.3412)
Speculative Bonds	5.4410**	5.2317**	-6.6774*	-6.8893**
	(0.0154)	(0.0195)	(0.0585)	(0.0460)

Table 2.16: Continued

	Swap Volume (Extent)			
	Before		After	
	(1)	(2)	(3)	(4)
Age	-0.0056***	-0.0056***	-0.0092***	-0.0092***
	(0.0007)	(0.0006)	(0.0000)	(0.0000)
Δ 3M Yield	-0.0019	-0.0019	0.0085	0.0086
	(0.4302)	(0.4305)	(0.8374)	(0.8362)
Δ Yield curve	-0.0022	-0.0022	0.0006	0.0007
	(0.4213)	(0.4213)	(0.8677)	(0.8621)
Δ Credit Spread	-0.0011	-0.0011	0.0011	0.0011
	(0.5603)	(0.5541)	(0.7384)	(0.7311)
Index Return	-0.2305	-0.2330	-0.7099	-0.7077
	(0.7054)	(0.7027)	(0.6220)	(0.6234)
VIX	-0.0012	-0.0008	-0.0105	-0.0098
	(0.9585)	(0.9725)	(0.8340)	(0.8455)
Constant	-13.7319***	-13.4211***	-11.6291***	-11.0235***
	(0.0000)	(0.0000)	(0.0005)	(0.0013)
N	889	889	534	534
R-squared	0.523	0.522	0.506	0.505

Note) *Swap Volume* = ln (swap transactions / net admitted assets), *Size* = ln (net admitted asset). *Stock* is 1 if stock firms, 0, otherwise. *Group* is 1 if group, 0, otherwise. *Leverage* = liabilities/net admitted assets. *Tax* is 1 if firm pays tax at the current year, 0, otherwise. *Reinsurance* is ratio of reinsurance premium ceded to the sum of direct premiums written and reinsurance assumed. *Reinsurance Affiliation* = total transaction amount with affiliated firms over total reinsurance transactions. *AH Business* is 1 if a firm operates accident/health business, 0, otherwise. *Foreign Business* is 1 if a firm earns premiums from foreign countries except for Canada, 0, otherwise. *Foreign Investment* = (total amounts invested in foreign bonds, preferred stocks, and common stocks) / total invested assets. *Invested Assets* = (bond + preferred stock + common stock) / total invested assets. *Speculative Bond* = Total amounts invested in speculative bond / total invested bonds. ALM Mismatch (Assets) = ln{Max [0, (current assets - non-current liabilities) / total admitted assets] }. *ALM Mismatch (Liabilities)* = ln{Max [0, (non-current liabilities - current assets) / total admitted assets]}. *Age* = current year – established year. *FS* is 1 if year>=2007, 0, otherwise. *DF* is 1 if year>=2010, 0, otherwise. Δ 3M Yield is a change in the three-month Treasury bill rate. Δ Yield curve is a change in the spread between 10-year Treasury bill rate and the three-month Treasury bill rate. Δ Credit Spread is a change in the spread between Moody's Baa-rated bonds and 10-year Treasury rate. Index Return is an annual return of S&P 500 index. VIX measures the volatility implied by S&P 500 index options.

2.6 Conclusion

Over the last two decades, derivatives have been used as a risk management tool in the insurance market. In the U.S. insurance market, life insurers have accounted for over 95% of total derivative transactions and such proportion is much higher than those of other countries. However, there has been little attention to the derivative practice of the U.S. life insurers. It is quite surprising considering: (1) the transaction volume and its potential risk are monumental; (2) the financial crisis that occurred over 2007-2008 was considerably attributed to the misuse of derivatives; (3) insurers regularly report their derivative transactions due to the strict regulatory requirements; and (4) newest regulatory requirements in the Title VII of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) were introduced in 2010.

Although there has been an effort to examine determinants of derivative participation and its extent, prior literature has several limitations: 1) a short-term sample period (e.g., Cummins, Phillips, and Smith, 1997; Colquitt and Hoyt, 1997), 2) an endogenous problem between reinsurance and derivative use, 3) inaccurate transaction volumes, and 4) lack of study considering impacts of the financial crisis and the Dodd-Frank Act. This study extends prior literature by 1) using a wider period of sample data 2) mitigating an endogenous issue through IV probit and 2SLS regressions, 3) estimating notional amount more accurately, and 4) including variables of the financial crisis and the Dodd-Frank Act in the models.

