**Determinants of Derivative Use and The Impacts of the Financial Crisis and the Dodd-Frank Act: Evidence from the U.S. Life Insurance Industry**

## ABSTRACT

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. There are only a few prior studies examining the practical use of derivatives in the U.S. life insurance market, but several limitations exist in terms of data they used (single-year, outdated, and inaccurate). In this paper, 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.

## 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.[1] 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. The most recent U.S. financial crisis over 2007-2008 was partly attributed to the misuse of derivatives. Therefore, regulators and market participants began to pay attention to insurers' practice of derivative use. 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 introduced in 2010. The enactment of the Dodd-Frank Act changes the environment of both the derivative market and the insurance market.

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

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.[2] 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.[3] Second, there are only a few studies that examine the U.S. insurance market by using one year and outdated samples (see, e.g., Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 1997, 2001).[4] 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

[2] 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).

[3] 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. 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).

[4] 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.

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[5]; 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 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

[5] 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.

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 study the impact of the Dodd-Frank Act which mainly regulates swap contracts.

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 enactment of 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 reviews existing literature and develops hypotheses based on theoretical background. Section 3 describes our sample data and discusses the methodologies for the empirical analysis. Empirical findings are provided in section 4. The last section concludes results and discusses limitations of this study.

## 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.[6][7] 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 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

[6] 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.

[7] 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).

(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.[8] 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.

## 3. Research Hypothesis

### 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,

[8] 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.

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.

*Hypothesis 1: The financial crisis decreases insurers' derivative participation and volume (−).*

### 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.[9] The Title VII has three primary goals: 1) minimize systemic risk from derivative 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.[10] 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

[9] The Congress regards that 2007-2008 financial crisis is exacerbated due to the lack of regulations of OTC derivatives.
[10] 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.

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 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*).

---

*Hypothesis 2A: The enactment of the Dodd-Frank Act decreases insurers' derivative participation and transaction volume (−).*

*Hypothesis 2B: The enactment of the Dodd-Frank Act increases insurers' derivative participation and transaction volume (+).*

---

## 4. Methodology and Data

### 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.[11]

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 risk-averse managers. In addition, mutual firms do not have a strong mechanism to effectively control managers'

[11] 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.

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 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. we measure 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)

### 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. The reporting of derivatives is based on *SSAP No.86, Accounting for Derivative Instruments and Hedging, Income Generation, and Replication (Synthetic Asset*), the statutory accounting principles (SAP). 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 (see Table 1).

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 1>

**4.3 Data**

To examine the determinants of derivative participation and its extents (volume), we collect the data from NAIC between 2001 and 2015.[12] 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 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 1).

<Table 2>

<Figure 1>

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

[12] SNL Financial also provides Schedule DB data of NAIC during the period between 2001 and 2015.

sample consists of 13,042 firm-year observations.

The definition of variables and summary statistics on each variable are presented in Table 3 and Table 4 respectively. As shown in Table 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 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.

<Table 3>

<Table 4>

Additionally, Figure 2 shows the total notional amount of derivatives used by life insurance firms between 2001 and 2015. As shown in Figure 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>

## 5. Empirical Results

### 5.1 Decision of Participation

#### 5.1.1 Total Derivative Participation

The empirical results on the determinants of derivative participation are shown in Table 5. Table 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 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 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 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 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 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 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.

<Table 5>

As noted earlier, the empirical results in Table 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 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 6 are consistent with those in Table 5. Therefore, we do not explain the results in Table 6.

<Table 6>

Table 5 and Table 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 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 7>

### 5.1.2 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 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, it provides interesting evidence that the likelihood of swap participation is reduced after the enactment of 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 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. Although the coefficient of *reinsurance* in Table 5 is positive and insignificant, the coefficient of *reinsurance* in Table 8 are positive and significant. Therefore, those results implicate that certain types of risk can be managed through specific types of derivatives. Table 9 provide 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 9.

