Consolidation of the US property and casualty insurance industry: Is climate risk a causal factor for mergers and acquisitions?*

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Abstract

This report analyzes the difference between mergers and acquisitions (M&As) of target insurers in the US life and non-life insurance sectors. We first document M&A transactions in the US insurance market between 1990 and 2021 and select the M&A transactions related to US target insurers. We then study the evolution of the life and non-life insurance sectors over time in order to determine whether there are parallel trends between the evolution of M&As of target insurers in these two sectors over time. We empirically test the difference between the M&As of the life and non-life insurance sectors by employing a natural experiment method and verify whether climate risk has been a causal factor in the observed difference in mergers and acquisitions between the two sectors after 2012. Our results do not support a causal link between climate risk and M&As during the period of analysis. Insurers choose other diversification sources of capital, including reinsurance, premium management, CAT bonds, and better capital management under stronger risk regulation.

Keywords: Mergers and acquisition, US insurance industry, property and casualty insurance, life insurance, health insurance, climate risk, capital management, reinsurance, ILS, CAT bonds, premium management, risk regulation.

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1. Introduction

The main objective of this study is to measure a causality effect of climate risk on property and casualty (P&C) insurance industry consolidation. More generally, we examine how catastrophic events may have affected industry resilience by focusing on M&As in the US insurance industry.

The proponents of diversifying risk portfolios via M&A argue that acquisitions between different industries allow the acquiring insurer to benefit from economies of scope and scale through the joint use of customer databases, managerial expertise, and brand name. In addition, diversified transactions are expected to reduce acquirers' risk because this allows them to operate in a broader range of insurance lines and to better diversify extreme risks. By contrast, the proponents of focusing transactions within the same industry (or business line) argue that insurers are better off when they concentrate on their core business. It is not clear that such concentration is always beneficial in presence of climate risk.

In both cases transactions are also likely to be initiated by managers wishing to protect their human capital or increase their private benefits (Amihud and Lev, 1981; Jensen, 1986). Such behavior could be very risky for poorly diversified acquirers.

We have not found studies linking catastrophic risks to M&As in the insurance industry. Cummins and Weiss (2004), Cummins and Xie (2008) and Boubakri et al. (2008) analyze M&As in the insurance industry. They do not focus on catastrophic or climate risks, and their methodology is not up-to-date because they do not perform a causality analysis on the effect of different factors on M&As. One way to extend this literature is to investigate how climate risk events might be causal variables in explaining M&As. Difference-in-differences analysis is a methodology that can be applied by using insurers in activities less exposed to climate risk events as a control group and insurers in more climate-exposed activities as a treatment group. For example, insurers in the life insurance industry can be considered less exposed to climate risks than P&C insurers.

There are two major difficulties associated with isolating climate risk events as a causal effect on M&As during our period of analysis (1990 to 2021). The first is separating M&As from the varied alternative sources of capital consolidation that the insurers can use to protect themselves from natural catastrophes. Dionne and Desjardins (2022) show that US property and casualty insurers significantly increased their capital over recent years. They also identify various potential sources of capital, such as reinsurance, M&As, premium management, capital regulation, and insurance-linked securities (ILS).

The second difficulty is identifying factors other than climate risk events that may have affected M&As during the period of analysis. Notably, our period of analysis contains the 2007–2009 financial crisis. The US insurance industry was affected by this crisis, albeit less significantly than banks. Market conditions were difficult after the crisis, particularly for the life insurance industry. Premium growth was low, as were interest rates. Moreover, new federal regulations for capital were introduced, particularly in and after 2012. These new regulations have affected the level of capital and introduced some uncertainty in the markets regarding M&As.

Our results do not support a causal link between climate risk and M&As during the period of analysis. Insurers choose other diversification activities, including reinsurance, premium management, catastrophe bonds, and better capital management under stronger risk regulation.

The rest of the paper is organized as follows. Section 2 presents a literature review on M&As in the insurance industry. Section 3 describes the evolution of M&As in the US insurance industry from 1990 to 2001. Section 4 documents natural weather disasters during the same period. Section 5 analyzes the impact of markets conditions and regulation on M&A after 2012. Section 6 proposes an analysis of the parameters for a DID analysis, while Section 7 describes the DID analysis. Section 8 discusses the results. Section 9 concludes. A robustness analysis is presented in the Online appendices along with additional results and literature review.

2. Literature review

Usually, bidders initiate M&A transactions only when they anticipate that these activities will create value for their shareholders. Thus, studying the impact of such deals on bidders' performance is of particular interest, especially for intra-industry transactions, because these are most likely to be driven by synergies, and hence, create value. The empirical literature shows that acquiring insurers in the US insurance industry experience greater efficiency and higher profitability three years after the M&A (Cummins et al., 1999; Cummins and Xie, 2008; Boubakri et al. 2008).

Among insurers' economic rationales for these operations are a desire to increase their geographical reach and product range (Amel et al., 2004) and to benefit from economies of scale and scope (Cummins et al., 1999). Further, insurers may initiate these transactions to benefit from financial synergies (Chamberlain and Tennyson, 1998) or to reduce their riskiness and/or improve the amount/timing of their cash flow streams (Cummins and Weiss, 2004). Estrella's (2001) findings refute the risk-reduction argument from transactions between different industries. Indeed, the article shows that the median failure probability resulting from combinations of two property-casualty firms is lower than that resulting from a combination of a property-casualty firm and a bank holding company.

The financial literature also suggests that M&A transactions may destroy rather than create value, especially if these transactions are motivated by managerial hubris, that is, where managers are more interested in maximizing the size of their business empires than in returning cash to shareholders (Roll, 1986; Denis and McConnell, 2003). Hence a negative impact on the bidders' firm value could be observed. For such behavior to be constrained, effective governance mechanisms must be put in place, such as 1) a strong board with competent independent directors, and 2) a legal environment that offers strong protection to minority shareholders. The legal environment relates not only to investor protection but also to transparency and overall quality of accounting standards, which were all recently shown by Rossi and Volpin (2004) and Moeller and Schlingemann (2005) to be significant determinants of M&A (see also Boubakri et al., 2008). Asymmetric information between acquiring firms on particular targets can also affect M&A activities by modifying the premiums of different deals (Dionne et al., 2015; Betton et al., 2009; Brockman and Yan, 2009).

Akhigbe and Madura (2001) report a positive and significant abnormal return for acquiring insurers and conclude that this favorable valuation effect is driven by the similarity of services provided by both the acquirer and the acquired. In other words, standardization in their products makes the merger of operations easier for both parties. Interestingly, Akhigbe and Madura (2001) document a higher positive and significant market effect for acquirers that are non-life insurers. Floreani and Rigamonti (2001) also report a positive and significant valuation effect for the bidder, following M&A transactions involving pure insurance partners. This market valuation is positive but slightly lower when the target firm is publicly traded. However, only transactions involving insurers buying insurers seem to create value for the bidder. Indeed, Cummins and Weiss (2004) report a small negative valuation effect on the bidder's shares following transactions that do not involve pure insurance partners.

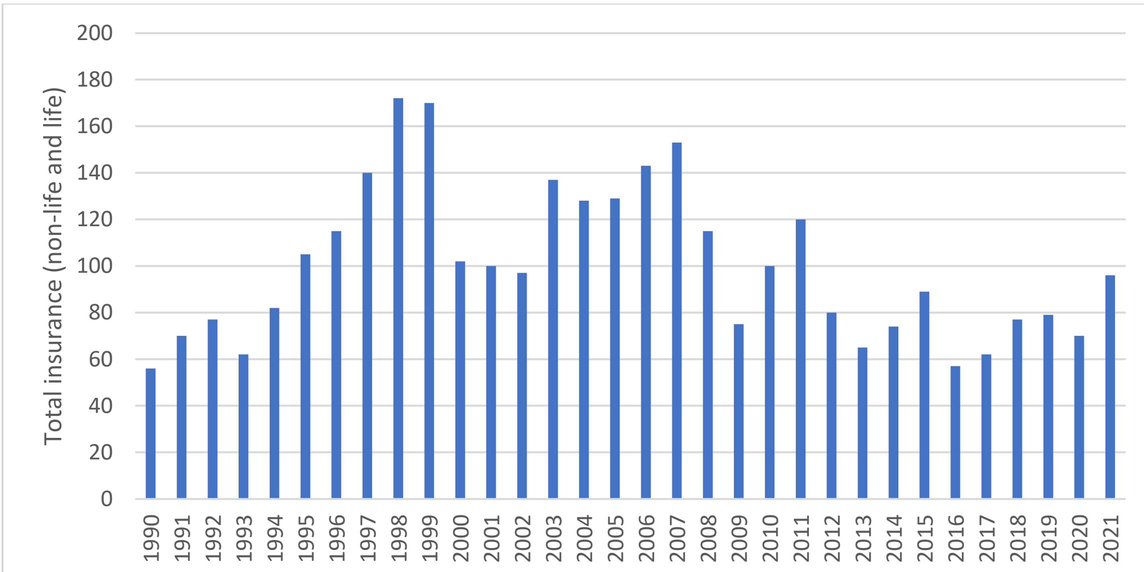
Additionally, cross-border transactions may generate a higher positive valuation effect for the bidder because they are perceived to lead to a geographic expansion of its market. The results of Floreani and Rigamonti (2001) support this argument. Specifically, they demonstrate that transactions involving insurance partners that are both located in the European Union countries are not welcomed by the financial market. On the other hand, cross-border transactions may also destroy value for the bidder because they are more difficult to manage (Cummins and Weiss, 2004)—a result not supported by Floreani and Rigamonti (2001). In the Online appendix 1, we present a detailed analysis of various contributions on the insurance industry.

3. M&A transactions related to US target insurers from 1990 to 2021

From the SDC database, we identify 3,198 M&A transactions related to US target insurers from 1990 to 2021. Data are annual observations as of December 31 of each year.

Figure 1 identifies the two main waves of target insurer M&As recorded in the US insurance industry over the past 32 years. There was strong M&A growth until the years 1997 to 1999, when the market reached its first peak since 1990.

Figure 1: Histogram of the annual number of M&A transactions related to US target insurers from 1990 to 2021

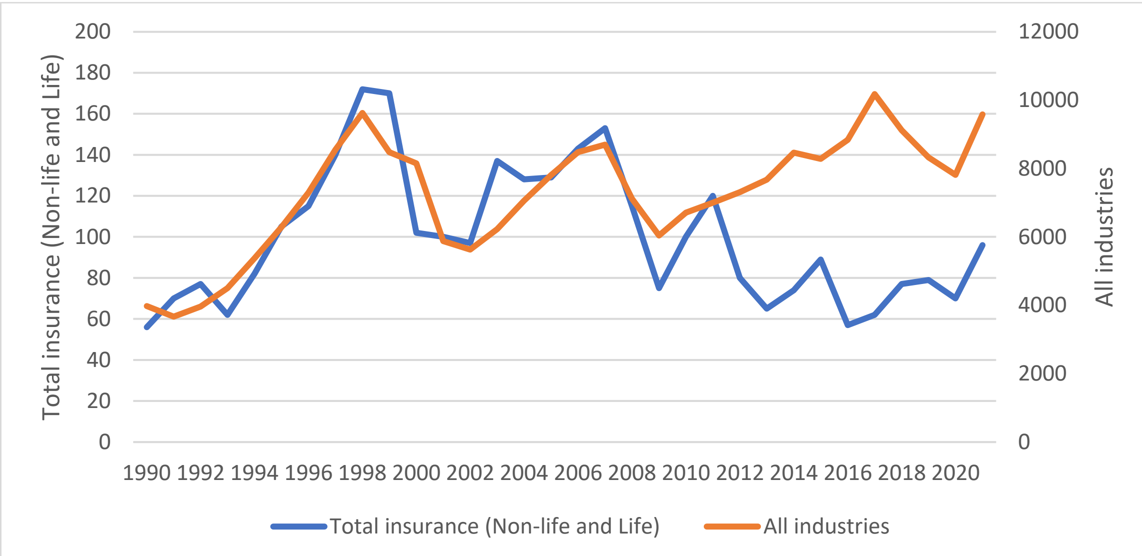


Data source: SDC database.

After a sharp decline in 2000, the M&A market resumed growth in 2003, and reached its second peak in 2007. Each of these wave years has more than 120 annual transactions. The two peaks correspond to periods of economic expansion. The wave recorded around 1997-1999 represents the largest of the US insurance industry during the period of analysis. The record years of 1998 and 1999 have not been broken since then. In fact, this period corresponds to the internet and new technologies growth of the years 1998-2000. The years of the second largest wave of M&As correspond to the economic expansion period before the financial crisis that began in August 2007.

Figure 2 depicts three peaks of M&As across all industries in the US (1998, 2007, and 2017) during the same period. As documented above, only two waves of M&As occurred in the US insurance industry during that period. Since the 2007 peak, the M&A market has exhibited an overall downward trend throughout the US insurance industry (life and non-life combined). By comparison, the all-industry M&A market resumed its overall upward trend after a short decline during the financial crisis, from 2007 to 2009, and reached a new peak in 2017. Figure 2 suggests that the post-2007 period is marked by a shift behavior of insurers across the US insurance industry, which may be explained by changes in industry regulation after the 2007-2009 financial crisis, market conditions, and climate risk.

Figure 2: M&A trends in the US insurance industry (total M&A for non-life and life targets, left) and for all industries in the US (right), 1990 to 2021

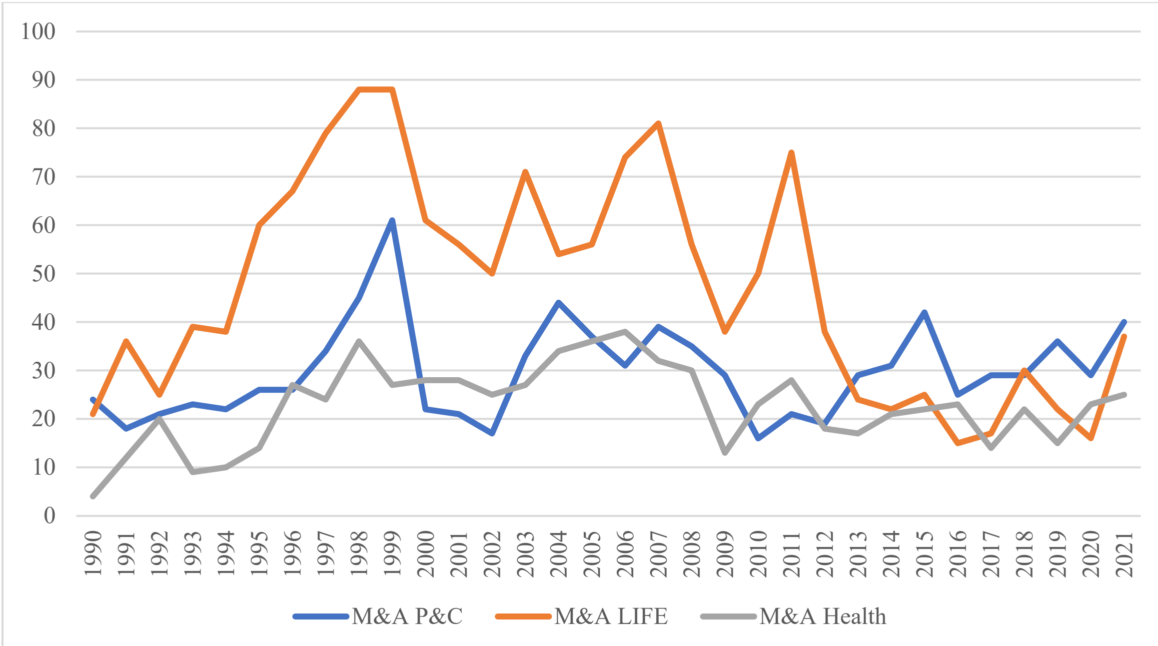


Data source: SDC database.