The key findings are as follows: First, the determinants of derivative (swap) participation are different from the determinants of derivative (swap) transaction volumes. Such results are consistent with findings of Colquitt and Hoyt (1997). Although some

factors such as firm size increases the participation probability and transaction volumes in the same manner, many other determinant factors differently affect life insurers' participation decision and its extent. In part, such results implicate that some insurers participate in derivative/swap transactions as a signal that they manage their risks through diverse risk management tools. Second, we find that insurers' derivative practical usage is not highly associated with the macroeconomic factors. The empirical results show that insurers' behaviors are not sensitive to the changes in the macroeconomic factors. Third, the financial crisis has limited impact on the derivative practice in the life insurance market. Fourth, the enactment of the Dodd-Frank Act not only reduces the likelihood of swap participation, but also stagnates the growth of the swap transaction volumes, while the total derivative transaction volumes are significantly increased. Such inconsistent aspects indicate that the costs of the new regulation overwhelm the benefits, due to the inefficient and inadequate regulatory changes, supporting the critical perspectives of the impact of the Dodd-Frank Act in prior literature.

Nevertheless, this study has the following limitations. First, this study measures the use of derivatives based on notional amounts. As explained by Cummins, Phillips, and Smith (2001), the notional volume does not reflect the economic value of derivative transaction. However, Cummins, Phillips, and Smith (2001) also suggest that "to the extent the measurement error is uncorrelated to the explanatory variables, the authors' estimates will remain unbiased." In addition, most existing literature on derivative use in both insurance market and non-insurance market has used notional amounts. Despite these arguments, it is necessary to examine the derivative practice (participation and its extent) with fair values of derivative transactions. Second, this study aggregates all data regardless

of transaction types. However, the determinants may be different depending on transaction types (e.g., call option, future, and swap). Therefore, it needs additional analysis on insurer's participation and volume decisions by transaction types. Finally, this study does not explain why the derivative volumes are significantly increased after 2010. If the specific reasons are clarified, it will be more helpful to understand the derivative practice of life insurers.

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APPENDIX A. RATING SORTING METHOD ONE

Rank	A.M. Best		Standard & Poor's		Moody's		Fitch Ratings	
1	A++	Superior	AAA	Extremely Strong	Aaa	Exceptional	AAA	Exceptionally Strong
	A+	Superior	AA+	Very Strong	Aa1	Excellent	AA+	Very Strong
2	A	Excellent	AA	Very Strong	Aa2	Excellent	AA	Very Strong
	A-	Excellent	AA-	Very Strong	Aa3	Excellent	AA-	Very Strong
	B++	Good	A+	Strong	A1	Good	A+	Strong
3	B+	Good	A	Strong	A2	Good	A	Strong
	B	Fair	A-	Strong	A3	Good	A-	Strong
	B-	Fair	BBB+	Good	Baa1	Adequate	BBB+	Good
4	C++	Marginal	BBB	Good	Baa2	Adequate	BBB	Good
	C+	Marginal	BBB-	Good	Baa3	Adequate	BBB-	Good
	C	Weak	BB+	Marginal	Ba1	Questionable	BB+	Moderately Weak
5	C-	Weak	BB	Marginal	Ba2	Questionable	BB	Moderately Weak
	D	Poor	BB-	Marginal	Ba3	Questionable	BB-	Moderately Weak
	E	Under Regulatory Supervision	B+	Weak	B1	Poor	B+	Weak
6	F	In Liquidation	B	Weak	B2	Poor	B	Weak
	S	Rating Suspended	B-	Weak	B3	Poor	B-	Weak
			CCC+	Very Weak	Caa1	Very Poor	CCC+	Very Weak
			CCC	Very Weak	Caa2	Very Poor	CCC	Very Weak
7			CCC-	Very Weak	Caa3	Very Poor	CCC-	Very Weak
			CC	Extremely Weak	Ca	Extremely Poor	CC	Extremely Weak
					C	Lowest	C	Distressed

Note) This sorting method is based on the guide of Insurance Literacy Institution (www.insuranceliteracy.org/) and Sommer and Pottier (2006)