<Table 8>

<Table 9>

We also examine whether the determinants of the swap participation decision were changed after the enactment of the Dodd-Frank Act. Table 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 10>

**5.2 Decision of Extent (Volumes)**

In a previous part, we examine the determinants of derivative/swap participation decisions. However, the determinants of derivative/swap participation can be different from those of transaction volumes. Therefore, we additionally test the determinants of derivative/swap transaction volumes (extent). Particularly, we include only those samples which use derivatives/swap contracts since using samples with many zeroes can provide biased and

inconsistent estimators.

### 5.2.1 Total Derivative Volumes

Consistent with prior findings, Table 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 11 also provides evidence that the determinants of derivative volumes are wholly different from those of derivative participation. Although *size* in Table 11 is still a significant factor, the impacts of other factors are different. First, Table 5 shows that stock firms engage more in derivative participation, whereas Table 11 illustrates that their transaction volumes are smaller than non-stock firms. Second, in Table 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 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 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 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 12 are consistent with previous findings in Table 11.

<Table 11>

<Table 12>

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 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 13>

### 5.2.2 Swap Volumes

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 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. Interestingly, 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 11 and Table 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.[13] 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 point out that the new regulatory intervention increases costs for the transactions and compliance. Under such conditions, the benefits from the 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 enactment of the Dodd-Frank Act reduces the likelihood of swap contract participation. In addition, swap volumes are not significantly increased after the new regulatory intervention even when the total derivative volumes are considerably increased.

Table 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 15 are consistent with those in Table 14.

<Table 14>

[13] 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

<Table 15>

Consistent with Table 13, we additionally investigate whether the determinants of swap transaction volumes have changed after the enactment of the Dodd-Frank Act. 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 15>

## 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.

## Reference


Adams, Mike, 1996, "The Reinsurance Decision in Life Insurance Firms: An Empirical Test of the Risk Bearing Hypothesis," *Accounting and Finance* 36: 15-30.

Allayannis George and James P. Weston, 2001, "The Use of Foreign Currency Derivatives and Firm Market Value," *The Review of Financial Studies* 14: 243-276.

Barr, Michael S., 2012, "The financial crisis and the path of reform", *Yale Journal on Regulation*, 29: 91-119.

Bartram, Söhnke M., Gregory W. Brown, and Jennifer Conrad, 2011, "The Effects of Derivatives on Firm Risk and Value," *Journal of Financial and Quantitative Analysis* 46: 967-999.

Bell, Marian and Benno Keller, 2009, Insurance and Stability: The Reform of Insurance Regulation, (Zurich, Switzerland: Zurich Financial Services Group).

Bierth, Christopher, Felix Irresberger, and Gregor N. F. Weiss, 2016, Derivatives Usage, Disclosure Standards, and Risk in the U.S. Insurance Sector: An Investor's View. Available at SSRN: https://ssrn.com/abstract=2807754

Colquitt, L. Lee, and Robert E. Hoyt, 1997. "Determinants of Corporate Hedging Behavior: Evidence from the Life Insurance Industry." *Journal of Risk and Insurance* 64:649–71.

Cragg, John G., 1971, "Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods" *Econometrica* 39: 829-44.

Cummins J. David and Mary A. Weiss, 2014, "Systemic Risk and the US Insurance Sector," *Journal of Risk and Insurance* 81: 489-527.

Cummins, J. David, Phillips, Richard D. and Smith, Stephen D., 1997, "Corporate Hedging in the Insurance Industry: The Use of Financial Derivatives by US insurers," *North American Actuarial Journal* 1: 13–40.

Cummins, J. David, Phillips, Richard D. and Smith, Stephen D., 2001, "Derivatives and Corporate Risk Management: Participation and Volume Decisions in the Insurance Industry," *Journal of Risk and Insurance* 68: 51-92.

Cummins, J. David and Qingyi (Freda) Song, 2008, Hedge the Hedgers: Usage of Reinsurance and Derivatives by Property and Casualty Insurance Companies, SSRN working paper.

Drechsler, Qingyi (Freda) Song and Cummins, J David, 2008, "Hedge the Hedgers: Usage of Reinsurance and Derivatives by Property and Casualty Insurance Companies," Available at SSRN: https://ssrn.com/abstract=1138028

De Ceuster Marc, Liam Flanagan, Allan Hodgson, and Mohammad I. Tahir, 2003, "Determinants of derivative usage in the life and general insurance industry: The Australian evidence," *Review of*

*Pacific Basin Financial Markets and Policies* 6: 405-431.

