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FEATURE ARTICLE

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Insurers' M&As in the United States during the 1990–2022 period: Is the Fed monetary policy a causal factor?

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Abstract

We investigate the causes of the gap in mergers and acquisitions (M&As) between life and nonlife insurers in the United States from 1990 to 2022. Our causality analysis indicates parallel trends between M&As in the life insurance and nonlife insurance sectors from 1990 to 2012, and a significant difference after 2012. There was a shock in the life insurance market that resulted in a reduction in M&As after 2012. Variable annuity sales and profitability in the life insurance sector declined after 2012. We find evidence that low interest rates observed after the implementation of the Fed's quantitative easing policy from 2008 to 2012 caused the difference in M&As between the life and nonlife sectors after 2012.

1 | INTRODUCTION

Understanding the effect of monetary policy on financial institutions is very important because these institutions play a key role in resource allocation and the welfare of countries. The insurance sector is among the main risk managers in the US economy, and the consolidation of this sector is an important source of economic stability.

This study is related to the literature on mergers and acquisitions (M&As) in the US insurance market. As indicated in the literature review below, recent contributions have provided evidence of the effect of low interest rates on life insurers' returns. However, to our knowledge, the causal link between monetary policy and mergers and acquisitions has not been

[Correction added on 19 December 2025, after first online publication: article category has been updated] studied. This link is very important because mergers and acquisitions have a great impact on the consolidation of an industry. Our first motivation is therefore to fill this gap in the literature. The main incentives for M&As are growth and expansion, synergies, diversification, and economies of scale. These incentives were quite absent for the potential acquirers in the studied time period, characterized by very low interest rates. It has often been documented that the deals creating the most value are those in the same industry, same country, and involving vertical integration. The number of acquisitions inside the US life insurance industry (US life acquirer and US life target) has dropped from an average of 20 from 2002 to 2012 to an average of less than 10 from 2013 to 2022. Our main research question is then: Was this drop in mergers and acquisition caused by low interest rates generated by the Fed monetary policy following the 2007–2009 financial crisis, particularly during the years 2008 to 2012?

The second motivation of our research is to establish a causal link between the above-mentioned monetary policy and mergers and acquisitions in the US life insurance industry. Causal analysis is essential to isolate both the factors that generate outcomes and the role of external shocks in resource allocation. Too many empirical analyses in the literature have limited their contribution to simple correlations with standard regression analysis. Not only may these correlations be bidirectional but, more importantly, they may not control for alternative confounding factors. We show that our results from the difference-in-differences (DID) methodology can only be due to the Fed's monetary policy. Finally, our results have important consequences for risk managers in different industries, including insurance and reinsurance. Risk managers and the Board must integrate the anticipated potential effects of macroeconomic policies in their future risk management planning. Regulators must also consider macroeconomic policies when setting their minimum capital requirements.

A significant decrease in M&As was observed after 2012 in the life insurance sector. We investigate the causes of the gap in M&As between life and nonlife insurers from 2013 to 2022. The nonlife insurance sector is considered as the control group while the life insurance sector is the target group. We first survey the M&A transactions observed in the US insurance market from 1990 to 2022 and select those transactions linked to US target insurers. We analyze the behavior of the two groups of insurers (life and nonlife) over time to determine whether there are any parallel trends between the M&A evolution of target insurers in these two sectors from 1990 to 2012. We then empirically test the difference between M&As in the United States life and nonlife insurance sectors after 2012, using the DID methodology and two more flexible models: synthetic control (SC) and synthetic DID (SDID).

Our analysis does not reject parallel trends between M&As in the life insurance and nonlife insurance sectors from 1990 to 2012, and confirms a significant difference after 2012. The analysis demonstrates that there was a shock in the life insurance market that resulted in the significant difference between M&As in the life and nonlife insurance sectors after 2012. The main reason for this decline in the life insurance sector is the decrease in variable annuity sales and the corresponding reduction in insurers' profitability. We find evidence that the low interest rates observed after the implementation of the Fed's quantitative easing (QE) policy from 2008 to 2012 caused the difference by reducing M&As in the life insurance sector after 2012.

At the end of the 2007–2009 financial crisis, US monetary authorities made a major shift to their monetary policy. Specifically, they bought large-scale assets to inject liquidity into the economy through the QE policy. By implementing this policy, the Fed kept its key interest rate at a very low level, for long enough. The QE policy was implemented from 2008 to 2012, and low interest rates were maintained for many years after that. During the QE1 phase, the 10-year Treasury yield dropped 107 basis points. Other significant declines were observed in the QE2 and QE3 phases. In 2012, a plan to increase long-maturity Treasury security holdings to $45 billion per month was implemented. As a result, variable annuity products became less attractive to investors, leading to a decline in sales after 2012. In addition, many insurers increased their fees, and others stopped offering minimum return guarantees in response to falling interest rates, as this risk management policy became very expensive. Others left the variable annuities market. This accentuated the decline in sales after 2012. We analyze in detail how the monetary policy affected this decline in the life insurance market after 2012, following the low interest rates resulting from the implementation of the QE policy. This policy not only affected potential targets in M&A transactions but also potential acquirers in the life insurance sector.

Our research contributes to the mergers and acquisitions literature by adding monetary policy as a key factor for explaining the relative evolution of mergers and acquisitions in an important industry. The results indicate that in insurance, and possibly other industries, managers must integrate the potential effects of monetary policy in their future risk management planning. Regulators must also consider the sensitivity of regulated firms to monetary policy when introducing and monitoring new capital requirements. These requirements should become more dynamic in relation to macroeconomic events.