Figure 3 presents the evolution of the numbers of M&As in the three insurance lines and Table 1 summarizes their main statistics. Property and casualty insurers and health insurers appear to be more similar than with life insurers. We also observe the large reduction in M&As in the life sector after 2011. In this paper, we consider that the US insurance industry consists of two main lines of business: life insurance, and non-life insurance that includes property and casualty insurance and health insurance.[1] Given that the two main lines of insurance can be affected differently by climate risk, market conditions, and insurance regulation, we have plotted the M&A transactions recorded in each of these two lines in order to analyze their behavior in relation to the target insurer M&A phenomenon. Figure 4 shows the evolution of M&As in each of the two main US insurance lines and that of the US insurance industry as a whole over the period of 1990 to 2021.

[1] We perform a robustness analysis in Online appendix 2 by merging health insurers with life insurers.

Figure 3: MA trends of target insurers by the three insurance sectors
in the US, 1990 to 2201



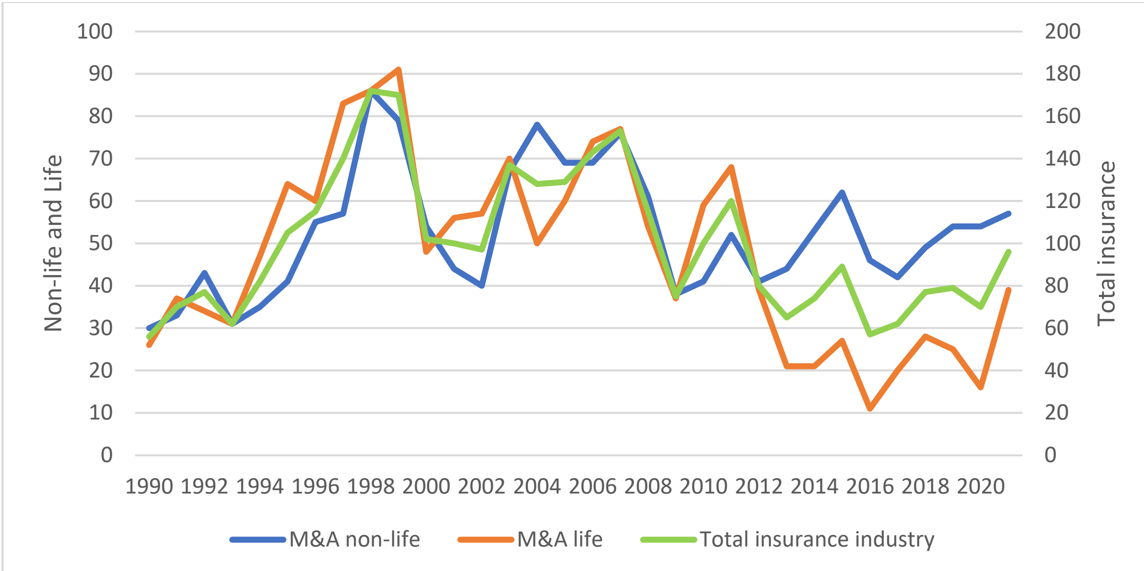
Data source: SDC database.

Table 1: Mean and standard deviation of the M&A in each sector

Period	1990-2021		1990-2012		Post-2012	
Annual number of MA	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
P&C sector	29.813	9.822	28.870	10.981	32.222	5.761
Life sector	47.156	22.598	56.565	19.294	23.111	7.079
Health sector	22.656	8.407	23.609	9.524	20.222	3.898

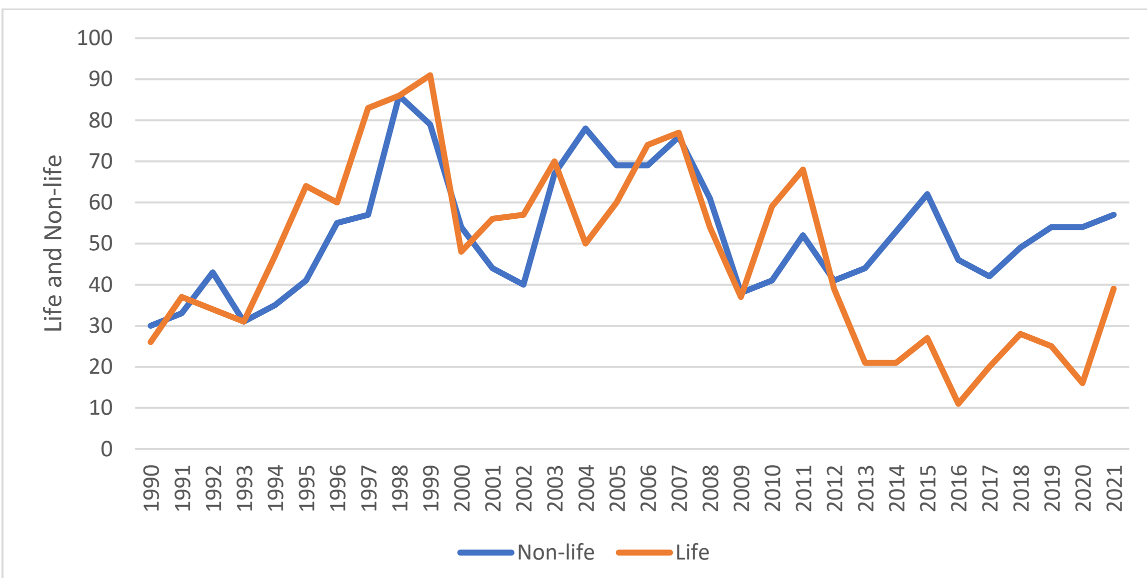
We observe, in Figure 4, that the evolution of M&As of target insurers in the life insurance sector seems to mirror the evolution of M&As of target insurers observed in the entire US insurance industry. More importantly, we confirm the strong decrease in mergers and acquisitions in the life insurance industry after 2012 while this activity seems more stable in the non-life insurance sector during the same period.

Figure 4: M&A trends for target insurers by the two major insurance lines (life or non-life, left) and the overall US insurance industry (right), 1990 to 2021



Data source: SDC database.

Figure 5: M&A trends of target insurers by the two main insurance sectors (life and non-life) in the US, 1990 to 2021



Data source: SDC database.

Figure 5 shows a parallel time trend in the evolution of target insurer M&As for life and non-life insurance from 1990 until 2009 and even 2012. This result suggests that the evolution of target insurer M&As in the non-life insurance sector is almost identical to that observed in the life insurance sector during this period. The parallel trends observed between the two groups started to disappear after 2009. The difference is more pronounced after 2012. Based on Figure 5, we retain the years 2009 and 2012 as potential candidates for the treatment date in our analysis with the difference-in-differences (DID) method. The choice of the treatment date for our DID method thus seems ambiguous. We will use a statistical approach, applied to time series, to validate the year that best suits our data.

It is worth trying to understand the divergence in the temporal trends in M&As observed between our two groups. It is possible that the temporal trends in M&As observed between our two groups cease being parallel in 2009 or 2012 owing to series of natural disaster events in the US or to the relative change in the regulation and market conditions of the two industries after the 2007-2009 financial crisis. To analyze these possible causes, we will first describe the evolution of the number and the severity of natural disaster events occurring in the US from 1990 to 2021.

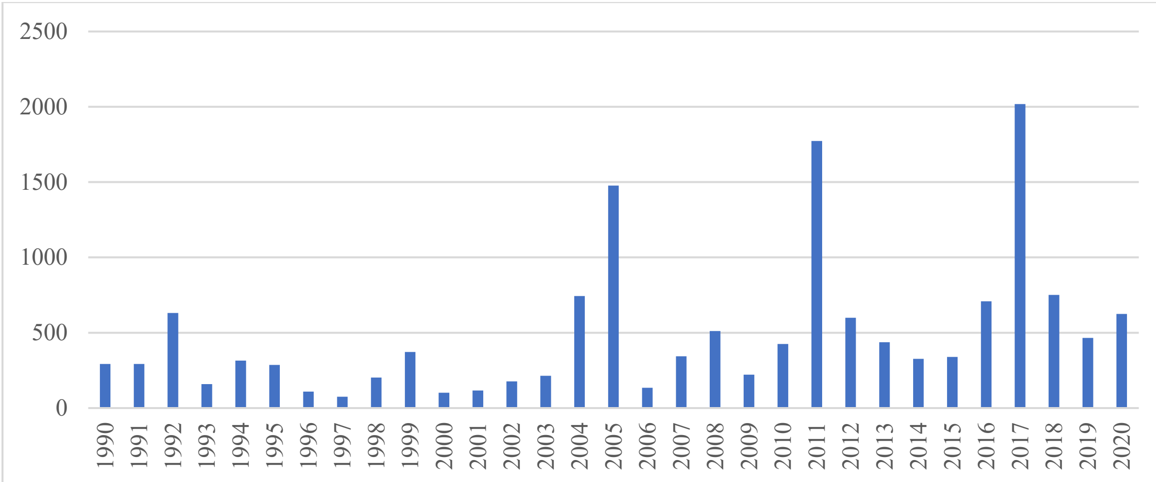
4. Analysis of the evolution of natural weather disasters events from 1990 to 2021

4.1. General statistics

The year 2011 will remain etched in the memory of insurers and reinsurers. It generated losses of exceptional magnitude, particularly in Japan, Thailand, New Zealand, Australia and the US. In other words, 2011 was a year of huge losses both globally and nationally (speaking of the US).

Globally, the last few decades have seen an increase in extreme weather-related events that have fueled the rise in the number of claims paid by insurers. Figure 6 shows three major peaks in the insured losses paid by insurers worldwide. The first largest peak in claims costs was in 2017. The year 2011 represents the second largest peak in the cost of claims borne by insurers worldwide. The year 2005 represents the third highest peak in insured losses. Looking only at the period prior to 2017, 2011 is the worst year for claims over the period of 1990 to 2017.

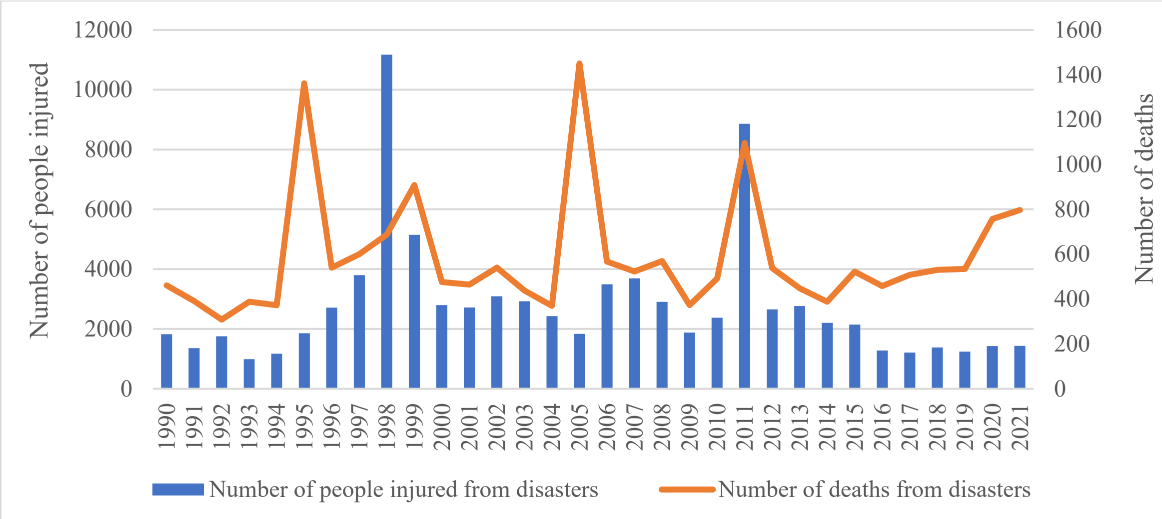
Figure 6: Insured losses (in million \$) from natural disaster events worldwide, 1990 to 2020



Data source: Our World in Data. Insured losses: property damage and business interruption, excluding liability and life damage.

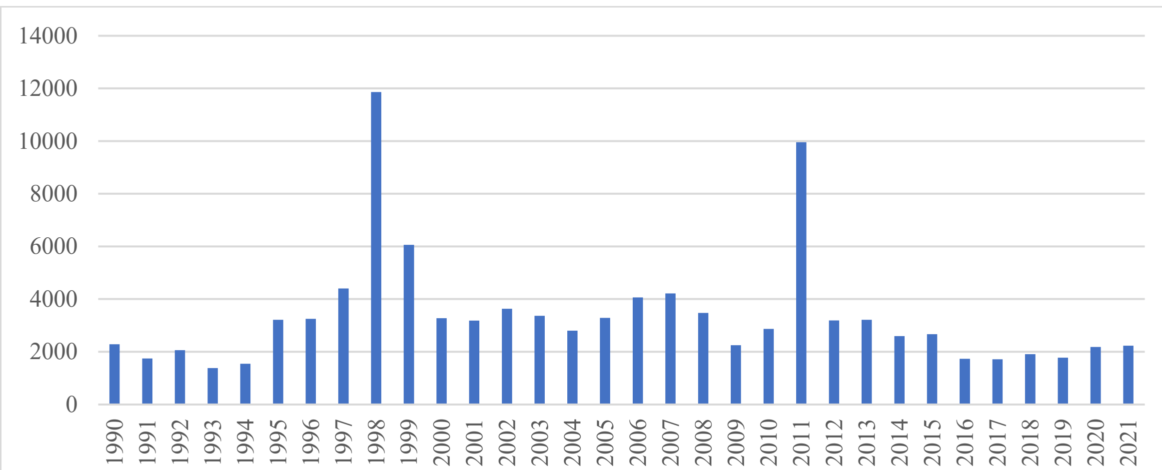
Figure 7 indicates that 2011 represents the third deadliest year due to natural disasters in the US. This 2011 record can be linked to the exceptional series of severe tornadoes that occurred that year in the Midwestern US. The most catastrophic year was 2005, the year Katrina struck. Figure 8 shows that 2011 is the year with the first highest number of injuries and deaths from natural disasters after 1998, the year of Hurricane Georges. Finally, the figure indicates a decrease in total casualties after 2011. Bear in mind that when a single natural catastrophe event affects a large number of policyholders, it increases claims costs on the one hand and management expenses (operating costs) on the other, putting upward pressure on the combined ratio and other financial ratios of insurers.

Figure 7: Numbers of injuries (left) and deaths (right)
from natural disasters observed in the US, 1990 to 2021



Data source: NOAA Weather Related Fatality and Injury Statistics. People injured or killed by natural disasters are not necessarily insured.

Figure 8: Total casualties (injuries and deaths)
from natural disasters in the US, 1990 to 2021

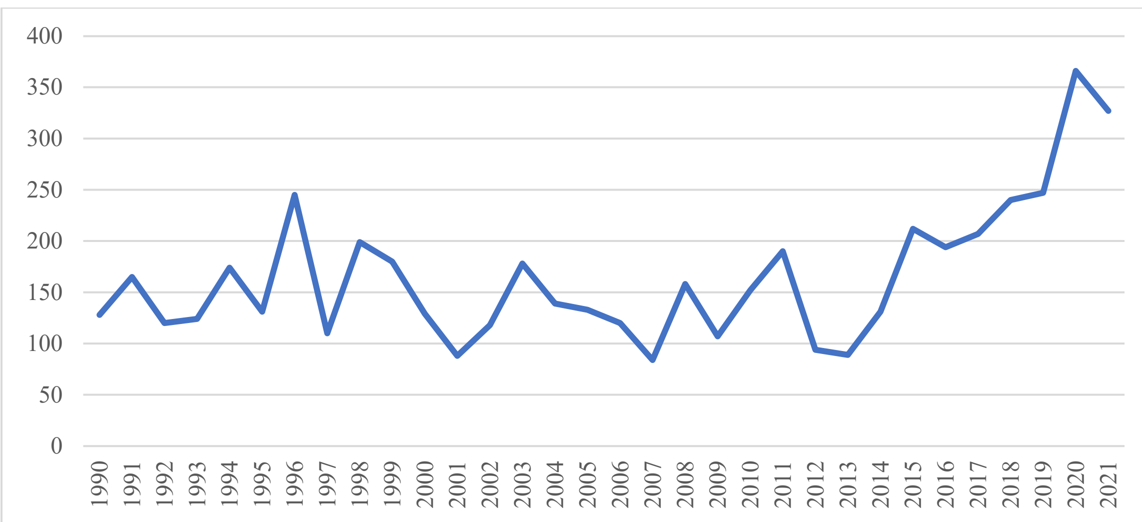


Data source: NOAA Weather Related Fatality and Injury Statistics. People injured or killed by natural disasters are not necessarily insured.