Fama, Eugene F. and Michael C. Jensen, 1983, "Agency Problems and Residual Claims," *Journal of Law & Economics* 26: 327-349.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein, 1993, "Risk Management: Coordinating Corporate Investment and Financing Policies," *Journal of Finance* 48: 1629–1658.

Gay, Gerald D. and Jouahn Nam,1998, "The Underinvestment Problem and Corporate Derivatives Use," *Financial Management* 27: 53–69.

Geneva Association, 2010, Systemic Risk in Insurance: An Analysis of Insurance and Financial Stability.

Greene, Econometric Analysis, 1997, 3rd edition Englewood Cliffs, New Jersey: Prentice Hall.

Guay, Wayne and S. P Kothari, 2003, "How much do firms hedge with derivatives?," *Journal of Financial Economics* 70: 423-461.

Gunther, Jeffery W. and Thomas F. Seims, 1995, The Likelihood and Extent of Bank Participation in Derivatives Activities," Financial Industry Studies – Working Paper Series 95-1, Federal Reserve Bank of Dollars

Hardwick, Philip and Mike Adams, 1999, "The Determinants of Financial Derivatives Use in the United Kingdom Life Insurance Industry," *ABACUS* 35: 163-184.

Harrington, Scott, 2009, "The Financial Crisis, Systematic Risk, and the Future of Insurance Regulation," *Journal of Risk and Insurance* 76: 785-819.

Hodgson, A. 1999. "Derivatives and Their Application to Insurance: A Retrospective and Prospective Overview." In the Changing Risk Landscape: Implications for Insurance Risk Management, edited by N.R. Britton, 151–72. Proceeding of a conference sponsored by Aon Group Australia Ltd., Sydney, Australia. (http:www.aonre.com.au/ pdf/Implications-Mahoney.pdf)

Hoyt, Robert E., 1989, "Use of Financial Futures by Life Insurers," *Journal of Risk and Insurance* 56: 740-749.

Hoyt, Robert E. and H. Khang, 1997, Determinants of Corporate Insurance Purchases: Empirical Evidence, Working Paper, University of Georgia, Athens

Jensen, M.C., and W.H. Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics* 3:305–60.

Jin, Yanbo and Philippe Jorion, 2006, "Firm Value and Hedging: Evidence from U.S. Oil and Gas Producers" *Journal of Finance* 61: 893-919.

Khademian, Anne M., 2013, "The financial crisis: a retrospective", *Public Administration Review*,

71: 841-849.

Kleffner, Anne E. and Neil A. Doherty, 1996, "Costly Risk Bearing and the Supply of Catastrophic Insurance," *Journal of Risk and Insurance* 63: 657-671.

Lantara, I Wayan N. and Atsushi Takao, 2014, "The Determinants of the use of Derivatives in the Japanese Insurance Companies," *Asia-Pacific Journal of Risk and Insurance* 8: 57-81.

Liebenberg, Andre P. and David W. Sommer, 2008, "Effects of Corporate Diversification: Evidence from the Property–Liability Insurance Industry," *Journal of Risk and Insurance* 75: 893-919.

Mayers, David, and Clifford W. Smith, 1981, "Contractual Provisions, Organizational Structure, and Conflict Control in Insurance Markets." *Journal of Business* 54:407–34.

Mayers, David and C. W. Smith, 1988, "Ownership Structure Across Lines of Property Casualty Insurance," *Journal of Law and Economics* 31: 351-378.

Mayers, David and C. W. Smith, 1990, "On the Corporate Demand for Insurance: Evidence from the Reinsurance Market," *Journal of Business* 63: 19-40.

Modigliani, Miller and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *The American Economic Review* 48:261-297.

Nance, Deana R, Smith, Clifford W, and Charles W Smithson, 1993, On the Determinants of Corporate Hedging, *Journal of Finance*, Vol. 48(1), pp. 267-284.

National Association of Insurance Commissioners, 2016, Update on the Insurance Industry's Use of Derivatives and Exposure Trends.