The rest of the paper is organized as follows. Section 1 reviews the main contributions in the literature on mergers and acquisitions in the insurance sector. We also discuss the effects of monetary policy on the insurance sector. Section 2 analyzes the main characteristics of the US insurance market during the 1990–2022 period. Section 3 presents the evolution of M&As in the US insurance market from 1990 to 2022, while Section 4 is dedicated to observed stylized facts and our research design. Section 5 presents the parallel trends analysis. We then perform the causality analyses in Section 6 and analyze the effects of the 2012 shock in the life insurance sector on M&As in Section 7. Section 8 concludes the paper. Additional information is available in a Supporting Information S1: Online Appendix.

2 | LITERATURE REVIEW

2.1 | Rationale for M&As

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 3 years after the M&A (Boubakri et al., 2008; Cummins & Xie, 2008; Cummins et al., 1999).

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 & Tennyson, 1998), to reduce their riskiness, and/or to improve the amount/timing of their cash flow streams (Cummins & Weiss, 2004). Estrella (2001) findings refute the risk-reduction argument from transactions between different industries. Indeed, the article shows that the median probability of failure resulting from combinations of two property-casualty firms is lower than from a combination of a property-casualty firm and a bank holding company.

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. Akhigbe and Madura (2001) document a higher positive and significant market effect for acquirers that are nonlife 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. 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.

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 (Boubakri et al., 2008; Denis & McConnell, 2003; Roll, 1986). Hence, a negative impact on the bidder's firm value could be observed. Results relating to CEO characteristics indicate that the percentage of shares held by the CEO and the CEO duality (CEO and board chair) are significantly and negatively related to the bidder's long-run performance, which is consistent with managerial entrenchment theory related to CEO ownership. For such behavior to be constrained, effective governance mechanisms must be put in place (Moeller & Schlingemann, 2005; Rossi & Volpin, 2004). Asymmetric information between acquiring firms on particular targets can also affect M&A activities by modifying the premiums of different deals (Betton et al., 2009; Brockman & Yan, 2009; Dionne et al., 2015).

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 their market. The results of Floreani and Rigamonti (2001) support this argument. Specifically, they demonstrate that transactions involving insurance partners that are both located in 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 & Weiss, 2004)—a result not supported by Floreani and Rigamonti (2001). In Supporting Information S1: Online Appendix A, we present a detailed analysis of various contributions on mergers and acquisitions in the insurance industry by focusing on their methodology. Very few contributions used causality analysis.

2.2 | Monetary policy and insurance

Pelizzon and Sottocornola (2018) studied the effect of QE monetary policies on insurance markets with an emphasis on European insurers. They indicate that extremely low interest rates constitute a major source of risk for life insurers and, particularly, for those offering financial products with guaranteed rates of return. Their event study shows, however, a moderate negative effect of the European QE policy on the insurance industry. Other researchers verified that German insurers had difficulty meeting the Solvency II capital requirements following the QE policy (Berdin & Gründl, 2015).[1]

[1]See also Holsboer (2000) and Wedow and Kablau (2011) on the effect of low interest rates on German insurers.

TABLE 1 Summary of the different insurance categories in our two groups.

Nonlife insurance			Life insurance
Property damage and miscellaneous risks	Civil liability	Health insurance	Life insurance and annuities
Coverage for movable and immovable property belonging to the insured	Coverage for damage of any kind caused by the insured to third parties	Coverage for medical services to the insured	Guarantees in the event of the insured's life or death; annuities
Insurers with SIC codes 6321, 6324, 6331, 6351, 6361, and 6399.			Insurers with SIC code 6311

Note: This table presents the divisions of the two main insurance sectors in the United States along with their SIC codes.

Koijen and Yogo (2021) analyzed the effect of minimum return guarantees on life insurers. Variable annuity insurers offering put options to guarantee minimum returns to their clients become risk managers that are exposed to low-interest risk. The authors discuss potential regulatory changes to ensure more stability in the life insurance sector. On variable annuity risks, see also Chahboun and Hoover (2019), Egan et al. (2021), Gagnon et al. (2011), Verani and Yu (2021), and Gatzert and Schmeiser (2025). None of these studies has related low interest rates to mergers and acquisitions in the insurance industry.

3 | THE US INSURANCE MARKET

The insurance industry comprises three main sectors. The first is property and casualty insurance (P&C). It covers property damage and miscellaneous risks (coverage for the insured's movable and immovable property) and civil liability (coverage for damage of all kinds caused by the insured to third parties). The second sector is health insurance. It covers medical services received from different providers. The third sector is life insurance (Life insurance coverage and Life annuity contracts). In our analysis, target insurers with SIC code 6331 are insurers in the P&C market.[2] Target insurers with SIC codes 6321 and 6324 are insurers corresponding to the Health insurance market (Accident and Health Insurance, and Hospital and Medical Service Plans). Target insurers with SIC code 6311 are from the life insurance market (Life). Table 1 summarizes the division of insurance sectors.

We first group the three insurance sectors into two major groups, according to the way in which insurance is managed and the duration of the contract: (1) life insurance, made up of the life insurance sector (Life) and (2) nonlife insurance (Nonlife), made up of the property and casualty insurance sector and the health insurance sector. This classification is often used by the OECD to distinguish between the life and nonlife insurance sectors. This separation simplifies the DID application, although it is not necessary, as we will see in the robustness analysis, where we consider the three groups separately with two control groups and one treatment group.

[2]Surety Insurance (6351), Title Insurance (6361), and Insurance Carriers Not Elsewhere Classified (6399) are included in the P&C sector.