4.2. Our data

We now present the definition of the three main variables used in the following analysis of the US insurance industry. The data for the first two measures of weather disasters are from the VERISK database. Our first variable is the annual number of natural weather disaster events that cause insured losses to the insurance industry of $25 million or more which is the VERISK threshold to document a catastrophe. Events that meet or exceed this threshold are considered natural disasters, given the magnitude of the loss costs incurred by insurers. Our second variable measures the total annual insured losses from natural weather disaster events that cause losses of $25 million or more to the insurance industry. Finally, our third variable measures the number of natural disaster casualties. It represents the sum of the annual number of deaths and injuries caused by natural disaster events. The data for the number of natural disaster casualties were obtained from the National Oceanic and Atmospheric Administration (NOAA) website. Figure 9 shows the evolution of the number of natural weather disaster events occurring in the US from 1990 to 2021, as reported by VERISK. They cover hurricane, tropical storm, wildland fire, wind and thunderstorm, and winter storm.

Figure 9: Number of natural disaster events in the US, 1990 to 2021



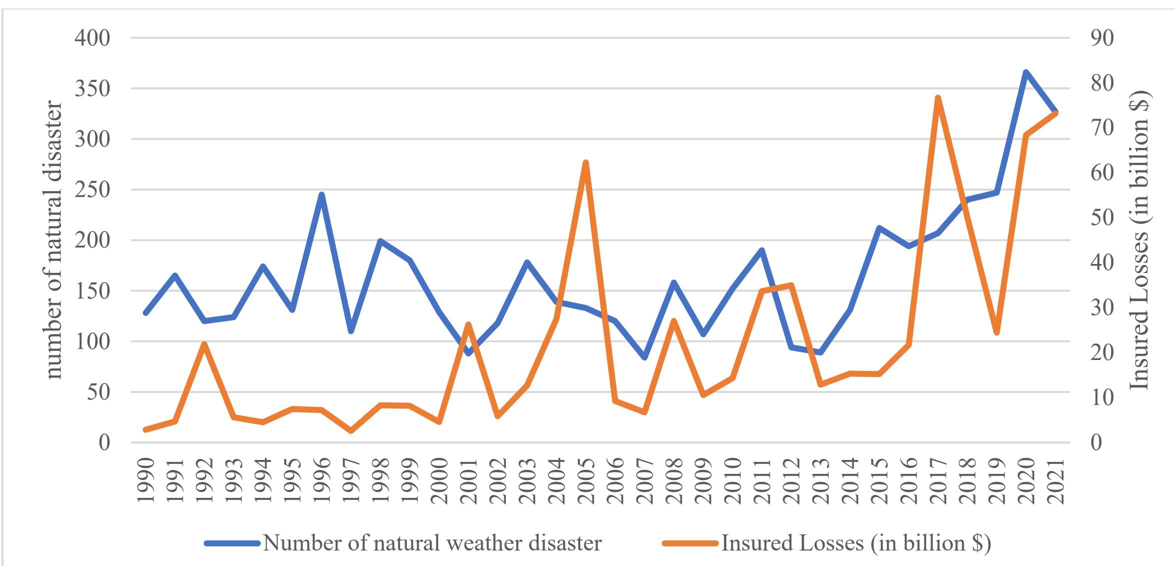
Data source: VERISK database.

Note: An "ISOnet PCS Loss Event" means an event occurring within the Service Area to which ISO assigns a serial number, based on ISO's judgment that the event is likely to cause $25,000,000 or more in total insured property losses within such Service Area and is likely to affect a significant number of property and casualty insurance policy holders and property and casualty insurance companies.

Figure 9 shows that there have been significant variations in the number of weather disaster events in recent years with an upward trend in the post-2013 period. The year 2013 is the turning starting point for this increase in the numbers. The increase in disaster weather events observed after 2013 could be attributed to variation in climate change.[2] This phenomenon may have posed a real threat to the American insurance market because of some extreme natural disaster events it has caused in the US. As can be seen in Figure 9, the number of natural disaster events has reached extremes over the last five years (2017 to 2021). Arguably, the insurance industry can be weakened by the increase in extreme natural disaster events because of the high claims costs they incur, particularly after 2017.

Our data indicates an average number of 241 natural disaster events per year during the post-2013 period, compared with 140 from 1990 to the end of 2013.[3] This analysis was limited to the number of events. It may be more appropriate to consider the losses in the insurance industry. Figure 10 relates annual numbers of natural disasters events and annual insured losses. See Appendix A3 for different correlation results. These results do not support any causality link.

Figure 10: Number of natural disaster events (left) and insured losses (right) linked to these natural disaster events observed in the US, from 1990 to 2020



Data source: VERISK database.

[2] Many references consider weather and climate risks to be synonymous. In this study, as in Dionne and Desjardins (2022), we use the NASA (2005) definitions of climate and weather. The main difference between the two definitions is time. Weather is atmospheric conditions over a short period of time, while climate covers a long period of time. Climate change is related to changes in average daily weather.

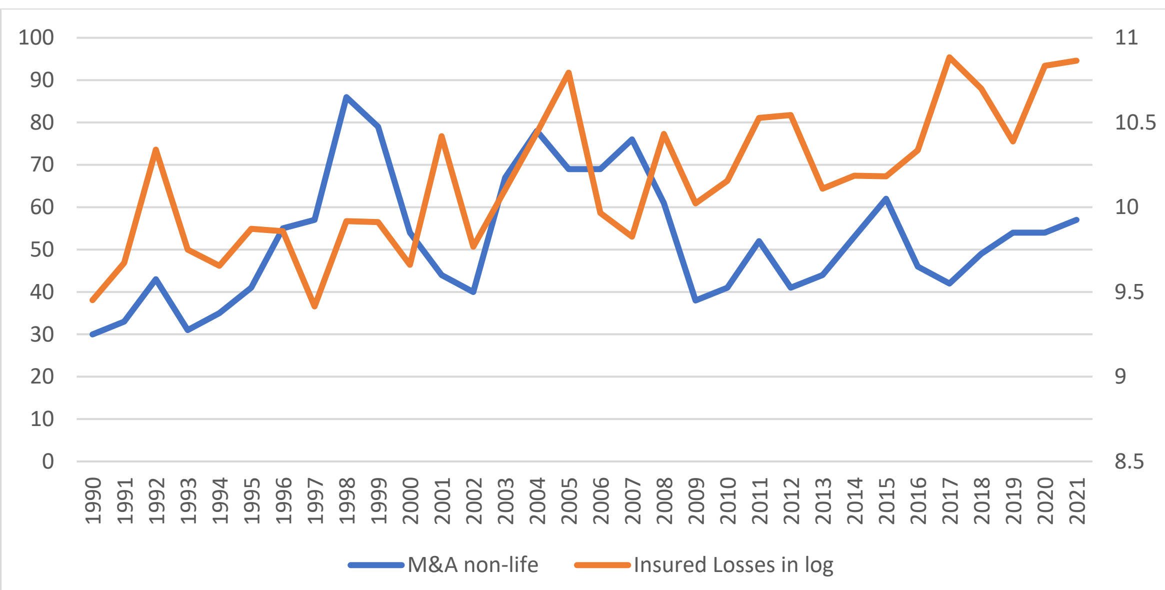
[3] The corresponding numbers for the period post-2012 and before are respectively 233 and 142.

4.3. Comparative analysis of the evolution of M&As and insured natural disaster losses

Figure 11 shows a link between insured losses from natural wealth disasters and the number of M&As per year in the non-life insurance sector. This link seems to confirm graphically the hypothesis that the number of target insurer M&As is an increasing function of the insured losses from natural disasters variable, particularly after 2012.

Given that the post-2012 period marked by the resurgence of natural disaster events coincides with the period of the loss of parallel trends observed between our two groups identified graphically (see Figure 5), we can assume that the upsurge in natural disaster weather events observed after the year 2012 may have caused the difference in the number of M&As of target insurers in the non-life insurance sector compared with the number of M&As of target insurers in the life insurance sector observed after 2012. We will consequently select target insurers in the non-life insurance sector as organizations affected by the increase in natural disaster events observed during the post-2012 period, as our potential treatment group for our DID analysis between the M&As of target insurers in the life and non-life insurance sectors in the US.

Figure 11: Comparison of M&A trends in the non-life insurance sector (left) and observed insured losses from weather events (right) during the period 1990 to 2021



Data sources: SDC database and VERISK database.

According to a study published by Atlas Magazine, the emergence of new hazard detection technologies and the generalization of anti-seismic construction standards, especially in developed countries, have significantly limited the number of natural disaster casualties in the world. This information seems relevant to explain the relatively stable level of casualties observed after the year 2012 (Figure 8) despite the upsurge in extreme natural events compared with the period of 1990 to 2012.

The capacity of new hazard detection technologies to warn residents of potential extreme natural events enables these individuals to leave their areas of residence when natural disasters occur, which limits the number of deaths and injuries. However, even if residents are warned about the possibility of an extreme natural disaster, they cannot take real estate such as houses and buildings with them when they evacuate the area. In other words, insured losses are still potentially present in the non-life insurance sector despite the advent of new hazard detection technologies. The direct consequence of this would be an increase in insured losses associated with extreme natural disasters, which would increase the claims costs paid by non-life insurers, thereby worsening their financial performance and potentially increasing the number of M&As.

We have shown above that the upsurge in natural disaster events observed after 2012 has led to increased growth in insured losses from natural disasters for non-life insurers (Figure 10). We have also shown that the number of natural disaster casualties remains relatively stable despite the upsurge in extreme natural events observed in the post-2012 period (Figure 8).

As to which event may have produced an exogenous change in treatment that further increased the number of M&As for target insurers in the non-life insurance sector relative to the life insurance sector, our analysis indicates that the upsurge in natural disaster events observed in the post-2012 period may represent a causal shock on M&As in the non-life sector.

After having motivated our first theoretical hypothesis graphically and statistically, we will analyze a second potential causal factor explaining the difference in M&As between life and non-life sectors after 2012.

5. Impact of market conditions and regulation on M&As after 2012[4]

5.1. Markets conditions and regulation

In the preceding sections, we emphasized climate risk as motivating the difference between the life and non-life insurance industries in the evolution of M&A after 2012. In this section, we document potential alternative economic explanations of this difference before proceeding to the formal DID analysis.

Another catastrophe in the US economy in recent years was the 2007–2009 financial crisis. Although this crisis affected banks more significantly, it also disrupted the insurance industry. It took many years for the US insurance industry to recover. Moreover, the insurance industry was subject to new federal regulations in the years following the crisis. In these years, economic growth was slow due to a lack of liquidity in the US economy, partly explained by the strong new banking regulation. In particular, the secondary market for bond trading was out of liquidity. Interest rates were very low for investments, and the European economy was in distress. These facts seem to have affected the life insurance industry more strongly than the P&C insurance industry.

The year 2012 was an active one for life insurance M&As, with 39 transactions, as shown in Figure 5. The aggregate deal value involving US targets for the year was about $4.2 billion, which is higher than the $775 million in 2011, but significantly less than the $21.6 billion reported in 2010 (59).[5] This can be explained by AIG's activity of selling firms following the financial crisis (Mayer Brown, 2013). This decrease was mainly due to the need for acquirers to maintain capital under new regulatory capital requirements and to the uncertainty around the impact of Solvency II in Europe.

Acquisition activity in the property-casualty sector was significantly lower in 2012 than in 2011. The announced aggregate US deal value for 2012 (39) was approximately $6 billion,

[4] This section is based on many reports from industry, including the annual reports of Mayer Brown and documents from KPMG. The SDC database is also used to document the annual numbers of mergers and acquisitions.

[5] Numbers in parentheses are observations on the number of mergers and acquisitions, as illustrated in Figure 5.

down from approximately $10 billion in 2011 (68). Moreover, 2012 was characterized by small and medium-sized deals under $500 million (Mayer Brown, 2013). P&C activity was driven primarily by geographic or product expansions, as well as by runoff transactions involving insurers deciding to exit some lines of business.

The year 2013 was characterized by the continued decline in deal activity in the US life insurance M&A market (transactions involving US targets), as compared to 2010, in terms of deal values and numbers (21 instead of 59). Deal value in the life sector was $3.2 billion, compared to $4.2 billion in 2012. Continued macroeconomic uncertainty presented challenges for product sales in this industry, and low interest rates continued to create challenges for long-term investment returns in bonds. Regulatory changes, such as the NAIC's Own Risk Solvency Assessment (ORSA, adopted in 2012, effective in January 2015) and the international accounting convergence project contributed to a climate of caution among buyers and sellers in the M&A markets. To increase shareholder value, insurers tended to use excess capital for share repurchases and dividend distributions rather than M&A activity. ORSA represented a major regulatory change in the insurance industry. Insurers must now use market value information instead of accounting values to compute economic capital. It represented an additional source of uncertainty, because many insurers had to learn about capital computation with market information.

Acquisition activity in the P&C sector was stable in 2013 compared to 2012, despite generally favorable market valuations on companies' balance sheets in a year marked by few large catastrophe losses. Major runoff acquisition specialists continued to be active acquirers in the global P&C sector. Many P&C companies were still overcapitalized. Some companies were returning capital in the form of stock buybacks and dividends, but high stock prices made stock buybacks expensive.

At the NAIC's Summer 2013 National Meeting, the Solvency Modernization Initiative (SMI) Task Force adopted a white paper: the US National State-band System of Insurance Financial Regulation and the Solvency Modernization Initiative (NAIC, 2013). The white paper also highlighted the importance of the national state-based system of insurance regulation, instead of state only regulation as before the financial crisis.

In addition, regulatory scrutiny of M&As in the two areas may have had a slight negative effect on capital management, thus limiting M&As: the restrictive use of captives for reserve financing and additional requirements for approval of acquisitions raised difficulties in making acquisitions (Mayer Brown, 2014).

Acquisition activity in the P&C sector was lower in 2013 than in 2012, continuing the trend from the prior year (21 instead of 39). This occurred despite generally favorable market valuations and significant cash balances on P&C companies' balance sheets in a year marked by few large catastrophe losses. Since catastrophe losses had been relatively modest, many P&C companies remained overcapitalized. M&A was not considered an important activity for consolidation during these years.

The number of US life insurance M&A deals in 2014 was down for the third straight year, but overall, the deal value on announced transactions was $8 billion in 2014, more than double the total for 2013 (Mayer Brown, 2015). There were 53 announced M&A deals involving property and casualty companies (Figure 5). The year was again characterized by small- and medium-sized deals.

Insured losses from natural catastrophes fell significantly in 2014, according to research from Swiss Re's Sigma (2015), as reported in Mayer Brown (2015). The global insured losses for 2014 fell by 24% to $34 billion, compared to $45 billion the previous year. The number of life insurance M&A transactions involving US targets was on the rise in 2015 after falling in each of the previous two years. The number of annual P&C insurance M&A transactions in 2015 was up for the third straight year, increasing from 44 to 62. The overall deal value on announced transactions was also up, from approximately $12 billion in 2014 to $48 billion in 2015. The year 2015 saw a number of very large transactions being announced, as buyers increasingly sought scale, diversification, and market access (Mayer Brown, 2016).

The number and size of life insurance M&A deals was very low in 2016 (only 11), compared to 2015 (27). The slowdown in activity was due to a number of obstacles facing the US life industry, including low life insurance policy sales, continued profit pressure in investments arising from the low interest-rate environment, and regulatory-change uncertainty.

The number of M&A transactions involving P&C insurance targets decreased in 2016 to 45, as compared to 62 in 2015, according to data compiled from the SDC database. The 2016 P&C insurance segment was again characterized by small and medium-sized transactions, with more than 75% of all announced deals valued below $200 million. The growing need for capital expenditure for investments, to support new digital and high-tech business models demanded that smaller and mid-sized companies look to M&As as an option for continued growth. Insurers worked to adapt to technological growth. For example. developments in insurtech continued to be important in 2016, with significant deals and expansion across product lines and markets. Moreover, in 2016, regulators took significant steps to enhance the regulation of insurers' data practices. Cybersecurity became a new priority for regulators (Mayer Brown, 2017).