Nwogugu, Michael I.C., 2015, "Failure of the Dodd-Frank Act," *Journal of Financial Crime*, 22: 520-572.

OECD, 2010, "Insurance Companies and the Financial Crisis" *OECD Journal: Financial Market Trends* 2009/2: 123-151.

Polk, Davis, 2016, Dodd Frank progress report – (available at www.davispolk.com/Dodd-Frank-Rulemaking-Progress-Report)

Purnanandam, Amiyatosh, 2008, "Financial Distress and Corporate Risk Management: Theory and Evidence," *Journal of Financial Economics* 87: 706-739.

Raturi, Mayank, 2005, "The Use of Derivatives by US Insurers Empirical Evidence and Regulatory Issues," *The Journal of Risk Finance* 6: 87-97.

Santomero, Anthony M. and David F. Babbel, "Financial Risk Management by Insurers: An Analysis of the Process," *Journal of Risk and Insurance* 64: 231-270.

Shiu, Yung-Ming, 2007, "An Empirical Investigation on Derivatives Usage: Evidence from the United Kingdom General Insurance Industry," *Applied Economics Letters* 14:353–60.

Shiu, Yung-Ming, 2011, What Motivates Insurers to Use Derivatives: Evidence from the United Kingdom Life Insurance Industry," *The Geneva Papers* 36: 186–196.

Shiu, Yung-Ming, Chi-Feng Wang, Andrew Adams, and Yi-cheng Shin, 2012, "On the Determinants of Derivative Hedging by Insurance Companies: Evidence from Taiwan," *Asian Economic and Financial Journal* 2: 538-553.

Smith, Clifford W., and Rene Stulz, 1985, "The Determinants of Firms' Hedging Policies," *Journal of Financial and Quantitative Analysis* 20:391–405.

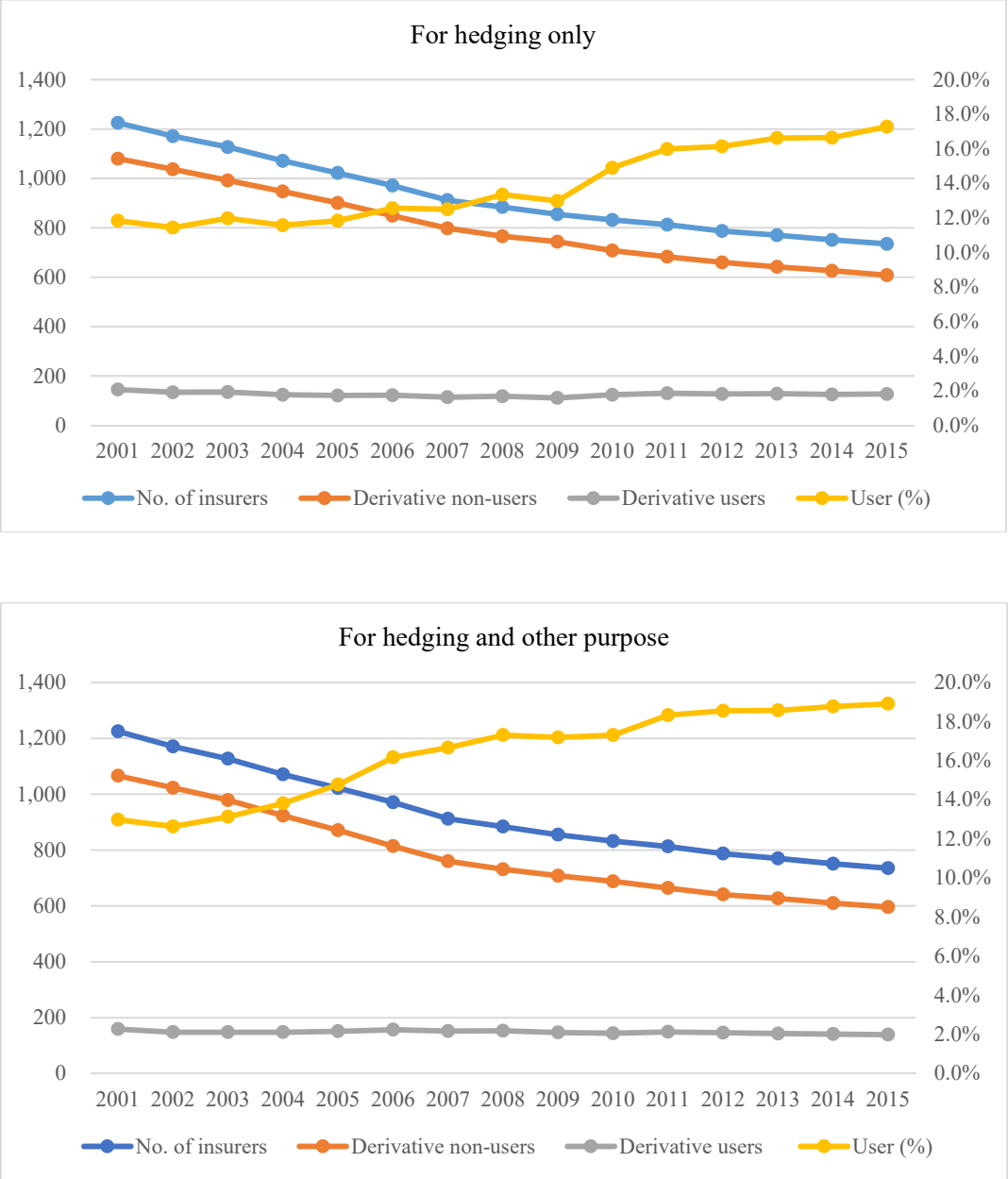
Smith, Larissa Roxanna and Víctor M. Muñiz-Fraticelli, 2013, "Strategic shortcomings of the Dodd-Frank Act," *The Antitrust Bulletin* Vol. 58, No. 4/Winter, 617-633.