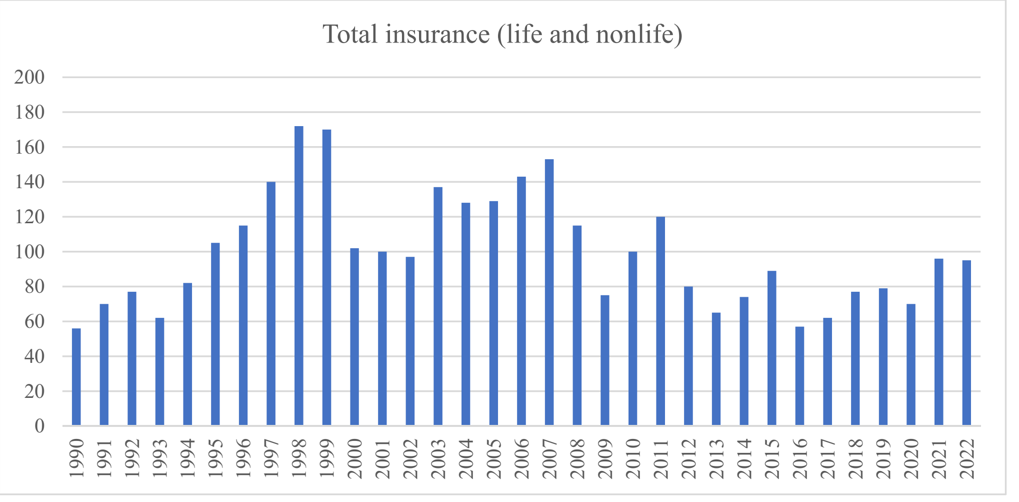

FIGURE 1 Histogram of the annual number of M&A transactions related to US target insurers. This figure presents the temporal evolution of the annual numbers of M&A transactions in the total insurance industry from 1990 to 2022. The vertical axis indicates the number of annual M&A transactions and the horizontal axis indicates the corresponding years. The data source is the SDC database, which provides information on all mergers and acquisitions of insurance firms.

4 | M&A TRANSACTIONS RELATED TO US TARGET INSURERS FROM 1990 To 2022

From the Securities Data Company (SDC) Platinum database, we identify 3366 M&A transactions related to US target insurers (public and private) from 1990 to 2022. 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 33 years. There was strong M&A growth until the years 1997 to 1999, when the market reached its first peak since 1990.

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 for the US insurance industry during the period of analysis. The record years of 1998 and 1999 have not been broken ever since. In fact, this period corresponds to the Internet and new technology growth of 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. The post-2012 period is less active, with a partial recovery in 2021 and 2022.

Figure 2 depicts three peaks of M&As across all industries in the United States (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 nonlife 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-2012 period is marked by a behavioral shift among

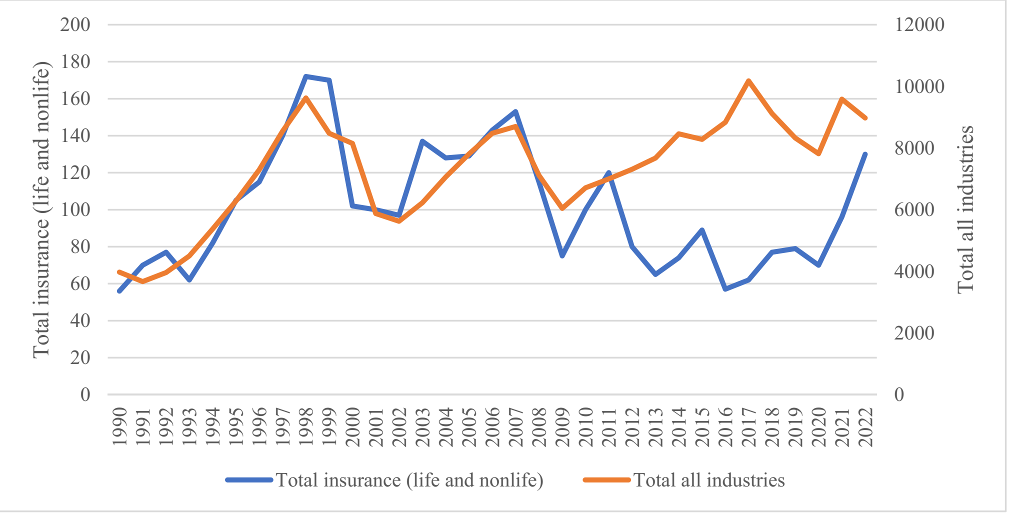

FIGURE 2 M&A trends in the US insurance industry (total M&A for nonlife and life targets, left) and for all industries in the United States (right). The left vertical axis indicates the total annual numbers of M&A transactions in the US insurance industry while the right vertical axis indicates the total annual numbers of M&A transactions in all US industries. The horizontal axis indicates the corresponding years.

insurers across the US insurance industry where the total yearly number of mergers and acquisitions is below 80 for many years until 2021.

Figure 3 presents the evolution of the annual numbers of M&As in the three insurance lines, and Table 2 summarizes their main statistics. Property and casualty insurers and health insurers appear to be more similar to each other than to life insurers. We also observe a large reduction in M&As in the life sector after 2012.

As already mentioned, we consider that the US insurance industry consists of two main lines of business: life insurance and nonlife insurance, the latter including P&C insurance and health insurance. Given that the two main lines of insurance can be affected differently by market conditions, life expectancy, and climate risk, we have plotted the M&A transactions recorded in each of these two lines to analyze their behavior in relation to the target insurer M&A activity. Figure 4 shows the evolution of M&As in each of the two main US insurance lines over the period of 1990 to 2022. We confirm the strong decrease in M&As in the life insurance industry after 2012, while this activity seems more stable in the nonlife insurance sector during the years 2012 to 2021.