In January 2017, the US and Europe announced an agreement regarding international insurance groups doing business in the US and the EU, to enhance regulatory certainty for insurers and reinsurers operating in both places. Meanwhile, the number of M&A transactions involving P&C insurance targets continued to decrease in 2017, to about 42, as compared to 46 in 2016 (SDC database). Overall, the deal value on transactions in 2017 was down to $7.5 billion, compared to $12 billion in 2016 (Mayer Brown, 2017).

With excess capital, more insurers saw themselves as buyers rather than sellers, which pushed the valuation levels of target companies upwards. Insurers in the P&C market appeared more likely to allocate their excess capital to investments in technology and marketing. Consequently, instead of buying competitors, insurers were more likely to make acquisitions of insurtech enterprises to improve their diversification.

The number and size of life insurance M&A deals involving US targets were up in 2017 (20), compared to 2016 (11). According to the SDC database, 2017 saw several large deals take place. The continued low-interest-rate environment, combined with the significant amount of capital available for deployment into the life and annuity sector led to a number of large annuity transactions in 2017. The year 2017 was notable for the occurrence of a number of catastrophic events, including hurricanes Harvey and Irma and wildfires in California all of which caused losses for several outstanding catastrophe bonds. The availability of this financial market protection in a year with significant catastrophe losses illustrates the robust nature of the insurance market and its critical importance in providing the resources needed to pay claims (Dionne and Desjardins, 2022).

The number of M&A transactions in 2018 involving P&C insurance targets rose to 60, compared to 42 in 2017, according to data compiled by the SDC database. The $32 billion in aggregate transaction value ranks as the most active year for P&C M&As since 2015. It should be noted that approximately two-thirds of that amount is attributable to two very large acquisitions. As in the previous years, small and medium-sized transactions of deals valued below $500 million represented more than 70% of transactions (Mayer Brown, 2019).

Despite around $80 billion of catastrophe losses in 2018, which followed on record catastrophe losses in 2017, the P&C industry continued to be regarded as overcapitalized. Other key factors limiting the increase in P&C M&As included federal tax reform and continued inbound interest from international acquirers seeking a meaningful presence in the US market (Mayer Brown, 2019). Established players were pursuing strategic investments in insurtech businesses.

Issuance of RWI policies continued to be important in the Americas, predominantly in the US. RWI is a form of insurance policy that is purchased in connection with an M&A transaction that protects the insured party (almost always the buyer) against financial loss arising from an unanticipated or unknown breach of certain conditions in the purchase agreement. While there are no market studies that provide reliable figures on the numbers of RWI policies written each year, data from several market studies suggest that numbers have doubled every two years since 2013. The year 2018 also saw the first transfer of pure wildfire risk to the capital markets. Two California utility providers sponsored a catastrophe bond covering third-party liability losses due to wildfires caused by their respective infrastructure. Demand for reinsurance remained high following the ongoing capital requirements of the Solvency II regime, which made reinsurance attractive.

One of the consequences of the 2007–2009 financial crisis was a decision by the federal government to revisit the regulatory system in the McCarran-Ferguson Act. The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) gave increased systemic risk regulatory authority to the Federal Reserve. In addition, Dodd-Frank also created a Federal Insurance Office within the Department of the Treasury to establish greater uniformity among the states with regard to excess and surplus insurance and reinsurance lines.

The development of the COVID-19 pandemic in the first quarter of 2020 created uncertainty regarding all aspects of the insurance business. This resulted in a halt in insurance P&C transactions in the US, as insurers and investors reevaluated their strategic plans. Despite of this first quarter slowdown, an increase in industry M&As from the third quarter of 2020 resulted in deal-making in 2020 whose value exceeded that of 2019 (Mayer Brown, 2021).

The year 2020 has been described as the Year of the SPAC.[6] According to SPAC Insider, 248 special purpose acquisition corporations (SPACs) completed their initial public offerings (IPOs), raising over $83 billion. The recent rise of the SPAC has had an important effect on the US IPO market and, to a lesser extent, the US IPO market for insurance companies. In 2020, three SPACs completed IPOs, with a stated focus on the insurance (including insurtech) industry.

During 2020, US jurisdictions began revising their laws and regulations governing credit for reinsurance to implement the amendments to the NAIC Credit for Reinsurance Model Law and Model Regulation adopted in 2019. Those amendments were designed to satisfy the requirements of the bilateral agreement on insurance and reinsurance between the US and EU.

Climate risk and sustainability were established as a key theme of the IAIS (International Association of Insurance Supervisors) strategy for 2020–2024. Included in this strategy is its partnership with the United Nations Environmental Programme's Sustainable Insurance

[6] A SPAC is a newly formed company with no assets or operations, also known as a blank check company.

Forum. The IAIS is one of the first global standard-setting bodies to adopt policy to guide its performance in terms of environmental issues: incorporating risks from climate change into their governance frameworks, risk management processes, and business strategies.

5.2. Use of ILS for catastrophes losses

The use by insurers and reinsurers of insurance-linked securities (ILS) as a supplemental source of capital for their protection continued after 2012. The capital markets have become a critical component of managing catastrophe risk for a growing number of insurers and reinsurers, although the relative magnitude is still low compared to the total capital available in the industry (Dionne and Desjardins, 2022).

The catastrophe bond market was quite strong in 2013, with a total of $7.5 billion of new catastrophe bonds issued, the second highest annual issuance volume in market history. As of December 31, 2013, there was $20.3 billion of catastrophe bonds outstanding. US catastrophe risks (particularly US wind) continued to dominate, representing approximately 51% of outstanding bonds (Mayer Brown, 2014).

In 2017, the ILS market solidified its importance as a critical component of the global reinsurance market, representing almost 20% of dedicated reinsurance capacity. There was a $31.0 billion total aggregate principal amount of risk-linked securities outstanding, almost 20% higher than the amount at the end of 2016 (Mayer Brown, 2018).

In 2020, the volume issued was the largest in market history, beating the record level of 2018. The total aggregate principal amount of risk-linked securities outstanding of $46.4 billion represented a yearly growth of approximately $5.7 billion. It should be mentioned that the total capital of the US insurance industry was about $1.1 trillion in 2020 (Dionne and Desjardins, 2022).

Reinsurance and premium growth are other sources of capital in the P&C insurance industry (Dionne and Desjardins, 2022). We shall look at these sources of capital later on. In the next section, we continue our statistical analysis of M&As.

6. Validation of the selected treatment date and the presence of parallel trends

In our DID approach, we propose that the increase in natural disaster events observed in the post-2012 period could be a cause of the difference in the number of M&As of target insurers in the non-life insurance sector, relative to the number of M&As of target insurers in the life insurance sector. The varied changes in regulations and economic conditions in the insurance industry during the post-2012 period could also be a cause. These new regulations were motivated by the 2007–2009 financial crisis. Very low interest rates significantly affected the benefits of the insurance industry, particularly in the life insurance industry. Looking at these two potential causes, it appears that a shock event occurred in the years preceding 2013 that might have caused an exogenous change in the treated units that increased the difference in the number of M&As of the treatment group relative to the control group. In short, we consider the increase in natural disaster losses observed after 2012 as a situation that induced an exogenous variation in the treated units (target non-life insurers) that maintained the number of M&As of target insurers in the non-life insurance sector (treatment group), compared to those in the life insurance sector (control group), which decreased significantly during the post-2012 period.

Based on an analysis of Figure 5, we have identified two years in which the parallel trends observed between our two groups began to disappear: 2009 and 2012. However, our analysis of Figure 10 allows us to propose that it was the insured losses from natural disaster events observed after the year 2012 that likely caused the increase in the number of M&As of target insurers in the non-life insurance sector, compared to the number of M&As of target insurers in the life insurance sector, observed in the post-2012 period. Therefore, we can define our treatment effect as a positive difference between the average number of M&As per year of target insurers in the non-life insurance sector and the average number of M&As of target insurers in the life insurance sector. Alternatively, market conditions and variations in the regulation of the insurance industry may also explain the difference observed in Figure 5. The following analysis is independent of the two potential causes.

6.1. Validation of the choice of treatment date using five statistical tests

To choose the most appropriate treatment date for our data, we use a statistical approach applied to the annual data of M&As in the two insurance sectors (Berck and Villas-Boas, 2016; Imbens and Wooldridge, 2009; Roberts and Whited, 2012). We first calculate the annual difference between the number of M&As of target insurers in the non-life insurance sector versus the number of M&As of target insurers in the life insurance sector observed over our entire study period, that is 1990 to 2021. Next, we calculate the mean and median of the difference between the number of target insurer M&As in the non-life insurance sector and the number of target insurer M&As in the insurance sector over the pre-treatment period (including the year of the candidate date) and over the post-treatment period for each of our two selected candidate dates (2009 and 2012). Finally, we perform five statistical tests—the mean statistical test, the median statistical test, the distribution statistical test, the monotonicity test, and the median-criteria test—to validate the choice of treatment date. The results of the first three tests are presented in Table 2, where the differences between various statistics are presented.

Table 2: Statistical descriptions (median, mean of the number of M&As) and validation tests of the treatment date

Period	1990-2009	Post-2009	1990-2012	Post-2012	1990-2021
Median	–2	22.50	–3	29	2
Mean	–2.75	18.4167	–3.78	28.11	5.18
Student's test	–0.9864	3.3066	–1.4679	11.015	1.6014
Median test[1]	0.8238	0.0386	0.6776	0.0039	0.3771
Wilcoxon test[2]	–0.915	2.589	–1.354	2.666	1.356

[1] Sign test (Snecdecor and Cochran, 1989).
[2] Signed rank test (Wilcoxon, 1945).

6.1.1. Statistical test based on the mean (Student's test)

Our decision criterion for the choice of treatment date is to test the null hypothesis (H0) that the average number of M&As in the non-life sector and the average number of M&As in the life sector are statistically similar over the period of 1990 to the end of the candidate date (2009 or 2012) on the one hand, and, on the other hand, to test the null hypothesis

(H0) that the average number of M&As in the non-life sector and the average number of M&As in the life sector are statistically different over the post-treatment date period (post-2009 or post-2012) due to the treatment effect.

According to Table 2, the *t*-test statistic yields a value of -0.9864 over the period of 1990 to 2009 and 3.3066 over the post-2009 period. Given that the absolute *t*-test value is less than 1.96 over the period of 1990 to 2009, the null hypothesis (H0) is not rejected. In addition, because the *t*-test value is greater than 1.96 over the post-2009 period, the null hypothesis (H0) is rejected. The year 2009 is therefore retained by our *t*-test criterion as the treatment date for our DID method. Further, Table 2 shows that the *t*-test statistic yields a value of -1.4679 over the 1990 to 2012 period and 11.015 over the post-2012 period. The null hypothesis (H0) is not rejected over the 1990 to 2012 period and the null hypothesis (H0) is rejected over the post-2012 period. We can therefore conclude that the average number of M&As in the non-life sector and the average number of M&As in the life sector are statistically the same over the period of 1990 to 2012 and statistically different over the post-2012 period. Our *t*-test statistic criterion also retains the year 2012 and cannot discriminate between the two years and between the two potential interpretations.

6.1.2. Statistical test based on the median

This test was proposed by Snecdecor and Cochran (1989). Based on this test, the analyze of the null hypothesis (H0) that the difference between the median number of M&As of target non-life insurers and the median number of M&As of target life insurers is equal to 0.

Our treatment date decision criterion is to test the null hypothesis (H0) that the median number of M&As in the non-life sector and the median number of M&As in the life sector are statistically similar over the period of 1990 to the end of the candidate date (2009 or 2012) on the one hand, and, on the other hand, to test the null hypothesis (H0) that the median number of M&As in the non-life sector and the median number of M&As in the life sector are statistically different over the post-treatment date period (post-2009 or post-2012) due to the treatment effect.

Table 2 reports a *p*-value of 0.8238 over the period of 1990 to 2009 and 0.0386 over the post-2009 period. Because the *p*-value is above the critical threshold of 5%, the null hypothesis is not rejected. In addition, because the *p*-value is lower than the 5% threshold over the post-2009 period, the null hypothesis (H0) is rejected. We can therefore conclude that the median number of M&As in the non-life sector and the median number of M&As in the life sector are statistically similar over the period of 1990 to 2009 and statistically different over the post-2009 period. The year 2009 is therefore retained by our median-based statistical test as the treatment date for our DID method. Further, Table 2 shows a *p*-value of 0.6776 over the 1990 to 2012 period and 0.0039 over the post-2012 period. Because the *p*-value is greater than the 5% critical threshold, H0 is not rejected. In addition, because the *p*-value is below the 5% threshold in the post-2012 period, the null hypothesis (H0) is refuted. We can therefore conclude that the median number of M&As in the non-life sector and the median number of M&As in the life sector are statistically similar over the period of 1990 to 2012 and statistically different over the post-2012 period. Our test based on the median also retains the year 2012 and cannot discriminate between the two dates.

6.1.3. Statistical test based on distributions

This test was proposed by Wilcoxon (1945). We test the null hypothesis (H0) that the distributions of the number of M&As per year of target non-life insurers and the number of M&As per year of target life insurers are close.

According to Table 2, the Z-test statistic yields a value of -0.915 over the period of 1990 to 2009 and 2.589 over the post-2009 period. Because the Z-test value in absolute terms is less than 1.96 over the period of 1990 to 2009, the null hypothesis (H0) is not rejected. In addition, because the Z-test value is greater than 1.96 over the post-2009 period, the null hypothesis (H0) is rejected. We can therefore conclude that the distribution of the number of M&As in the non-life sector and the distribution of the number of M&As in the life sector are statistically similar over the period of 1990 to 2009 and statistically different over the post-2009 period. The year 2009 is therefore retained by our statistical test based on the distributions as the treatment date for our DID method. In contrast, Table 2 shows that the *t*-test statistic yields a value of -1.354 over the 1990 to 2012 period and 2.666 over the post-2012 period. Because the value of the Z-test statistic in absolute terms is less than 1.96 over the period of 1990 to 2012, the null hypothesis (H0) is therefore not rejected. In addition, because the Z-test value is greater than 1.96 over the post-2012 period, the null hypothesis (H0) is rejected. We can therefore conclude that the distribution of the number of M&As in the two industries are statistically similar over the period of 1990 to 2012 and statistically different over the post-2012 period. Our test of the distribution-based statistic also retains the year 2012 and cannot discriminate between the two dates.

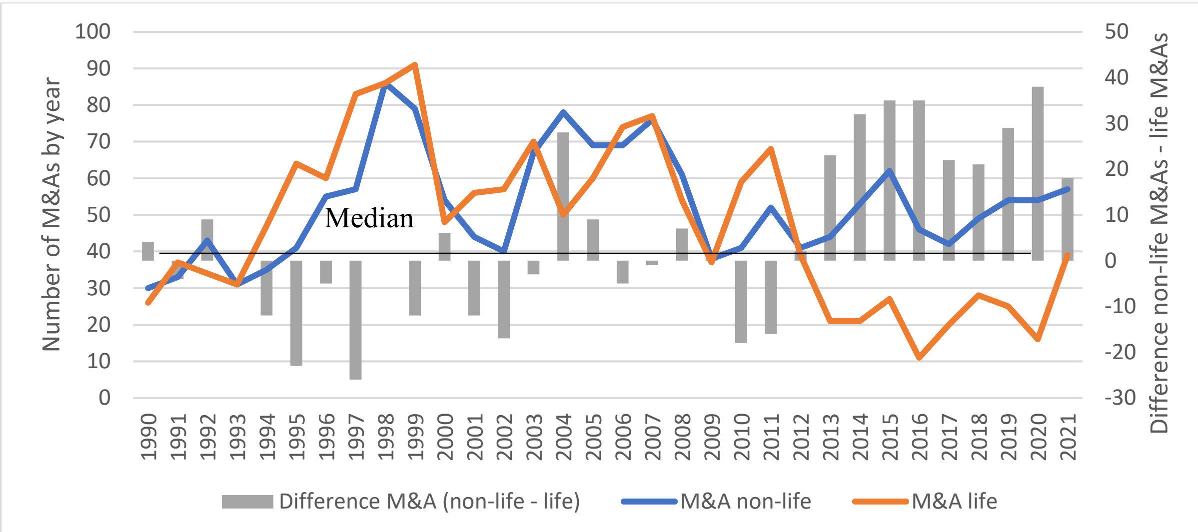
6.1.4. Monotonicity hypothesis

We employ an additional criterion called the monotonicity hypothesis, often used in econometrics to evaluate the treatment effect. This hypothesis postulates that when there is a change, the treatment effect can go in only one direction. To choose our treatment date based on the criterion of the monotonicity assumption, we used a graphical approach based on the analysis of Figure 12.