Trapp, Rouven and Gregor N.F. Weiß, 2016, "Derivatives Usage, Securitization, and the Crash Sensitivity of Bank Stocks," *Journal of Banking & Finance* 71: 183-205.

Tyler, Ralph and Karen Hornig, 2009, "Reflections on State Regulation: A Lesson of the Economic Turmoil of 2007-2009", *Journal of Business & Technology Law* 4: 349-370.

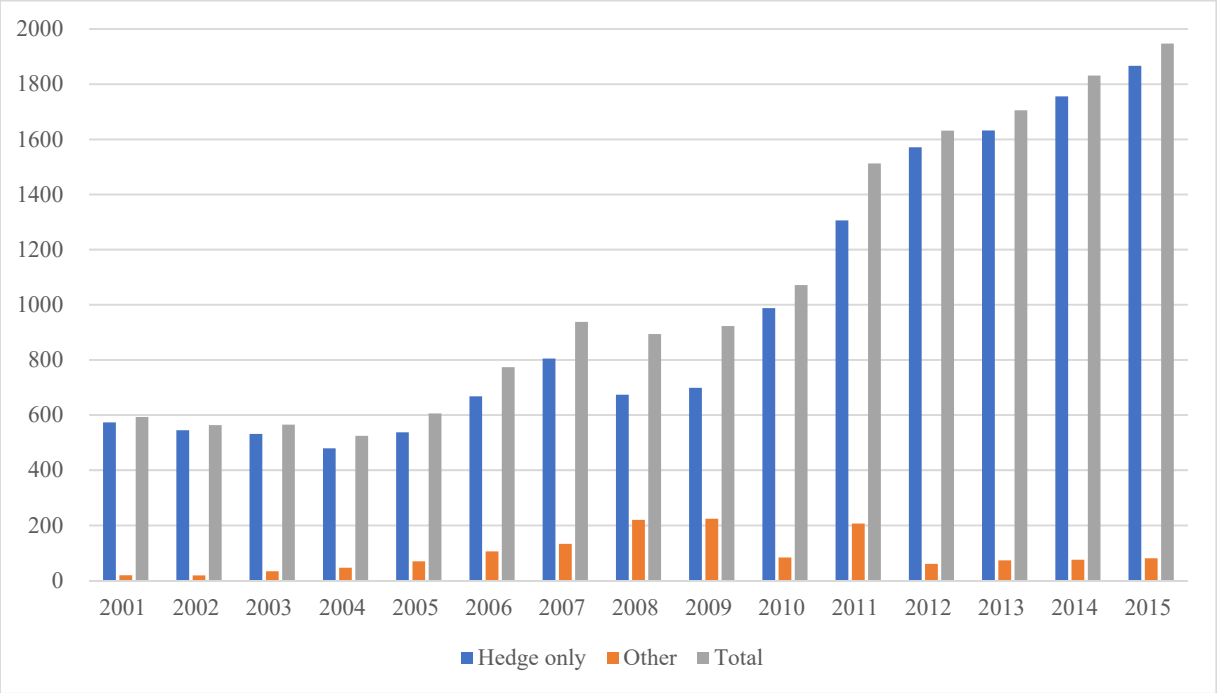
Warner, Jerold B., 1977, "Bankruptcy Costs: Some Evidence," *Journal of Finance* 32: 337-347.