Figure 4 also shows a parallel time trend in the evolution of target insurer M&As for life and nonlife insurance from 1990 until 2009 and even 2012 (see the corresponding Table B1 in Supporting Information S1: Online Appendix B). This result suggests that the evolution of target insurer M&As in the nonlife 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. The choice of the treatment date for our DID method thus seems ambiguous. Based on Figure 4, we select the years 2009 and 2012 as potential candidates for a treatment date in our analysis with the DID method. We will use, in Section 5, statistical tests to validate the year that best suits our data.

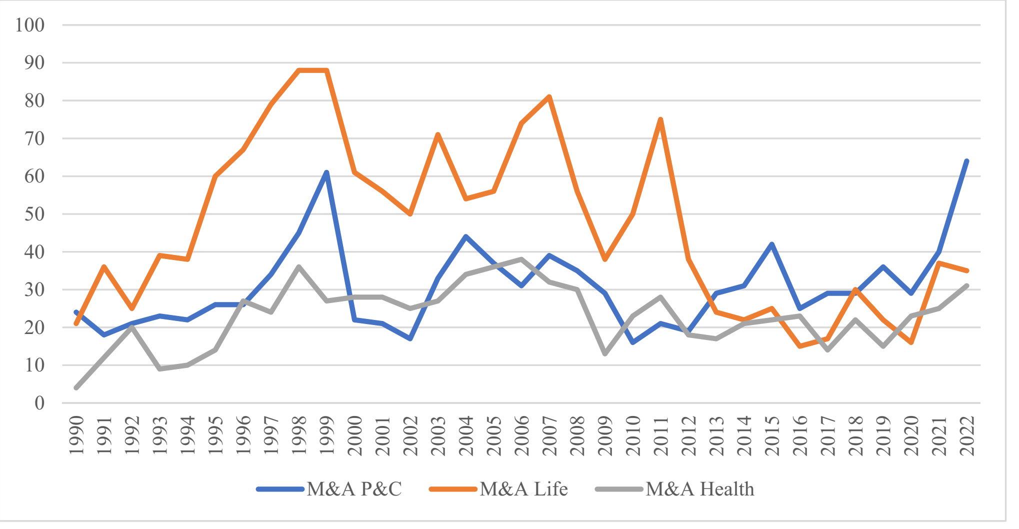

FIGURE 3 M&A trends of target insurers in the three insurance sectors. The vertical axis indicates the number of M&A transactions in each of the three insurance sectors. The horizontal axis is for the corresponding years. We observe the temporal evolution of mergers and acquisitions in the three main US insurance sectors between 1990 and 2022. The annual number of M&A in the life insurance industry dropped significantly to less than 30 after 2012, while those in the two other sectors remained quite constant. The data source is the SDC database.

TABLE 2 Annual mean and standard deviation of the M&A in each sector.

	1990–2022		1990–2012		2013–2022	
Period	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
P&C sector	30.848	11.353	28.870	10.981	35.400	11.423
Life sector	46.788	22.342	56.565	19.294	24.300	7.660
Health sector	22.909	8.402	23.609	9.524	21.300	5.012

Note: This table presents the mean and standard deviation of the number of M&A in three subperiods between 1990 and 2022. As seen in the table, the mean and standard deviation decreased significantly in the life insurance sector after 2012 while they remained quite stable in the P&C sector and the health sector. The data source is the SDC database.

5 | STYLIZED FACTS AND RESEARCH DESIGN

In this section, we describe the basic stylized facts on the relation between low interest rates and profitability in the variable annuity market, and we motivate the causality analysis to show the QE monetary policy was a causal factor to separate trends in mergers and acquisitions between life and nonlife insurance sectors.

We now turn to our main identification strategy, a DIDs strategy using a quasi-natural experiment. Specifically, we exploit the large decline in interest rate after the 2007–2009 financial crisis as our event of interest. As can be seen in Figure 5 interest rates decreased significantly after 2007 and 10-year T-bonds rates remained below 3% after 2012. The decline in T-bonds interest rate became very costly for insurers offering variable annuities with a guaranty return of 3%.

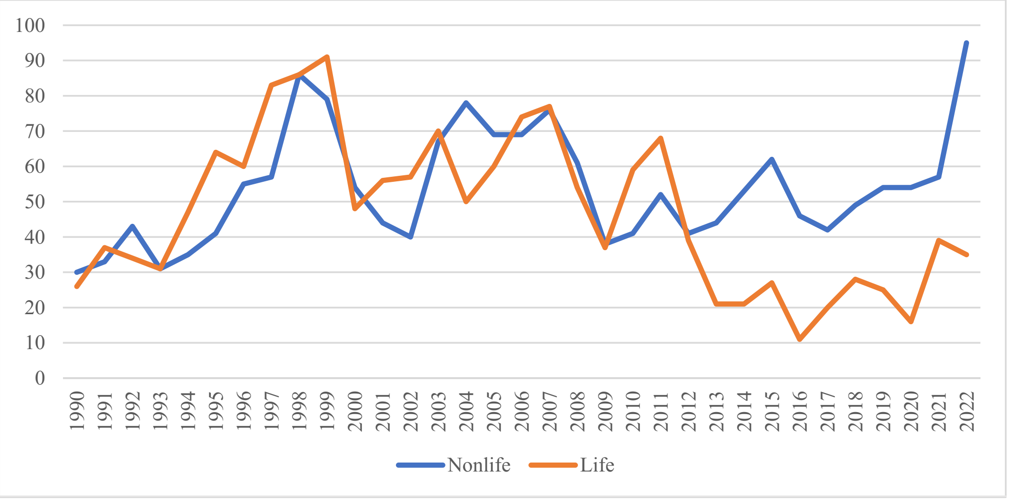

FIGURE 4 M&A trends of target insurers in the two main US insurance sectors (life and nonlife) in the United States during the 1990–2022 period. The vertical axis indicates the number of M&A transactions of target insurers in the life and nonlife insurance sectors while the horizontal axis indicates the corresponding years. This figure clearly shows a separation between the two sectors after 2012 while we observe parallel trends before 2012. The data source is the SDC database.