Figure 12 clearly shows a large difference between the number of M&As of target insurers in the non-life insurance sector compared with the number of M&As of target insurers in the life insurance sector observed over the post-2012 period. Moreover, we note that our treatment effect, defined as a positive difference between the number of M&As per year of target insurers in the non-life insurance sector and the number of M&As of target insurers in the life insurance sector, is respected for each year of the post-2012 period (9 years with a positive difference versus 0 year with a negative difference). In other words, 2012 changes the treatment effect in only one direction (positive difference) for each of the years in the post-2012 period. This affirms our monotonicity hypothesis. In contrast, Figure 12 shows that the year 2009 does not cause a change in the treatment effect in a single direction for each of the years in the post-2009 period (10 years with a positive difference versus 2 years with a negative difference). As can be seen, we get a negative difference for the years 2010 and 2011 and a positive difference for each of the other years in the post-2009 period. This violates our monotonicity condition (hypothesis). To conclude, because only the year

2012 meets the monotonicity condition, we select the year 2012 as the treatment date for our DID method with the monotonicity hypothesis.

Figure 12: Evolution of the number of M&As per year in each of the two insurance sectors (non-life and life, left) and their difference (in histogram, right)



Data source: SDC database.

6.1.5. Median-criteria test of Guest (2021)

For robustness, a last statistical criterion based on the median is applied to ensure the reliability of the choice of the selected year 2012. To do this, we draw on the work of Guest (2021), who applies a median-based statistical criterion. This allows us to define a selection criterion whereby the treatment effect for each of the years in the post-treatment period (post-2009 or post-2012) is greater than the median value of the difference between the number of M&As per year of target insurers in the non-life insurance sector and the number of M&As of target insurers in the insurance sector over our entire study period (1990 to 2021), which is equal to 2 (see Table 2). This criterion supports the choice of 2012 as the treatment date for our DID method. As can be seen in Figure 12, the positive difference between the number of M&As per year of target insurers in the non-life insurance sector and the number of M&As of target insurers in the life insurance sector is greater than the median value of our entire study period (1990 to 2021) for each of the years in the post-2012 period. This is not the case for the post-2009 period, where we in fact observe a negative difference for the years 2010 and 2011, which is thus lower than the median of the entire sample. Therefore, our median-based criterion rejects the choice of the year 2009 as the treatment date for our DID method. To summarize, the statistical criterion based on the median supports the choice of the year 2012 retained by our affirmation of the monotonicity hypothesis.

6.2. Parallel trends analysis

We have just validated the choice of 2012 as the treatment year for our DID method. We will now perform a validation test for the presence of parallel trends before the end of that period. To do this, we first create 32 dummy variables for each of the years in the period of 1990 to 2021. Then, we create a dummy variable $\mathrm{Treated_i}$ with *i* equal to 1 for the treated group and 0 for the control group. Our Treated dummy (non-life sector) is then represented by the $\mathrm{Treated_i}$ variable. We also create 32 interaction variables between the Treated dummy and the year dummy for each year from 1990 to 2021. Finally, we regress our dependent variable, number of M&As per year and state, on our 32 $\mathrm{Treated_i} \times \mathrm{Year}$ interaction variables in each of the 51 states and in the two insurance sectors using the OLS method of estimation for panel data. With the OLS method, we capture the individual effect (state) and the time effect (year). The results are presented in Table 3 with 3,264 observations (32 × 51 × 2).

The results of our regressions validate the presence of a parallel trend before the end of 2012. As can be observed, the obtained coefficients are overall not statistically significant for the pre-treatment period (before 2013). Our F-test supports this result. It shows that the F-statistic on our $\mathrm{Treated_i} \times \mathrm{Year}$ interaction variables prior to the treatment date (1990 to 2012) is $F(23, 3200) = 0.59$ with a probability $\mathrm{Prob} > F = 0.9709$. Given that the *p*-value is greater than 5%, we do not reject the null hypothesis, and we can conclude that the coefficients obtained before the treatment date are not significantly different from zero overall. In contrast, the coefficients obtained for each of the years during the post-2012 period are all statistically significant at the 1% level (except for the year 2021). Our F-test supports this result. The F-test over the post-treatment period (2013 to 2021) yields an $F(9, 900) = 5.20$ with $\mathrm{Prob} > F = 0.0008$. Because the *p*-value is less than 5%, we reject the null hypothesis and can thus say that the coefficients considered as a whole are significant over the post-2012 period. These results allow us to validate our parallel trend test econometrically and thus confirm the choice of the year 2012 as the treatment year to be retained for our DID method.

Table 3: Parallel trends analysis for DID validation test

Test	Validation test		1st Robustness Test		2nd Robustness test	
Independent variable	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Treated×Year1990	2.034***	(0.242)	–		–	
Treated×Year1991	–0.0784	(0.182)	2.005***	(0.260)	–	
Treated×Year1992	0.176	(0.191)	0.176	(0.192)	2.220***	(0.260)
Treated×Year1993	0.00	(0.209)	0.00	(0.210)	0.00	(0.211)
Treated×Year1994	–0.235	(0.163)	–0.235	(0.164)	–0.235	(0.163)
Treated×Year1995	–0.451**	(0.206)	–0.451**	(0.207)	–0.451**	(0.208)
Treated×Year1996	–0.0980	(0.274)	–0.0980	(0.274)	–0.0980	(0.274)
Treated×Year1997	–0.510**	(0.239)	–0.510**	(0.239)	–0.510**	(0.239)
Treated×Year1998	0.00	(0.342)	0.00	(0.341)	0.00	(0.340)
Treated×Year1999	–0.235	(0.327)	–0.235	(0.327)	–0.235	(0.325)
Treated×Year2000	0.118	(0.239)	0.118	(0.240)	0.118	(0.240)
Treated×Year2001	–0.235	(0.224)	–0.235	(0.226)	–0.235	(0.227)
Treated×Year2002	–0.333	(0.208)	–0.333	(0.208)	–0.333	(0.208)
Treated×Year2003	–0.0588	(0.272)	–0.0588	(0.272)	–0.0588	(0.271)
Treated×Year2004	0.549**	(0.270)	0.549**	(0.271)	0.549**	(0.270)
Treated×Year2005	0.176	(0.248)	0.176	(0.249)	0.176	(0.248)
Treated×Year2006	–0.0980	(0.289)	–0.0980	(0.289)	–0.0980	(0.290)
Treated×Year2007	–0.0196	(0.320)	–0.0196	(0.321)	–0.0196	(0.320)
Treated×Year2008	0.137	(0.238)	0.137	(0.236)	0.137	(0.235)
Treated×Year2009	0.0196	(0.201)	0.0196	(0.202)	0.0196	(0.203)
Treated×Year2010	–0.353*	(0.211)	–0.353*	(0.212)	–0.353*	(0.213)
Treated×Year2011	–0.314	(0.198)	–0.314	(0.198)	–0.314	(0.198)
Treated×Year2012	0.0392	(0.203)	0.0392	(0.204)	0.0392	(0.204)
Treated×Year2013	0.451***	(0.162)	0.451***	(0.164)	0.451***	(0.165)
Treated×Year2014	0.627***	(0.182)	0.627***	(0.183)	0.627***	(0.182)
Treated×Year2015	0.686***	(0.199)	0.686***	(0.199)	0.686***	(0.198)

Treated×Year2016	0.686***	(0.188)	0.686***	(0.190)	0.686***	(0.191)
Treated×Year2017	0.431**	(0.206)	0.431**	(0.206)	0.431**	(0.207)
Treated×Year2018	0.412*	(0.211)	0.412*	(0.211)	0.412*	(0.210)
Treated×Year2019	0.569***	(0.151)	0.569***	(0.152)	0.569***	(0.153)
Treated×Year2020	0.745***	(0.182)	0.745***	(0.183)	0.745***	(0.183)
Treated×Year2021	0.353	(0.233)	0.353	(0.234)	0.353	(0.234)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,264		3,162		3,060	
R-squared	0.631		0.628		0.630	

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

To ensure the reliability of our validation test of the choice of treatment date for our DID method, we conduct two robustness tests. The first test consists in ignoring the first year of observation: Treated×Year1990. The second test consists in ignoring the first two years of observations: Treated×Year1990 and Treated×Year1991. The results of these two robustness tests, as shown in Table 3, confirm the validation of the year 2012 as the treatment date to retain for our DID method.

7. DID analysis

In this section, we present in detail the variables of interest that we introduced into our regressions to analyze the difference between M&As in the US life and non-life insurance sectors using the DID method. The data utilized in this study come from the SDC database. The SDC database provides comprehensive quantitative and qualitative information on the characteristics of M&A transactions over the period of 1990 to 2021 in the two insurance sectors.

7.1. Description of variables

7.1.1. Natural experiment

In our econometric approach, we opted for a natural experiment methodology using the difference-in-differences estimator (DID). This estimator must separate the firms that have received a treatment (treatment group) and firms that have not received a treatment (control group).

7.1.2. Treatment group and control group variable

The purpose of our study is to determine the impact of climate risks or regulatory changes and market conditions on target insurers in the US. Because insurers in the non-life insurance sector are more exposed to climate risks and less exposed to market conditions and regulatory changes than are insurers in the life insurance sector during our period of analysis, we select insurers in the non-life insurance sector as our treatment group. We create a dichotomous variable Treated_i with *i* equal to 1 for the treatment group (non-life insurance sector) and 0 for the control group (life insurance sector).

7.1.3. Regression model

Based on our variables of interest, we consider the following regression model:

$$\text{Nbr M\&A}_{it} = \alpha + \delta_1 \text{Treated}_i \times \text{Post2012} + c_i + \eta_t + \epsilon_{it} \tag{1}$$

where:

$\text{Nbr M\&A}_{it}$: number of M&A in state *i* during year *t*;

$\text{Treated}_i \times \text{Post2012}$: equal to 1 for the treatment group after the treatment period and equal to 0 otherwise;

α : constant;

c_i : individual effects that exert the same influence on the state i in all periods;

η_t: temporal effects that affect all states equally in period *t*;

ϵ_{it} : standard random effects.

What interests us in equation (1) is the interaction variable Treated_i x Post2012. It indicates the impact of the treatment on the insurers in the treatment group. Given that the regulation of insurance companies differs from state to state in the US, we created dummy-states variable to capture the individual effect of each state. The model assumes that the time shocks η_t affect all units in the two groups equally in period *t*. For this reason, we create dummy-periods to capture the time effect in each period. In our estimation of equation (1), we maintain the constant α since we use an estimation procedure that controls for multicolinarity. This approach is contrary to those of Dionne and Liu (2021) and Giorcelli and Moser (2020).

7.1.4. Description of targets

The targets selected for our study are US insurers that were acquired or merged during the period of 1990 to 2021. These targets operated in the life or non-life insurance sectors prior to the M&A transaction. We exclude from our sample of targets financing agency insurers or brokers with an SIC code of 6411 (Insurance Agents, Brokers and Service). The US targets selected for this study have the following SIC codes:

- 6311: Life Insurance
- 6321: Accident and Health Insurance
- 6324: Hospital and Medical Service Plans
- 6331: Fire, Marine, and Casualty Insurance
- 6351: Surety Insurance
- 6361: Title Insurance
- 6399: Insurance Carriers, Not Elsewhere Classified

Targets with the SIC codes 6321, 6324, 6331, 6351, 6361, and 6399 (Non-life Insurers) represent our treatment group, and targets with the Code 6311 (Life Insurance) represent our control group.[7]

After having presented the SIC codes of the target insurers selected for our analysis, we now document geographic information to determine the US states in which target insurers were most affected by the two waves of M&A transactions that we identified in Figure 1. Most large insurers have developed models based on geographic, seismic, and meteorological information to estimate the level of exposure to climate risks and the associated losses. In this study, we document geographic information to estimate targets' level of exposure to climate risks captured by the fixed effects. To do this, we break down the number of M&A transactions of the targets by state over the period of 1990 to 2021.

[7] In Online appendix 2, we regroup 6321 and 6324 with 6311. The statistical results remain the same but their interpretation changes.

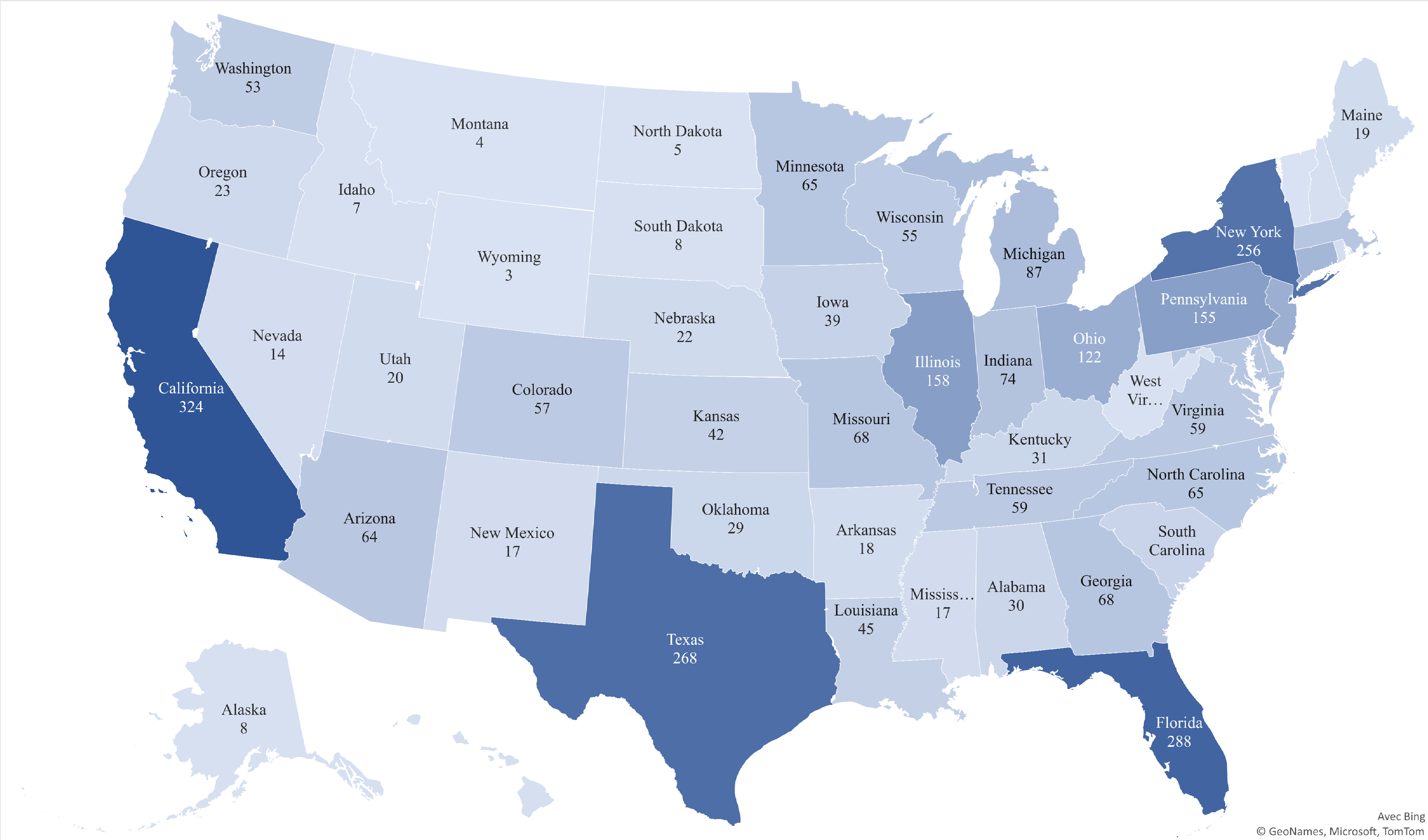
We find that states such as California (324), Florida (288), New York (256), Texas (268), Illinois (158), Pennsylvania (155), Ohio (122), Michigan (87), Connecticut (101), New Jersey (119), Indiana (74), Massachusetts (69), Georgia (68), Maryland (68), Missouri (68), Minnesota (65), North Carolina (65), Arizona (64), and Delaware (63) each have a number of M&A transactions that exceeds the insurance industry average of 62. In other words, these regions have seen a significant number of M&A transactions over the past 30 years.