APPENDIX B. RATING SORTING METHOD TWO

Rank	A.M. Best		Standard & Poor's		Moody's		Fitch Ratings	
1	A++	Superior	AAA	Extremely Strong	Aaa	Exceptional	AAA	Exceptionally Strong
	A+	Superior						
2	A	Excellent	AA+	Very Strong	Aa1	Excellent	AA+	Very Strong
	A-	Excellent	AA	Very Strong	Aa2	Excellent	AA	Very Strong
			AA-	Very Strong	Aa3	Excellent	AA-	Very Strong
3	B++	Good	A+	Strong	A1	Good	A+	Strong
	B+	Good	A	Strong	A2	Good	A	Strong
			A-	Strong	A3	Good	A-	Strong
4	B	Fair	BBB+	Good	Baa1	Adequate	BBB+	Good
	B-	Fair	BBB	Good	Baa2	Adequate	BBB	Good
			BBB-	Good	Baa3	Adequate	BBB-	Good
5	C++	Marginal	BB+	Marginal	Ba1	Questionable	BB+	Moderately Weak
	C+	Marginal	BB	Marginal	Ba2	Questionable	BB	Moderately Weak
			BB-	Marginal	Ba3	Questionable	BB-	Moderately Weak
6	C	Weak	B+	Weak	B1	Poor	B+	Weak
	C-	Weak	B	Weak	B2	Poor	B	Weak
			B-	Weak	B3	Poor	B-	Weak
7	D	Poor	CCC+	Very Weak	Caa1	Very Poor	CCC+	Very Weak
			CCC	Very Weak	Caa2	Very Poor	CCC	Very Weak
			CCC-	Very Weak	Caa3	Very Poor	CCC-	Very Weak
8	E	Under Regulatory Supervision			Ca	Extremely Poor	CC	Extremely Weak
9	F	In Liquidation	CC	Extremely Weak	C	Lowest	C	Distressed

Note) This sorting method is based on the rating category provided by Pottier and Sommer (1999)

APPENDIX C. CATEGORY OF BUSINESS LINES (BASE ON YEAR 2010)

Business Lines	Components	Line No.
1. Accident and Health	Group Accident and Health	# 13
	Credit Accident and Health (group and individual)	# 14
	Other Accident and Health	# 15
2. Aircraft (all perils)	Aircraft	# 22
3. Auto	Private Passenger Auto Liability	#19.1,19.2
	Commercial Auto Liability	#19.3,19.4
	Auto Physical Damage	# 21
4. Boiler and Machinery	Boiler and machinery	# 27
5. Burglary and Theft	Burglary and theft	# 26
6. Commercial Multi-Peril	Commercial multiple peril	# 5
7. Credit	Credit	# 28
8. Earthquake	Earthquake	# 12
9. Farmowners	Farmowners multiple peril	# 3
10. Financial Guaranty	Financial guaranty	# 10
11. Fidelity	Fidelity	# 23
12. Fire and Allied lines	Fire	# 1
	Allied lines	# 2
13. Homeowners	Homeowners multiple peril	# 4
14. Inland Marine	Inland marine	# 9
15. International	International	# 29
16. Medical Malpractice	Medical Malpractice–Occurrence	# 11.1
	Medical Malpractice–Claims Made	# 11.2
17. Mortgage Guaranty	Mortgage guaranty	# 6
18. Ocean Marine	Ocean marine	# 8
19. Other	Warranty	# 30
	Aggregate write-ins for other lines of business	# 34
20. Other Liability	Other liability—occurrence	# 17.1
	Other liability—claims-made	# 17.2
21. Products Liability	Products Liability–Occurrence	# 18.1
	Products Liability–Claims Made	# 18.2
22. Reinsurance	Reinsurance-nonproportional assumed property	# 31
	Reinsurance-nonproportional assumed liability	# 32
	Reinsurance-nonproportional assumed financial lines	# 33
23. Surety	Surety	# 24
24.Workers' Compensation	Workers' compensation	# 16
	Excess workers' compensation	# 17.3

Note) Net Written Premium by line of business are obtained from the Underwriting and Investment Exhibit

APPENDIX D. DEFINITION OF DERIVATIVE PURPOSES

(1) **Hedging Effective**: A derivative transaction that is used in hedging transaction that meet the criteria of a highly effective hedge as described in *SSAP No.86 - Derivatives*, which are valued and reported in a manner that is consistent with the hedged asset or liability. There transactions have been voluntarily designated and are effective as of the reporting date.

(2) **Hedging Other**: A derivative transaction that is used in a hedging transaction where the intent is for an economic reduction of one or more risk factors. This transaction is not part of an effectively designated relationship as described under *SSAP No. 86 - Derivatives*.

(3) **Replication**: A derivative transaction entered into in conjunction with other investments in order to reproduce the investment characteristics of otherwise permissible investments as described under *SSAP No. 86 - Derivatives*. A derivative transaction entered into by a reporting entity as a hedging or income generation transaction shall not be a replication (synthetic asset) transaction. These transactions are regarded as replications as of the reporting date.

(4) **Income Generation**: A derivative transaction written or sold to generate additional income or return to the reporting entity as describe under SSAP No. 86-Derivatives.

(5) **Other**: A derivative transaction written or sold by the reporting entity used for means other than (1) Hedging Effective; (2) Hedging Other; (3) Replication; or (4) Income Generation (definition listed above or referenced in SSAP NO.86-Derivatives). When this subcategory is utilized, a description of the use should be included in the footnotes to the financial statements.

Source) SNL Financial