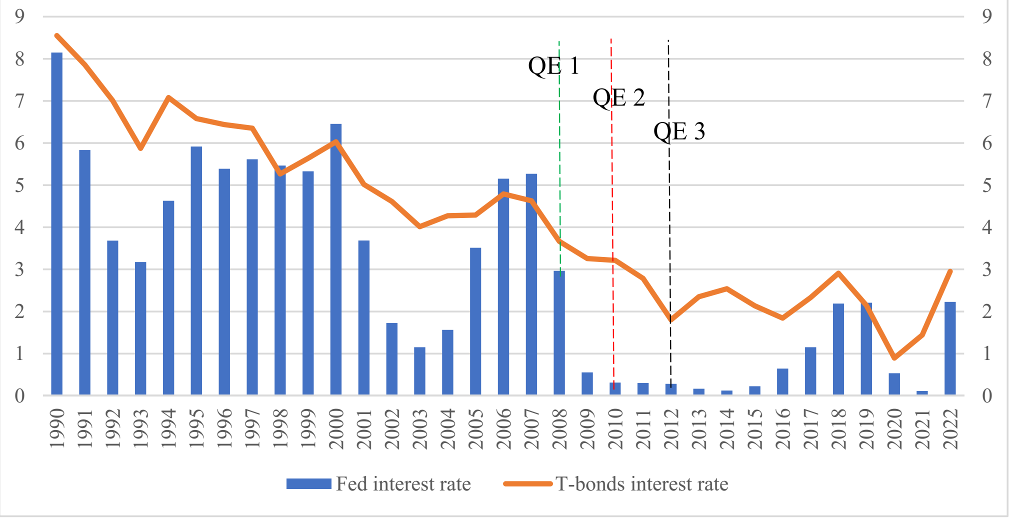

FIGURE 5 Trends in the Fed interest rate and 10-year T-bonds interest rate in the United States, 1990–2022. The vertical axis indicates the Fed interest rates and the T-bonds interest rates while the horizontal axis indicates the corresponding years. The three phases of the QE were the following: QE1 in 2008, QE2 in 2010, and QE3 in 2012. In addition, the Fed implemented an operation twist mechanism in 2011 to keep long-term interest rates low for an additional amount of time. This operation was extended in 2012. The data source is the World Bank database.

5.1 | Interest rate policy and annuity sales in the post-2012 period

Following the financial crisis of 2007–2008, the US monetary authorities made a major shift in their monetary policy. This involved the purchase of large-scale assets to inject liquidity into the economy through QE policies. Specifically, the Fed applied three major QE measures. First, between early 2008 and March 2010, it purchased $1750 billion in long-term securities under QE1 ($1.25 trillion in Mortgage-backed securities (MBS), $300 billion in Treasury securities, and $200 billion in debt securities issued by federal agencies). In late November 2010, the Fed announced its intention to make additional purchases of long-term government securities worth $600 billion under QE2, which ended in June 2011. QE3 was launched on September 13, 2012, with monthly purchases of $40 billion in MBS and a plan to increase long-maturity Treasury security holdings to $45 billion per month. By implementing a policy of quantitative easing, the Fed demonstrated its determination to keep the Fed interest rate low enough, for long enough. Figure 5 clearly illustrates the impact on interest rates of the three major QE measures implemented in the US after the 2007–2009 financial crisis.[3] Finally, in 2011, the Fed implemented an operation twist mechanism, as a complement to the QE policy, by lowering long-term interest rates while continuing to keep short-term interest rates near zero for a few years. The operation twist of 2011 was extended in June 2012 through 2012.

As mentioned above, by implementing QE, the Fed demonstrated its determination to keep the Fed rate low enough for long enough. If life insurers had found this commitment credible, they should have anticipated low short-term interest rates for many months after 2012. They should also have anticipated long-term interest rates to fall, given that long rates reflect expected short-term interest rates. For example, according to Gagnon et al. (2010) and Chung et al. (2011), the Fed's injection of liquidity via its program of purchasing long securities between the end of 2008 and March 2010 have caused long-term rates to fall by around 50 basis points. Figure 5 supports the idea that QE measures caused short-term and long-term interest rates to decline from 2008 to 2012.

Figure 5 also shows that the third QE measure, implemented in 2012, was very noteworthy because the 10-year T-bonds reached a level of 2% for the first time, well below the critical level of 3% significant for the variable annuity markets. The 3% rate is often a guarantee on the minimum interest rate on 10-year T-bonds, used to calculate the value of variable annuities in the United States (Berends et al., 2013). Indeed, variable annuity contracts often include a guarantee on the minimum interest rate used to preserve their value. This guarantee entitles the insured to their accumulated value at a minimum interest rate of 3%. In other words, when the 10-year T-bonds interest rate falls below 3%, as was the case between 2012 and 2022, the insured holding this put option continues to receive an investment return of 3%, with the difference being the interest rate management costs borne by the insurer. To cover the costs of integrated guarantees, insurers charge additional fees to policyholders.