Using the distribution of the number of target M&A transactions by state shows that states can be subdivided into two groups based on whether the state is located in a coastal or a non-coastal zone. According to the National Oceanic and Atmospheric Administration (NOAA) website classification,[8] coastal zones include the following 30 states: New York, Florida, Connecticut, Pennsylvania, Texas, Illinois, California, Georgia, South Carolina, Maryland, Ohio, Virginia, Washington, Louisiana, Mississippi, New Jersey, Michigan, Alabama, North Carolina, Oregon, Maine, Massachusetts, Delaware, New Hampshire, Hawaii, Indiana, Minnesota, Wisconsin, Rhode Island and Alaska. The remaining 21 states (including District of Columbia) are located in non-coastal zones.

Figure 13 shows that all states identified as having a number of M&A transactions that exceeds the all-state average are in coastal zones except for Missouri and Arizona. In contrast, all non-coastal states have a number of M&A transactions per state that is below the all-state average except Missouri and Arizona. This distribution suggests that insurers located in coastal zones are more active in M&As. The extreme weather conditions that occur in these zones could explain this situation. Extreme weather can quickly trigger natural disaster events such as hurricanes, wildfires, tornadoes, and winter storms, and cause significant or extreme losses to insurers located in coastal zones. To summarize, insurers located in coastal zones have a higher level of exposure to climate risks than do insurers located in non-coastal zones. In our estimations, these differences will be taken into account by the fixed-effects variable.

[8] https://coast.noaa.gov/czm/mystate/.

Figure 13: Geographic distribution of the number of M&As transactions by state (1990 to 2021)



Data source: SDC database.

Additional states with numbers of MA in parentheses: South Carolina (34), Connecticut (99), Delaware (63), Maryland (67), Massachusetts (67), New Hampshire (10), New Jersey (116), Vermont (3), West Virginia (6).

The larger the number, the darker the color.

7.1.5. Description of acquirers

The acquirers are US or foreign companies that have carried out M&A transactions with the US target insurers over the period of 1990 to 2021. Based on the distribution of M&A transactions observed between 1990 and 2021, we identify two categories of transactions: inter-state transactions and intra-state transactions. According to this categorization of transactions, we determine that, over the period of 1990 to 2021, 24.14% of the M&A transactions were carried out by targets and acquirers from the same state (intra-state) and 75.86% of M&A transactions were carried out by targets with acquirers from different states (inter-state) or with foreign acquirers. Thus, this distribution suggests that acquirers have increased their geographic scope significantly over the period of 1990 to 2021.

Further, based on the distribution of M&A transactions observed between 1990 and 2021, we identify and determine the percentage of M&A transactions that occurred between targets and acquirers that operate in the same industry sector (i.e. that has the same SIC code). Our data show that 36.15% of the transactions were between targets and acquirers that have the same SIC code (concentration). In other words, 63.85% of the transactions were between targets and acquirers that have different SIC codes (diversification). This distribution suggests that acquirers have mostly opted for a management strategy based on diversification of operations rather than on concentration of operations.

7.1.6. Description of explanatory variables

Table 4 presents in detail the description of the variables we introduce into our model (1) to empirically test the difference between M&As in the US life and non-life insurance sectors by adopting the natural experiments method or the DID estimator.

We argue that the increase in natural disaster events that occurred in the post-2012 period, and especially the significant insured losses that they caused to insurers in the non-life insurance sector after 2012, seriously weakened target insurers in the non-life insurance sector. This has caused an increase in the number of M&A targets per year in the non-life insurance sector relative to the life insurance sector in the post-2012 period.

Table 4: Description of explanatory variables

Explanatory variable	Description	Expected sign
$\mathrm{Treated_i}$ (dichotomous)	$\mathrm{Treated_i}$ variable with *i* equal to 1 for the treated group (non-life insurance sector) and 0 for the control group (life insurance sector)	n.a
$\mathrm{Post2012}$ (dichotomous)	The $\mathrm{Post2012}$ variable takes the value 0 if the period is before the treatment (12-2012) and the value 1 if the period is after the treatment.	n.a
$\mathrm{Treated_i} \times \mathrm{Post2012}$ (dichotomous)	The interaction variable $\mathrm{Treated_i} \times \mathrm{Post2012}$ captures the effect of the treatment administered to the insurers in the treated group (non-life insurance sector) after the treatment.	+

We expect a positive sign of the coefficient of the variable $\mathrm{Treated_i} \times \mathrm{Post2012}$ on the number of target M&As per year. Otherwise, market conditions and changes in regulation after 2012 seem to have more negatively affected the life insurance industry. This observation may also explain a positive sign on the coefficient of the interaction variable.

7.2. Data and descriptive statistics of variables

The database used is the population of state-aggregated data on the characteristics of the target insurers' M&A transactions, observed in the two main sectors of US insurance (non-life and life) over a 32-year period and documented in the SDC database. Our data includes the 50 states of USA and the District of Columbia. This means that if a typical non-life insurance company operates across the country, it will be subject to 51 different regulations and different climate risk exposures. In order to capture the different structure of insurance companies as it often changes from state to state, we separate our data by state (51) and by year (32) according to each of our two insurance sectors. We obtain a total of 3,264 observations.

Table 5 presents the descriptive statistics of the variables related to the characteristics of M&As according to the two groups in our study sample. To compile this table, we calculate the means and standard deviations of the different variables within our two groups.

Table 5 shows that the average number of M&As per year and by state is 1.030 in the non-life insurance sector and 0.928 in the life insurance sector. In addition, the number of M&As for our two groups as a whole is 0.979 with a standard deviation of 1.634. Table 6 presents the mean and standard deviation of mergers and acquisitions by period. The mean is lower after 2012.

Table 5: Mean and standard deviation of the variables by insurance sector

Sample	Total sample (N=3264)	Non-life sector (N=1632)	Life sector (N=1632)
Dependent variable			
Number of M&As per year and by state	0.979 (1.634)	1.030 (1.662)	0.928 (1.605)
Variable of interest			
$\text{Treated}_i \times \text{Post2012}$	0.140 (0.347)	0.281 (0.449)	n.a n.a

Numbers in parentheses are standard deviations.

Table 6: Mean and standard deviation of the M&A by period

Period	1990-2021		1990-2012		Post-2012	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Number of M&As per year and by state	0.979	1.634	1.077	1.743	0.728	1.282

Table 5 indicates that the average number of M&As per year and by state observed in the non-life insurance sector over the period of 1990 to 2021 is roughly the same as that observed in the life insurance sector. To validate this observation, we statistically test the null hypothesis that the average number of M&As per year and by state in the non-life sector and the average number of M&As per year and by state in the life sector are statistically the same. Our statistical *t*-test yields a value of 1.60. Because the *t*-test value obtained is below the critical value of 1.96 (5% threshold), the hypothesis is not rejected. We can therefore conclude that the average number of M&As per year and by state in the non-life sector and the life sector are statistically the same over our entire study period, i.e. from 1990 to 2021.

7.3. Estimation results

The regression results of model (1) were obtained using the OLS method of estimation with fixed-effects. Our results presented in Table 7 indicate that the coefficient of our variable $\mathrm{Treated_i} \times \mathrm{Post2012}$ is positive and statistically significant at the 1% level. This result suggests a higher number of M&As in the treated group following the treatment date of 2012.

Table 7: Regression results for model (1) using OLS
with fixed effect on the state and on time

Dependent variable	Number of M&As per year (non-life and life)	
Independent variables	Coefficient	Standard error
$\mathrm{Treated_{NL}} \times \mathrm{Post2012}$	0.626***	0.0871
Constant	3.013***	0.226
State FE	Yes	Yes
Year FE	Yes	Yes
Observations	3,264	
R-squared	0.551	

Robust standard errors.
*** p<0.01.

The sign of the coefficient of the variable $\mathrm{Treated}_i \times \mathrm{Post2012}$ is as expected. This result empirically validates the assumption that the increase in natural disaster events or the variations of market conditions and in regulation that occurred during the post-2012 period may have seriously modified the insurers consolidation behavior between the two insurance sectors. These potential causes may have increased the difference of target M&As per year in the non-life insurance sector compared with the life insurance sector during the post-2012 period.

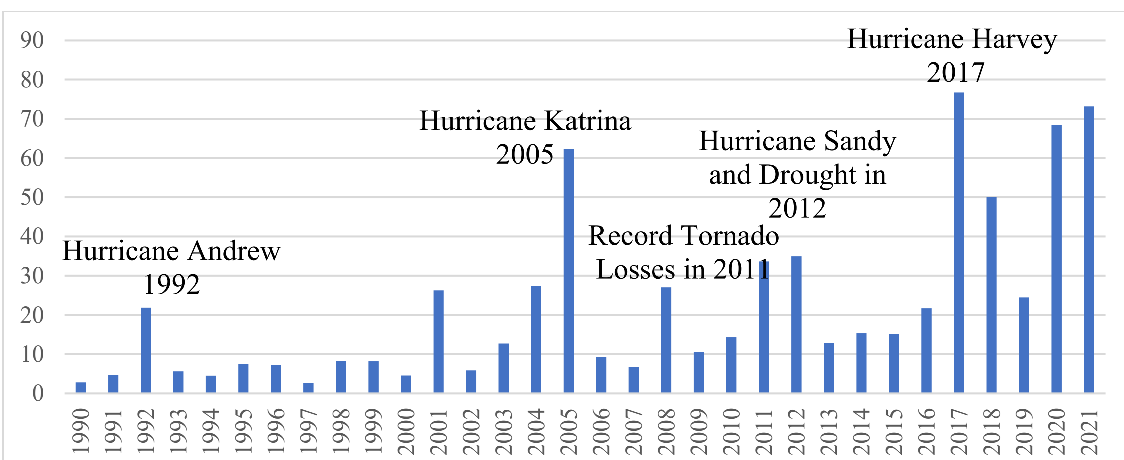
8. Financial health of US P&C insurers, 1990 to 2021

8.1. Combined ratio

Figure 14 shows the insured losses from natural disasters, while Figure 15 describes the evolution of the combined ratio. The combined ratio of the US non-life insurance industry has reached three major peaks since the 2000s. The first was in 2001 and reflects the major economic losses associated with the September 11, 2001, terrorist attack. The second peak occurred in 2005 and reflects the large economic losses associated with hurricanes Katrina, Rita, and Wilma, in 2005. Finally, the third peak was reached in 2011 and illustrates the costs of major claims generated by the exceptional series of violent tornadoes that occurred in 2011 in the US Midwest. If one considers only the level of the combined ratio attributable to natural catastrophe events in the US since the early 2000s, it is clear that 2011 was the second-most costly year for US insurers, after 2005.

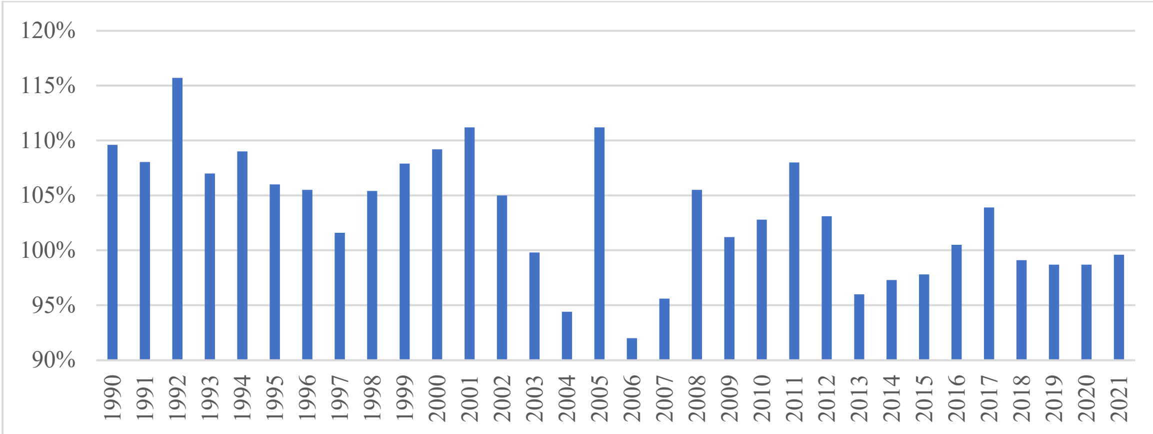
Analysis of Figure 15 shows that the combined ratio for 2011 is higher than for 2017, which was a year of extremes in terms of US natural event losses, as shown in Figure 14. In other words, insured losses from natural catastrophe events in 2011 are lower than in 2017, but the combined ratio is higher.

Figure 14: Insured losses (billion $) from natural disaster events in US, 1990 to 2021



Data source: VERISK database. VERISK selects events with insured losses of $25 million and above. Insured losses: property damage and business interruption, excluding liability and life damage.

Figure 15: Combined ratio US property-casualty, 1990 to 2021



Data source: NAIC data, Federal Insurance Office, US Department of the Treasury, Annual Report on the Insurance Industry (before 2018), and Statista data. Combined ratio formula = (claims costs + management expenses) / premiums earned.

The combined ratio is affected by the claims losses variable (the combined ratio being an increasing function of insured losses). The combined ratio is also affected by the management expenses variable (the combined ratio being an increasing function of management expenses). Another variable that affects the level of the combined ratio is the premiums earned variable. As the formula noted below Figure 15 indicates, the combined ratio is a decreasing function of the premiums earned variable.

Our data from the NAIC[9] indicate that total claims costs (including those due to natural catastrophe events) in 2011 were $296 billion, as compared to $354 billion in 2017, an increase of 20% from 2011 to 2017. These loss cost figures suggest that the 2017 combined ratio level should be higher than that of 2011. In addition, management expenses in 2011 were $180 billion, versus $214 billion in 2017, for an increase of 19% from 2011 to 2017.

In other words, we should expect a higher combined ratio in 2017 than in 2011, given that the total loss costs and management expenses, which were $477 billion in 2011, rose to $568 billion in 2017, an increase of 19%. Our data, however, indicate the opposite: in Figure 15, a ratio of 108% in 2011 (the record year for natural event losses in the US) versus a ratio of 103% in 2017, equal to a 5% decrease in the combined ratio.

[9] US Property & Casualty and Title Insurance Industries – 2020 Full Year Results.