Figure 1. Derivative Use Trend




Data) NAIC (2001-2015)

Figure 2. Transaction Volume (Notional Amount) (Unit: $B)




Data) NAIC (2001-2015)

Table 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 |

Table 2. Number of Derivative Users (Before data screening)

| 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 | 0.12 |
| 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 | 0.13 |
| 2010 | 832 | 708 | 124 | 0.149 |
| 2011 | 813 | 683 | 130 | 0.16 |
| 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 | 0.13 |
| 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 |

Table 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 4. Descriptive Statistics

| Variables | All samples | | | | Non-users | | | | Users | | | | Difference | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | Median | SD | N | Mean | Median | SD | N | Mean | Median | SD | Mean | Midian |
| Derivative Participation | 13042 | 0.1636 | 0.0000 | 0.3699 | 10908 | 0.0000 | 0.0000 | 0.0000 | 2134 | 1.0000 | 1.0000 | 0.0000 | - | - |
| Derivative Volume | 13042 | 3.2262 | 0.0000 | 7.4362 | 10908 | 0.0000 | 0.0000 | 0.0000 | 2134 | 19.7172 | 20.1887 | 3.5748 | - | - |
| Swap Participation | 13042 | 0.1091 | 0.0000 | 0.3118 | 11619 | 0.0000 | 0.0000 | 0.0000 | 1423 | 1.0000 | 1.0000 | 0.0000 | - | - |
| Swap Volume | 13042 | 2.18437 | 0.0000 | 6.3084 | 11619 | 0.0000 | 0.0000 | 0.0000 | 1423 | 20.0201 | 20.0553 | 2.7646 | - | - |
| Size | 13042 | 18.8244 | 18.5775 | 2.9315 | 10908 | 18.0210 | 17.8574 | 2.3908 | 2134 | 22.9313 | 23.0174 | 1.7713 | *** | *** |
| Stock | 13042 | 0.9271 | 1.0000 | 0.2600 | 10908 | 0.9306 | 1.0000 | 0.2541 | 2134 | 0.9091 | 1.0000 | 0.2875 | *** | *** |
| Group | 13042 | 0.7485 | 1.0000 | 0.4339 | 10908 | 0.7098 | 1.0000 | 0.4539 | 2134 | 0.9461 | 1.0000 | 0.2259 | *** | *** |
| Leverage | 13042 | 0.6541 | 0.7779 | 0.3037 | 10908 | 0.6050 | 0.6968 | 0.3061 | 2134 | 0.9049 | 0.9330 | 0.0970 | *** | *** |
| Tax | 13042 | 0.6586 | 1.0000 | 0.4742 | 10908 | 0.6535 | 1.0000 | 0.4759 | 2134 | 0.6846 | 1.0000 | 0.4648 | *** | *** |
| Reinsurance | 13042 | 0.181 | 0.0540 | 0.2568 | 10908 | 0.1789 | 0.0419 | 0.2629 | 2134 | 0.1913 | 0.1057 | 0.2227 | ** | *** |
| Reinsurance Affiliation | 13042 | 0.181 | 0.0000 | 0.3754 | 10908 | 0.2376 | 0.0000 | 0.3783 | 2134 | 0.3322 | 0.2099 | 0.3498 | *** | *** |
| AH Business | 13042 | 0.3125 | 0.0000 | 0.4635 | 10908 | 0.2975 | 0.0000 | 0.4572 | 2134 | 0.3894 | 0.0000 | 0.4877 | *** | *** |
| Foreign Business | 13042 | 0.3143 | 0.0000 | 0.4643 | 10908 | 0.2264 | 0.0000 | 0.4185 | 2134 | 0.7634 | 1.0000 | 0.4251 | *** | *** |
| Foreign Investment | 13042 | 0.042 | 0.0087 | 0.0687 | 10908 | 0.0292 | 0.0000 | 0.0591 | 2134 | 0.1076 | 0.1017 | 0.0762 | *** | *** |
| Invested Assets | 13042 | 0.8676 | 0.9481 | 0.1952 | 10908 | 0.8939 | 0.9544 | 0.1674 | 2134 | 0.7330 | 0.8449 | 0.2605 | *** | *** |
| Speculative Bonds | 13042 | 0.0333 | 0.0117 | 0.0672 | 10908 | 0.0281 | 0.0035 | 0.0709 | 2134 | 0.0596 | 0.0583 | 0.0322 | *** | *** |