In 2010, 95% of life insurance contracts contained a minimum interest rate guarantee of 3% and 70% of annuity contracts had a minimum of 3% and higher. See Appendix E for more details. Variable annuities started in the 1980. They are like mutual funds offering tax advantage and minimum return guarantee. The minimum guarantee is a kind of long-term put option offered by insurers to their clients because variable annuities are much more risky than fixed annuities (Koijen & Yogo, 2021). The main source of revenue to insurers for managing this risk is long-term bonds. The risk management activity is partial, however, because bonds and options maturities are shorter than annuity maturities with guarantied revenue. This asset-

[3] On the effects of QE policy (see Bonis et al., 2017; D'Amico & King, 2013; D'Amico et al., 2012; Engen et al., 2015; Gagnon et al., 2011; Hamilton & Wu, 2012; Krishnamurthy & Vissing-Jorgensen, 2011; Meaning & Zhu, 2011, 2012; Sun et al., 2018; Swanson, 2011).

liability mismatch may also increase risk volatility for insurers. An annual fee is charged to the insured for the option.

5.2 | Research design

To study the causal effect of QE monetary policy on the life insurance sector, we use an identification strategy based on monetary policy shocks following the 2007–2009 financial crisis. For identification of the parallel trends loss between life and nonlife insurers, as illustrated in Figure 4, we exploit interest rate shocks resulting from Monetary policies due to lack of liquidity in financial markets following the 2007–2009 financial crisis. Our goal is to verify that the QE monetary policy is the principal determinant of variable annuity market losses in the life insurance sector after 2012. Life insurers that suffered these shocks lose money, reduced the supply of variable annuities, or exited the market.

We next test the main hypothesis of the theory using an identification strategy by focusing on decreases in interest rates attributable the QE monetary policy. We test 2012, the year of the QE3 monetary policy, as the treatment year and define life insurers exposed to variable annuity risk following the QE monetary policy, as treated institutions. P&C and Health insurers were not exposed to this variable annuity risk and represent the control group.

We observed that treated institutions reduced exposure to variable annuity market and lose money economically and statistically after 2012. Indeed, treated institutions variable annuity sales declined by as much as one-half after 2012 and their profitability was significantly reduced. This result supports the hypothesis that low interest rates following the QE monetary policy affected significantly the profitability in the life insurance sector. We then show that the monetary policy reduced significantly the number of mergers and acquisitions in the life insurance sector after 2012.

Finally, we show that our stylized facts are robust to controlling for three confounding factors. We emphasize that our results from the DID methodology cannot be due to alternative explanations for several reasons. First, since climate risk events are mainly related to the P&C market, we document these events did not affect significantly M&As market during the study period. In fact, M&A activity remained stable after 2012 in this insurance sector. P&C insurers covered the additional losses due to climate risk by increasing insurance premiums and buying more reinsurance (Dionne & Desjardins, 2022). Second, we show that changes in life expectancy, more related to the life insurance market, had no effect on the variation of mergers and acquisitions during the period of analysis. Third, our results cannot be due to variations in regulation of insurers risk management following the 2007–2009 financial crisis because the new capital regulations for solvency, after the financial crisis, were set up at the same time in both the control group and the treatment group.

6 | VALIDATION OF THE SELECTED TREATMENT DATE AND THE PRESENCE OF PARALLEL TRENDS

Based on Figure 4, we have identified 2 years in which the parallel trends observed between our two groups began to disappear: 2009 and 2012. We define our treatment effect as a difference between the average number of M&As per year of target insurers in the life insurance sector and the average number of M&As of target insurers in the nonlife insurance sector.

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 M&A data in the two insurance sectors (Dionne, 2025; Imbens & Wooldridge, 2009; Roberts & Whited, 2012). We first calculate the annual difference between the number of M&As of target insurers in the life insurance sector versus the number of M&As of target insurers in the nonlife insurance sector, as observed over our entire study period, that is 1990 to 2022. Next, we calculate the mean and median of the difference between the number of target insurer M&As in the life insurance sector and the number of target insurer M&As in the nonlife insurance sector over the pretreatment period (including the year of the candidate date) and over the posttreatment period, for each of our two selected candidate dates (2009 and 2012). Finally, we perform five statistical tests—the mean statistical test (Student), the median statistical test, the Wilcoxon test, the monotonicity hypothesis, and the median-criteria test—to validate the choice of treatment date.

6.1.1 | Three basic tests

The results of the first three tests are presented in Table C1 (Supporting Information S1: Online Appendix C), where the differences between various statistics are presented. Our first decision criterion for the choice of treatment date is to test the null hypothesis (H0) that the average number of M&As in the nonlife sector and the average number of M&As in the life sector are statistically similar (Student's test) over the period from 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 nonlife sector and the average number of M&As in the life sector are statistically different over the posttreatment date period (post-2009 or post-2012) due to the treatment effect. We also test the null hypotheses for the median and with the Wilcoxon (or distribution) test. According to the analysis presented in Supporting Information S1: Online Appendix C, the three tests cannot discriminate between the two periods (1990–2009 vs. 1990–2012).

6.1.2 | Monotonicity hypothesis

We employ an additional criterion, the monotonicity hypothesis, to evaluate the treatment effect. Imbens and Angrist (1994) proposed a definition of monotonicity for the identification of treatment parameters. This definition requires that responses to treatment are uniform toward the same choices. In other words, the control group is always untreated, and the treatment group only moves one time from untreated to treated. This hypothesis postulates that when there is a change, the treatment effect can only go in 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 6.