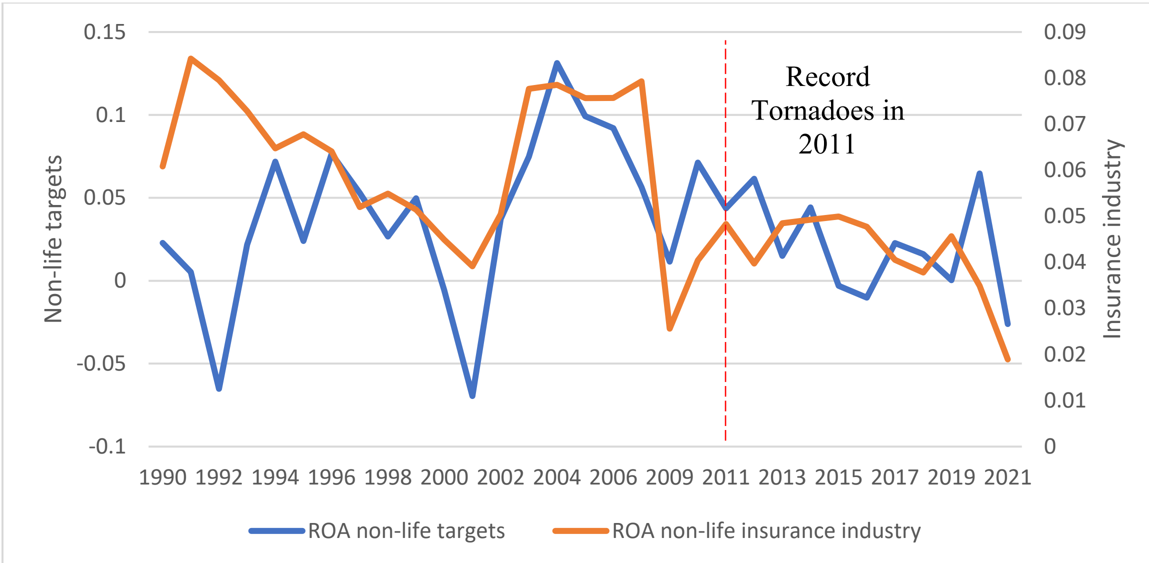
Our NAIC data also indicate that net premiums earned, which were $443 billion in 2011, grew to $550 billion in 2017, an increase of 24%. By contrast, the same data source shows that total loss costs and management, which were $477 billion in 2011, increased to $568 billion in 2017, a 19% increase. We clearly see that it is the increase in the growth of net premiums earned of 24% versus the increase in total loss costs and management expenses of 19% over the period from 2011 to 2017 (a difference of 5%) that could explain the reduction in the combined ratio level by 5% over the same period (108% in 2011 versus 103% in 2017).

8.2. ROA and asset-turnover of targets

To illustrate the very sharp deterioration in growth volume of all public non-life target insurers after the series of violent tornadoes that occurred in 2011, we use two profitability measures. The first is the return on total assets (ROA) profitability indicator and the second is the asset-turnover efficiency ratio. We use the ROA profitability indicator as a reliable instrument to measure the viability (growth) of our targets and non-life insurers. To be viable, insurers, like any other company, must generate profitability in all their businesses. They must repay their clients and creditors, satisfy their shareholders' demands, and finance their growth (on which their viability depends). Second, we use the asset-turnover ratio as another reliable measure of the viability of our non-life public targets. This ratio measures the efficiency with which a company uses its assets to produce revenue. In other words, asset-turnover measures performance in terms of return on assets.

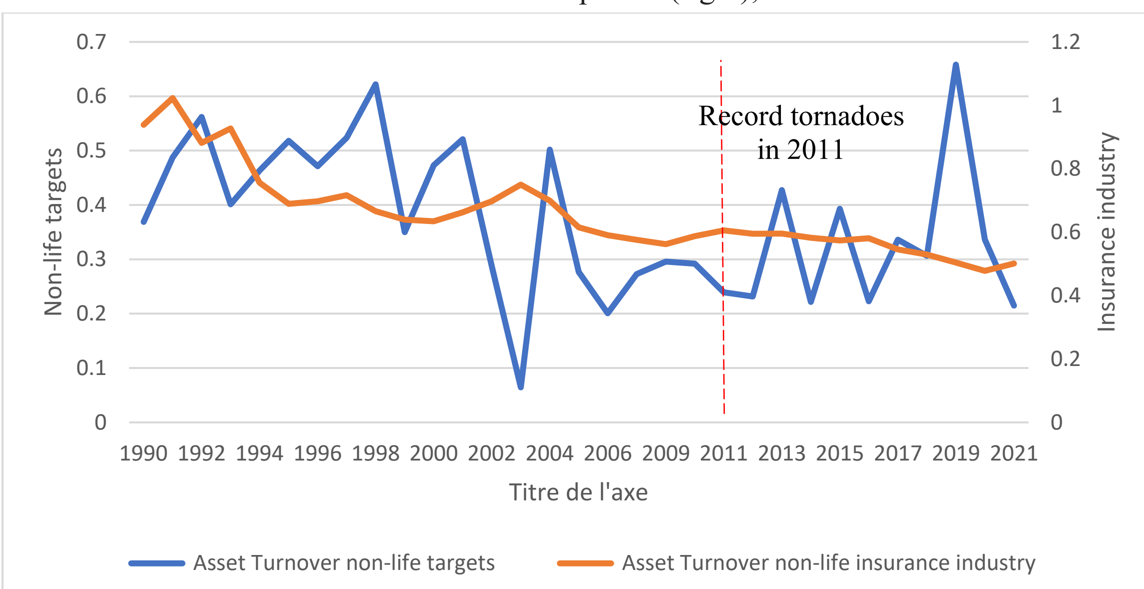
Figure 16 and Figure 17 compare the ROA and asset-turnover efficiency ratios of a sample of M&A targets in the US non-life insurance market with those of the non-life insurance industry. The two target ratios do not look very different than those of the industry, which indicates that the financial conditions of the targets were not necessarily bad at the merger or acquisition dates. We must note that these results are limited to a sample of 224 targets that may not represent the entire industry. They do not necessarily make it possible to reach a final conclusion about the overall insurance industry.

Figure 16: Return on total assets (ROA) for a sample of non-life targets (left) and for the non-life insurance industry (right) in the US, 1990 to 2021



Sources: COMPUSTAT and NAIC databases.

Figure 17: Asset-turnover efficiency ratios for a sample of non-life targets (left) and non- life insurance companies (right), 1990 to 2021



Sources: COMPUSTAT and NAIC databases.

8.3. CAT bonds

The exceptional series of severe tornadoes in 2011 also resulted in very high losses on two Mariah Re catastrophe (CAT) bonds: the Mariah Re 2010-1 CAT Bond triggered[10] on September 30, 2011; and the Mariah Re 2010-2 CAT Bond triggered on August 30, 2011. These two CAT bonds were issued in November 2010 (for Mariah Re 2010-1) and December 2010 (for Mariah Re 2010-2) by Mariah Re Ltd. They covered the risks of severe storms in the US. The losses on these two Mariah Re CAT bonds issued in 2010 represent the highest losses in the history of CAT bonds in the US. These results indicate how the utilization of ILS instruments helps the insurance industry maintain capital in years of very high losses.

8.4. World Economic Forum

The magnitude of the loss costs caused by the natural disasters in the US in 2011, to which can be added the natural disaster events that occurred internationally, notably in Japan, Thailand, New Zealand, and Australia, may have raised the collective awareness of the danger of natural (or weather) disasters, as indicated by the works from the experts of the World Economic Forum (Table 8).

The experts of the World Economic Forum show that awareness of environmental risks appeared among companies' top five concerns only starting in 2011, that is to say, after the occurrence of very large natural disasters. The analysis is based on an assessment of hazards by specialists from various sectors through a risk mapping model. Risk mapping is one of the risk management tools most widely used by companies, particularly insurers. It involves a graphic representation of a number of risks and serves to identify the threats and dangers incurred by organizations, synthesizing them in a hierarchical form. According to *Atlas* magazine (consulted on 6 December 2022), this hierarchy is based on criteria such as probability of occurrence, potential impact, and level of risk control. Further, mapping natural, economic, and social catastrophe risks enables insurance companies to better identify the threats likely to impact their business. Table 8 presents the World Economic

[10] Triggered means that the risk underlying the (CAT) bond has materialized and that the principal or capital is used to cover the insurer's loss instead of going back to the investors.

Forum's assessment of the perception (by year) of the five global risks to which companies are most sensitive, for the years 2007 to 2013.

The table shows that in 2011, the overall risk that leaders considered most worrisome for the next 10 years is meteorological catastrophes (storms, tornadoes and hurricanes). Climatological catastrophes (rain, snow, or hail) are ranked fifth, following the series of violent tornadoes in the Midwestern US and the natural and nuclear disasters in Japan and Thailand.

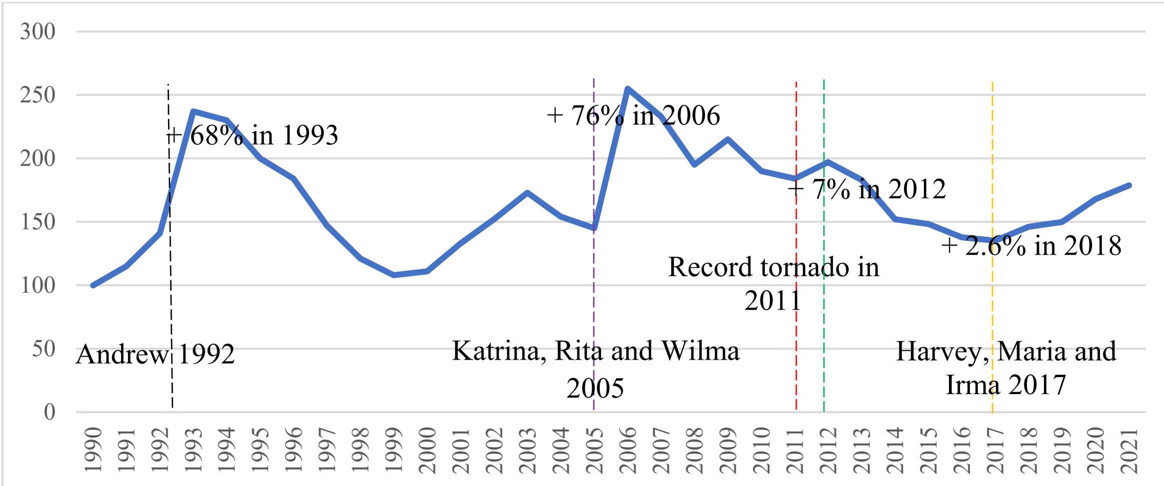
Table 8: Top five global risks in terms of probability of occurrence

	2007	2008	2009	2010	2011	2012	2013
1st	Breakdown of critical information infrastructure	Asset price collapse	Asset price collapse	Asset price collapse	Meteorological catastrophes	Severe income disparity	Severe income disparity
2nd	Chronic disease in developed countries	Middle East instability	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)	Hydrological catastrophes	Chronic fiscal imbalances	Chronic fiscal imbalances
3rd	Oil price shock	Failed and failing states	Chronic disease	Chronic disease	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions
4th	China economic hard landing	Oil and gas price spike	Global governance gaps	Fiscal crises	Biodiversity loss	Cyber attacks	Water supply crises
5th	Asset price collapse	Chronic disease, developed world	Retrenchment from globalization (emerging)	Global governance gaps	Climatological catastrophes	Water supply crises	Mismanagement of population ageing

Economic | Environmental | Geopolitical | Societal | Technological

Source: World Economic Forum.

Figure 18: US Property catastrophe rate-on-line index (private and public insurers)



Data source: Data from Guy Carpenter, presented by Artemis.bm.

Definition: Rate-on-line index (ROL) is the ratio of premium paid to loss recoverable in a reinsurance contract. In simple terms, ROL represents the amount of money an insurer must commit to obtain reinsurance coverage. A high ROL indicates that the insurer must pay more for coverage, while a low ROL means that an insurer pays less for the same level of coverage.

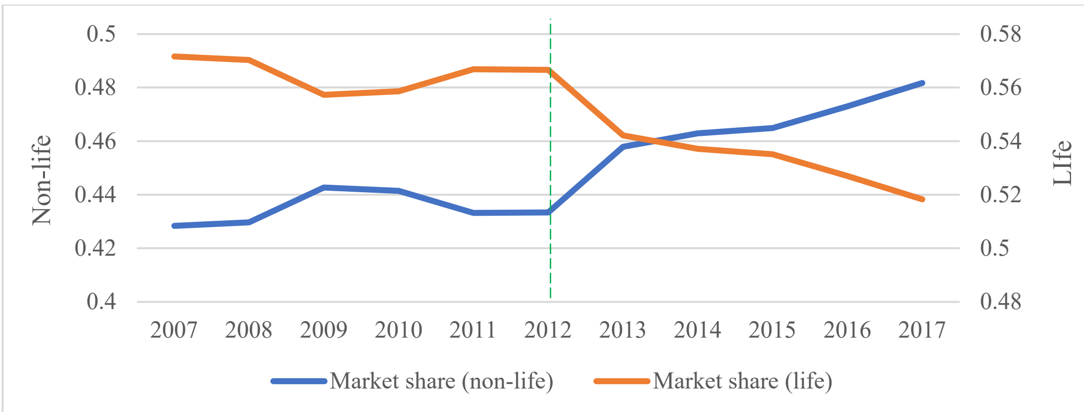
8.5. ROL index

Figure 18 indicates that major disasters led to large changes in the ROL index until 2012, and small changes thereafter. This is the case, for example, with Hurricane Andrew in 1992 and Hurricane Katrina in 2005. After Andrew in 1992, the catastrophe index increased 68% in 1993. It increased 76% in 2006 after Hurricane Katrina in 2005, and by 7% in 2012 after the series of severe tornadoes in the Midwest in 2011. By contrast, Figure 18 shows very small changes in the ROL index after 2012. All ROL changes remained below the 7% mark (ROL change from 2011 to 2012) throughout the post-2012 period, even after major hurricanes Harvey, Maria, and Irma of 2017 (the year of extremes); the ROL increased by only 2.6% in 2018.

8.6. Premium earned

Premiums earned are one of the main resources available to insurers to cover loss costs. Therefore, the small changes in the ROL index observed after 2012 suggest that non-life insurers increased their level of premium collection in the post-2012 period. To verify this, we use premium earned data and calculate the market share of each of our insurance sectors (non-life and life) over the period of 2007 to 2017. We retain this period because data on premiums earned, from the Insurance Information Institute, are available only for the period of 2007 to 2017.

Figure 19: Market share of premiums earned by all non-life (left) and life insurers (right) (private and public)



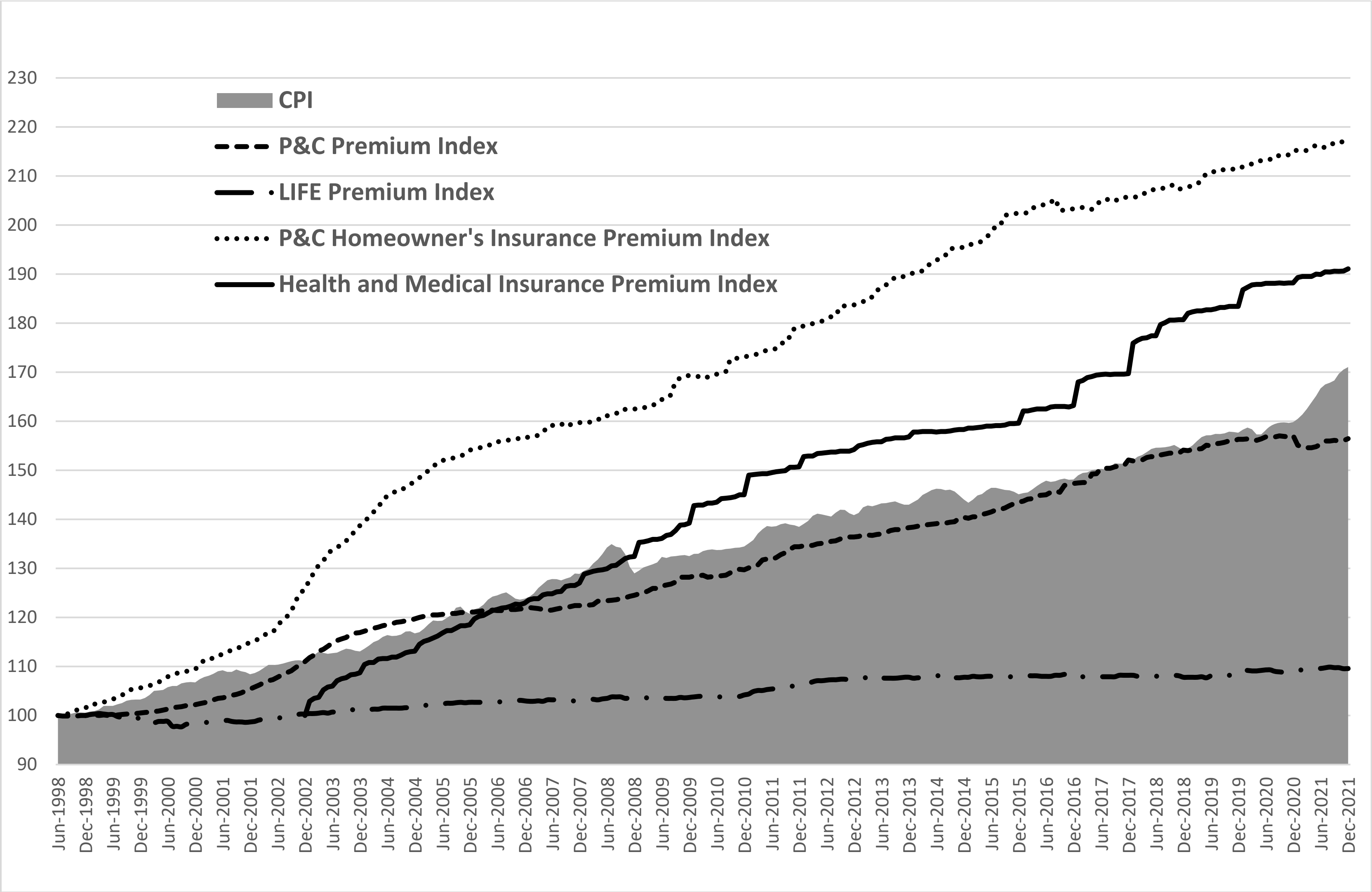
Data source: Insurance Information Institute.