| ALM Mismatch (Assets) | 13042 | 6.2819 | 0.0000 | 7.8797 | 10908 | 7.3222 | 0.0000 | 8.0162 | 2134 | 0.9642 | 0.0000 | 4.1466 | *** | *** |
| ALM Mismatch (Liabilities) | 13042 | 11.4402 | 16.0040 | 9.5471 | 10908 | 9.5932 | 13.9194 | 9.1042 | 2134 | 20.8808 | 22.0605 | 5.1789 | *** | *** |
| FS (Financial Crisis) | 13042 | 0.5228 | 1.0000 | 0.4995 | 10908 | 0.5107 | 1.0000 | 0.4999 | 2134 | 0.5843 | 1.0000 | 0.4929 | - | - |
| DF (Dodd-Frank Act) | 13042 | 0.3321 | 0.0000 | 0.4710 | 10908 | 0.3228 | 0.0000 | 0.4676 | 2134 | 0.3796 | 0.0000 | 0.4854 | - | - |
| Δ 3M Yield | 13042 | -45.3302 | -8.5833 | 136.3708 | 10908 | -46.1225 | -8.5833 | 136.9481 | 2134 | -41.2805 | -3.0833 | 133.3389 | - | - |
| Δ Yield curve | 13042 | 18.0239 | 4.2500 | 106.4428 | 10908 | 18.6502 | 4.2500 | 106.7258 | 2134 | 14.8226 | 4.2500 | 104.9509 | - | - |
| Δ Credit Spread | 13042 | 3.3720 | -0.4167 | 67.4885 | 10908 | 3.1629 | -0.4167 | 67.1380 | 2134 | 4.4408 | -0.4167 | 69.2585 | - | - |
| Index Return | 13042 | 0.0379 | 0.0899 | 0.1806 | 10908 | 0.0369 | 0.0899 | 0.1809 | 2134 | 0.0427 | 0.0899 | 0.1792 | - | - |
| VIX | 13042 | 20.7228 | 17.7989 | 6.3855 | 10908 | 20.7490 | 21.9829 | 6.3744 | 2134 | 20.5889 | 17.7989 | 6.4416 | - | - |

Table 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) |
| 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 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) |
| 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 |

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 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 |

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 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) |
| 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* is 1 if swap 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 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) |
| 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 |

Note) *Swap Participation* is 1 if swap 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 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 (Assets) | -0.0094 | | -0.0325*** | |
| | (0.1905) | | (0.0006) | |
| ALM Mismatch (Liabilities) | | 0.0115 | | 0.0293*** |
| | | (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 |

Note) *Swap Participation* is 1 if swap 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 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) |
| 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 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) |
| 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 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) |
| 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.

Table 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) |
| 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 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) |
| 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 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) |
| 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.

**Appendix 1. 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