Figure 6 clearly shows a large difference between the number of M&As of target insurers in the nonlife insurance sector compared to 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 difference between the number of M&As per year of target insurers in the

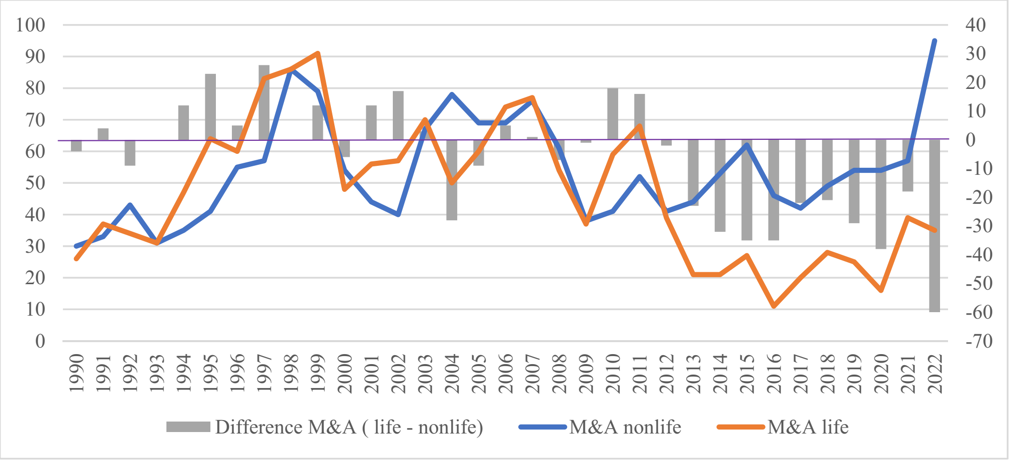

FIGURE 6 Evolution of the number of M&As per year in each of the two insurance sectors (nonlife and life, left) and their difference (in histogram, right). The left vertical axis indicates the numbers of M&A per year in the life and nonlife insurance sectors. The right vertical axis indicates their differences. The horizonal axis indicates the corresponding years. The histogram shows the differences between mergers and acquisitions in life and nonlife sectors. The difference becomes negative in 2012 and remains negative in all years after 2012 while it is still positive in 2010 and 2011. The data source is the SDC database.

life insurance sector and the number of M&As of target insurers in the nonlife insurance sector, is negative for each year of the post-2012 period (10 years with a negative difference vs. 0 years with a positive difference). In other words, 2012 changes the treatment effect in only one direction (negative difference) for each of the years in the post-2012 period. This affirms the monotonicity hypothesis. By contrast, Figure 6 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 (11 years with a negative difference vs. 2 years with a positive difference). This violates the monotonicity hypothesis. In conclusion, because only the year 2012 meets the monotonicity condition, we select the year 2012 as the treatment date for our DID method with this hypothesis.

6.1.3 | Median-criteria test

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 applied a median-based statistical criterion.

This allows us to define a selection criterion whereby the treatment effect for each of the years in the posttreatment period (post-2009 or post-2012) is lower than the median value of the difference between the number of M&As per year of target insurers in the life insurance sector and the number of M&As of target insurers in the nonlife insurance sector over our entire study period (1990 to 2022), which is equal to −2 (see Table C1 in Supporting Information S1: Online Appendix C). This criterion also supports the choice of 2012 as the treatment date for our DID method. As can be seen in Figure 6, the negative difference between the number of M&As per year of target insurers in the life insurance sector and the number of

M&As of target insurers in the nonlife insurance sector is lower than the median value of our entire study period (1990–2022) for each of the years in the post-2012 period. This is not the case for the post-2009 period, where we observe a positive difference for the years 2010 and 2011, which is thus higher than the median of the entire sample.[4] Therefore, our median-based criterion rejects the choice of the year 2009 as the treatment date for our DID method.

6.2 | Parallel trends analysis

We now perform a validation test for the presence of parallel trends before 2013. To do this, we first create 33 dummy variables for each of the years in the period of 1990 to 2022. Then, we define a dummy variable $\text{Treated}_{\text{L}}$ equal to 1 for the treated group. We also create 33 interaction variables between the Treated dummy and the year dummy for each year from 1990 to 2022. Finally, we regress our dependent variable, number of M&S per year and state in the two insurance sectors, on our 33 $\text{Treated}_{\text{L}} \times \text{Year}$ interaction variables in each of the 51 states and 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 the left section of Table 3, with 3366 observations ($33 \times 51 \times 2$) for the main test.

The results of our regressions validate the presence of parallel trends before the end of 2012. As can be observed, the coefficients obtained are overall not statistically significant for the pretreatment period. Our F-test supports this result. It shows that the F-statistic on our $\text{Treated}_{\text{L}} \times \text{Year}$ interaction variables before and at the treatment date (1990–2012) is $F(23, 2250) = 1.10$ with a probability $\text{Prob} > F = 0.3338$. We do not reject the null hypothesis at 5%. By 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, at 10%). Our F-test supports this result: $F(9, 1009) = 5.87$ with $\text{Prob} > F = 0.0000$. We reject the null hypothesis at 5% and can thus say that the coefficients considered as a whole are significant over the post-2012 period. These results validate our parallel trends test econometrically and thus confirm the choice of the year 2012 as the treatment year to be selected for our DID method.

The standard DID relies on the parallel trends assumption, suggesting that, in the absence of the treatment, both groups would have experienced the same outcome trends. However, recent studies have revealed that the standard parallel trends methodology may be a questionable modelling assumption and that pretrend tests may come with caveats (see, e.g., Kahn-Lang & Lang, 2020; Rambachan & Roth, 2023; Roth, 2022).

Although, the F-test does not reject the null hypothesis that the annual coefficients between 1990 and 2012 (in the left section of Table 3) are jointly not statistically significant at the conventional 5% level, we observe that some of them are statistically different from zero. We then follow the recommendation of Roth (2022) and run a dynamic event-study style regression that regresses the number of M&As with State and Year fixed effects (c_i and η_t), as well as dummies for time relative to 2012 which is the treatment year interacted with the treatment status ($\mathbb{1}[s = t] \times D_i$). D_i takes the value of one for Life insurers and 0 for nonlife insurers. 2011 is used as a reference year and its coefficient is normalized to zero. The regression is as follows:

[4]The negative value for 2012 is −2, as documented in Table B1 in Supporting Information S1: Online Appendix B.