Figure 19 shows that premiums earned share increased significantly in the post-2012 period in the non-life insurance sector. By contrast, premiums earned share decreased significantly during the post-2012 period in the life insurance sector. Over five years (2012 to 2017), the non-life sector's premium market share grew by 12%, while the life insurance sector's premium market share declined by 9%.

Figure 20 presents the different premium indexes during the period of analysis. Life premium growth is much lower than P&C premium growth. The P&C Homeowner's Insurance Premium Index more than doubles during the period of analysis.

The results obtained from figures 19 and 20 suggest that the recognition of natural catastrophe risk may have led insurers to readjust their pricing, to properly take climate risk into account. The net increase in the level of premiums earned in the post-2012 period illustrates this.

Figure 20: Insurance Premium Indices

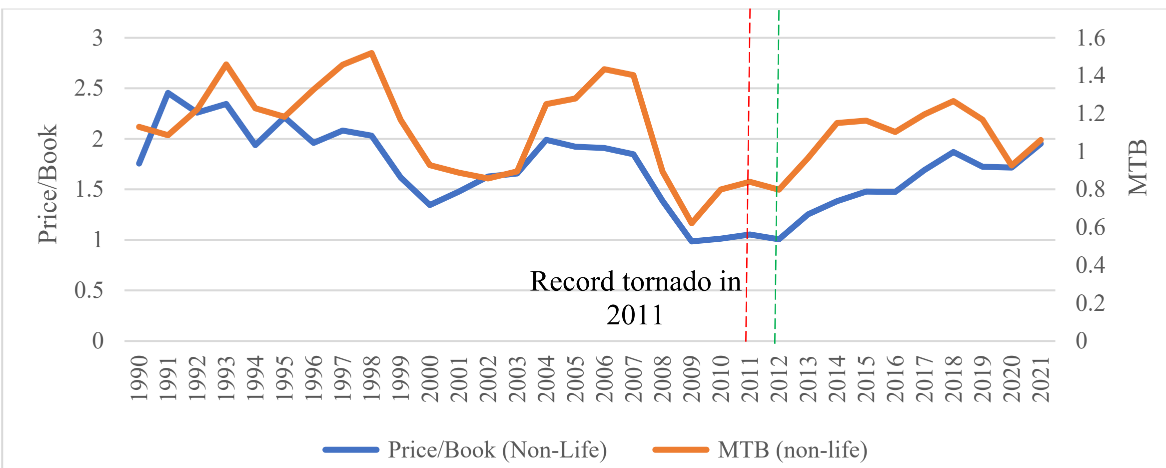


Data source: US Bureau of Labor Statistics.

8.7. Market-to-book and price/book

The results in Figure 21 suggest that there has been resilience to property damage due to natural disasters, in the non-life insurance industry in the post-2012 period, a period that was marked by sharp increases in claims costs due to natural disasters, especially starting in 2017 (the year of Harvey, Maria, and Irma). In other words, recognition of the risk of large claims from natural disasters in post-2012 allowed US non-life insurers to sufficiently cover loss costs with reserves from written premiums, allowing them to improve their financial health in the post-2012 period, as shown in Figure 21. Indeed, Figure 21 shows that the financial health (as measured by the price/book and market-to-book (MTB) indicators) of all insurers in the US non-life insurance industry improved significantly in the post-2012 period.

Figure 21: Evolution of the price/book and MTB ratios in the US non-life sector

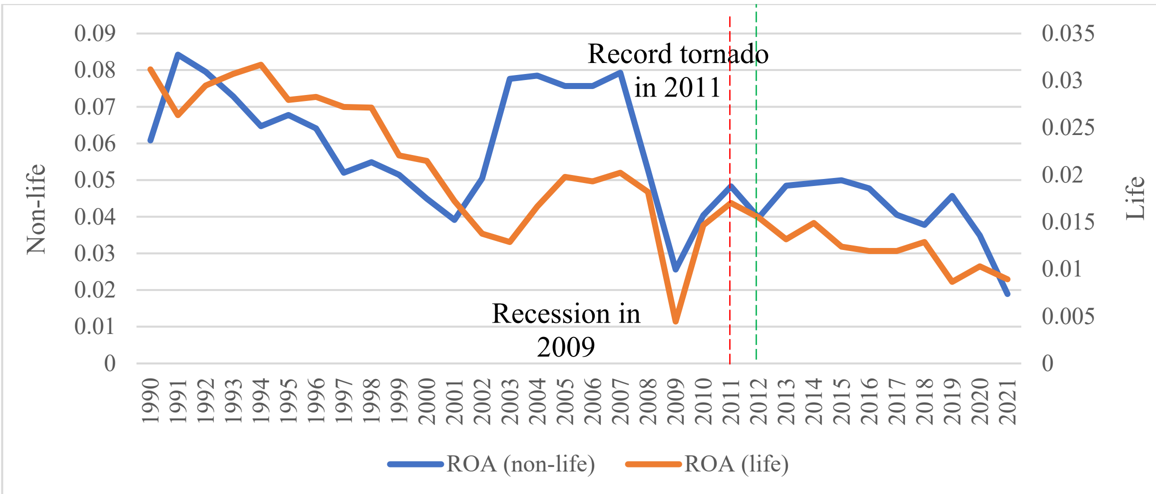


Data source: COMPUSTAT database.

8.8. ROA in both sectors

Figure 22 shows the evolution of the ROA ratio. It suggests that non-life insurers as a whole have returned to growth after the great economic recession of 2009 and the decline in 2012 caused by the Midwestern tornados in 2011 and the impact of Hurricane Sandy in 2012. By contrast, Figure 22 still points to a deterioration in organic growth across all life insurers during the same period. Figure 22 also shows a divergence in the trend between overall growth of non-life insurers and life insurers after 2012.

Figure 22: Evolution of the ROA ratio in the non-life and life insurance sectors in the US, 1990 to 2021



Data source: COMPUSTAT database.

Our data show, as Figure 22 indicates, that there is a clear positive difference between the ROA of the US non-life insurance industry and that of the US life insurance industry for almost every year in the post-2012 period. This difference was also observed between M&As of the US non-life insurance industry and those of the US life insurance industry, for each of the years over the same post-2012 period.

9. Conclusion and discussion

The main objective of this study is to test for the presence of a statistical link between climate risk and mergers and acquisitions (M&As) in the US property and casualty (P&C) insurance industry. The main research question is the following: is the observed increase in claims costs associated with climate risk events a causal factor for M&As growth during the 1990-2021 period? More generally, the study examines how the costs of catastrophic weather events associated with climate risk have impacted the insurance industry's resilience by affecting economic capital during the 1990–2021 period. The financial literature often describes M&As as consolidation activities in different industries.

We develop a natural experimental event study by identifying two groups of insurers that are exposed differently to climate risk events. The control group of insurers was less exposed to weather risk events, and the treatment group of insurers was more exposed to weather risk events. Life insurers were considered less exposed than P&C insurers. Our statistical results indicate that the post-2012 period was associated with a difference in M&A activity between the two insurance sectors, while both sectors had parallel trends in M&A prior to January 2013. The number of M&As was statistically higher in the P&C insurance sector than in the life insurance sector in the post-2012 period.

We faced two major difficulties isolating climate risk as having a causal effect on M&As. The first was separating M&As from other sources of capital consolidation that insurers can use to protect themselves from natural catastrophes. Dionne and Desjardins (2022) show that US P&C insurers significantly increased their capital between 1997 and 2020. These authors also identify different potential sources of capital, such as reinsurance, premium management, M&As, capital regulation, and insurance linked securities (ILS).

The second difficulty was identifying potential factors other than weather risk events that may have affected M&As in the two insurer groups in the 1990–2021 period of analysis. The US insurance industry overall was affected by the 2007–2009 financial crisis, and the life insurance industry in particular (Barnes et al., 2016). Market conditions were difficult after the crisis for the life insurance industry (NAIC, 2022; Federal Insurance Office, 2022). Premium growth was low in this line of business, and interest rates were very low in the whole economy. Different federal regulations for capital were introduced, particularly in and after 2012, to consolidate capital risk management following the financial crisis. These new regulations affected capital levels and may have introduced uncertainty into the markets about the potential future growth of M&As.

Our main results do not support a causal link between climate risk and M&As in the US insurance market during the period of analysis. We obtain a significant increase in the number of M&A events in the treatment group (target non-life insurers) compared to the control group (target life insurers) after the year 2012, but we cannot yet identify the actual cause of this result. Climate risk costs significantly increased after 2012 in the P&C insurance industry, but it is not clear that M&As were chosen to consolidate the industry. The observed difference could also be attributed to a significant reduction in M&As in the life insurance industry after 2012, which could be explained by stagnant activity growth in insurance premiums and very low interest rates in the economy.

It seems that P&C insurers choose other diversification activities, including reinsurance and premium management. ILS, including catastrophe bonds, became more popular during our period of analysis, but cannot be considered one of the main sources of capital in the US P&C insurance industry. Better capital risk management under the stronger risk regulation introduced in 2012 and following years could also have been another significant source of resilience for the P&C insurance industry. A preliminary analysis of all these potential sources of capital is presented in the appendix. It indicates that premium growth and reinsurance demand were the two main sources of capital in the P&C insurance industry during our period of analysis. Finally, our analysis of different financial indicators confirms the relative good health of P&C insurers after 2012.

Many extensions of our research are in development. Reinsurance is important to diversify climate risks around the world over time (Cummins and Weiss, 2000, 2004). It has been documented that the presence of reinsurance can affect P&C insurers' behavior (Desjardins et al., 2022). The introduction of a more active role for reinsurance in modeling insurers' capital should improve our understanding of the stability of this industry despite the increasing number and severity of climate risk events. But reinsurance capacity may have its limit, particularly with the increase of climate risk worldwide, which reduces international diversification capacities.

Our period of analysis ends with the year 2021. Many extreme events have been observed in the P&C insurance industry since 2017, which was a record year. The years 2021 and 2022 were particularly expensive and have significantly affected both the insurance and reinsurance industries. Some reinsurance companies have been downgraded by rating agencies and others have reduced their participation in the extreme weather risk market. Reinsurance premiums are very high in 2023, and insurers are also leaving the market in high-risk states such as Florida. To date, 2022 was the third-highest for total insured costs, behind 2017 and 2005, according to Aon re (2023) and Munich re (2023). Total economic losses were $165 billion in the US, with about $100 billion in insured losses for 2022. It seems that the annual $100 billion in insured losses is becoming the standard, or perhaps even a minimum! Updates of the data and analyses from this paper will be needed to take into account the new trend in the severity of catastrophic events that began in recent years.

Before 2021, many reports described the US P&C insurance industry as overcapitalized. It is not clear that this will remain true in the future, when we look at insured costs since 2017. These costs are not only high, they repeat every recent year. The years 2005 and 2011 used to be considered outliers, with a low probability of recurrence. This does not seem to be the case anymore with the recent years, as we observe the climate changing.

Finally, another issue concerns the effect of climate risk on life insurance. In a recent SCOR analysis (2022), climate change risks are related to potential life liabilities in the long run. The relevance of climate change risks for life insurance liabilities depends mainly on the insurer's location in the world. For example, the study shows that climate change could generate additional US heat mortality over a time horizon of several decades. More research on the effect of climate risk on the life insurance industry also seems necessary.

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Appendix 1
Sources of capital in the US insurance industry

Table A1: Descriptive statistics, P&C insurance industry, 1990-2021

Variable in 10^{12} \$	N	Mean	Std	Min	Median	Max	Data source
Total capital	32	0.76830	0.24772	0.36562	0.75035	1.30444	NAIC
Reinsurance demand ratio	32	0.46390	0.03451	0.40622	0.47744	0.50991	NAIC
Liquidity creation ratio	32	-0.51560	0.02989	-0.58240	-0.51357	-0.45720	NAIC
Direct premium written	32	0.60237	0.09591	0.47176	0.61269	0.79358	NAIC
Net premium written	32	0.55145	0.07755	0.44708	0.55084	0.71815	NAIC
Premiums earned	32	0.53979	0.07403	0.44336	0.53749	0.69036	NAIC
MA	32	29.8125	9.82242	16	29	61	SDC
Catastrophic losses	32	0.02769	0.02363	0.00439	0.01747	0.08644	VERISK
CAT and ILS issued	25	0.00632	0.00413	0.00133	0.00630	0.01400	Artemis
ILS issued	25	0.00062	0.00063	-0.00019	0.00041	0.00212	Artemis
CAT issued	25	0.00561	0.00359	0.00132	0.00566	0.01251	Artemis

Note: Annual values in 2021$.

Table A1 presents the data and their sources for the 1990-2021 period when there are 32 observations. The period is 1997-2021 otherwise.

Table A2: Sources of capital in the US P&C insured industry, 1997-2021 (all variables)

Variable	With ILS		Without ILS	
	Parameter	*t*	Parameter	*t*
Intercept	–2.71144**	–4.95	–2.63371**	–5.01
Reinsurance demand	2.16704*	2.47	2.12044*	2.52
Liquidity creation ratio	–3.06447**	–6.32	–2.97884**	–6.30
Post-2012	0.09938**	3.25	0.09807**	3.38
Premium earned	1.61666**	5.15	1.57369**	5.14
MA	–0.00168	–1.48	–0.00151	–1.36
Catastrophic losses	0.60532	1.29	0.62122	1.38
Catastrophe bonds and ILS	6.67811	1.39	–	–
Catastrophe bonds	–	–	8.87143	1.75
Number of observations	25			
R-squared	0.9639		0.9660	
R-squared adjusted	0.9491		0.9520	

*p<0.05; ** p<0.01

We observe in Table A2 that MA, catastrophe losses, and ILS are not statistically significant to explain the sources of capital in the P&C insurance industry. Reinsurance demand and Premium earned are important sources of capital.

Table A3: Sources of capital in the US P&C insurance industry, 1997-2021 (significant variables only)

Variable	With ILS		Without ILS	
	Parameter	*t*	Parameter	*t*
Intercept	–2.66866**	–4.70	–2.61057**	–4.82
Reinsurance demand	2.57214**	2.94	2.51303**	3.01
Liquidity creation ratio	–2.68013**	–5.96	–2.62595**	–6.03
Post-2012	0.08954**	2.87	0.08965**	3.02
Premium earned	1.46227**	5.29	1.44937**	5.44
Catastrophe bonds and ILS	9.44476*	1.99	–	–
Catastrophe bonds	–	–	11.59059*	2.33
Number of observations	25			
R-squared	0.9566		0.9592	
R-squared adjusted	0.9451		0.9484	

*p<0.10; ** p<0.01

Table A3 presents a robustness analysis of results of Table A12 when we drop non-significant variables. P&C insurers significantly increased their capital after 2012 (Post2012).