TABLE 3 Parallel trends analysis for DID validation test of M&A in each state, each year, and each sector.

Parallel trends			Robustness regression		
Independent variable	Coefficient	Standard error	Independent variable	Coefficient	Standard error
$Treated_L \times Year1990$	−0.078	(0.100)	$Treated_L \times Year1990$	−0.392	(0.267)
$Treated_L \times Year1991$	0.078	(0.146)	$Treated_L \times Year1991$	−0.235	(0.267)
$Treated_L \times Year1992$	−0.176	(0.115)	$Treated_L \times Year1992$	−0.490	(0.296)
$Treated_L \times Year1993$	−1.81e−17	(0.147)	$Treated_L \times Year1993$	−0.314	(0.305)
$Treated_L \times Year1994$	0.235*	(0.138)	$Treated_L \times Year1994$	−0.078	(0.248)
$Treated_L \times Year1995$	0.451***	(0.134)	$Treated_L \times Year1995$	0.137	(0.267)
$Treated_L \times Year1996$	0.098	(0.195)	$Treated_L \times Year1996$	−0.216	(0.351)
$Treated_L \times Year1997$	0.510***	(0.147)	$Treated_L \times Year1997$	0.196	(0.289)
$Treated_L \times Year1998$	−1.45e−16	(0.190)	$Treated_L \times Year1998$	−0.314	(0.326)
$Treated_L \times Year1999$	0.235	(0.156)	$Treated_L \times Year1999$	−0.078	(0.357)
$Treated_L \times Year2000$	−0.118	(0.114)	$Treated_L \times Year2000$	−0.431	(0.310)
$Treated_L \times Year2001$	0.235	(0.142)	$Treated_L \times Year2001$	−0.078	(0.304)
$Treated_L \times Year2002$	0.333**	(0.160)	$Treated_L \times Year2002$	0.020	(0.317)
$Treated_L \times Year2003$	0.059	(0.194)	$Treated_L \times Year2003$	−0.255	(0.353)
$Treated_L \times Year2004$	−0.549***	(0.180)	$Treated_L \times Year2004$	−0.863***	(0.327)
$Treated_L \times Year2005$	−0.176	(0.152)	$Treated_L \times Year2005$	−0.490	(0.329)
$Treated_L \times Year2006$	0.098	(0.147)	$Treated_L \times Year2006$	−0.216	(0.341)
$Treated_L \times Year2007$	0.020	(0.155)	$Treated_L \times Year2007$	−0.294	(0.313)
$Treated_L \times Year2008$	−0.137	(0.160)	$Treated_L \times Year2008$	−0.451	(0.318)
$Treated_L \times Year2009$	−0.020	(0.113)	$Treated_L \times Year2009$	−0.333	(0.282)

(Continues)

TABLE 3 (Continued)

Parallel trends			Robustness regression		
Independent variable	**Coefficient**	**Standard error**	**Independent variable**	**Coefficient**	**Standard error**
$Treated_L \times Year2010$	0.353***	(0.114)	$Treated_L \times Year2010$	0.039	(0.287)
$Treated_L \times Year2011$	0.314**	(0.154)	$Treated_L \times Year2011$	–	–
$Treated_L \times Year2012$	−0.039	(0.155)	$Treated_L \times Year2012$	−0.353	(0.241)
$Treated_L \times Year2013$	−0.451***	(0.127)	$Treated_L \times Year2013$	−0.765***	(0.260)
$Treated_L \times Year2014$	−0.627***	(0.127)	$Treated_L \times Year2014$	−0.941***	(0.283)
$Treated_L \times Year2015$	−0.686***	(0.129)	$Treated_L \times Year2015$	−1.000***	(0.296)
$Treated_L \times Year2016$	−0.686***	(0.132)	$Treated_L \times Year2016$	−1.000***	(0.295)
$Treated_L \times Year2017$	−0.431***	(0.102)	$Treated_L \times Year2017$	−0.745**	(0.313)
$Treated_L \times Year2018$	−0.412**	(0.151)	$Treated_L \times Year2018$	−0.726**	(0.287)
$Treated_L \times Year2019$	−0.569***	(0.111)	$Treated_L \times Year2019$	−0.882***	(0.266)
$Treated_L \times Year2020$	−0.745***	(0.154)	$Treated_L \times Year2020$	−1.059***	(0.271)
$Treated_L \times Year2021$	−0.353*	(0.193)	$Treated_L \times Year2021$	−0.667**	(0.315)
$Treated_L \times Year2022$	−1.176***	(0.202)	$Treated_L \times Year2022$	−1.490***	(0.317)
Constant	1.055***	(0.023)	Constant	N	N
State fixed effect	Y	Y	State fixed effect	Y	Y
Year fixed effect	Y	Y	Year fixed effect	Y	Y
Double SE clustering	State/Year	State/Year	SE clustering	State	State
Observations	3366			3366	
Adjusted R-squared	0.525			0.536	

Note: This table presents the parallel trends analysis between life and nonlife insurance sectors. Robust standard errors are documented. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. We do not reject the parallel trends hypothesis during the 1990–2012 period. The data source is the SDC database.

$$\text{Nbr M \& A}_{\text{it}} = c_i + \eta_t + \sum_{s \neq 2011} \beta_s \times \mathbb{1}[s = t] \times D_i + \epsilon_{it}, \tag{1}$$

where β_s is the event study coefficient for the year s. β_s could be interpreted as the difference between the average outcomes (average number of M&A by State) across treated and control groups and between the year s and the reference year 2011. The sequence of β_s across the different years corresponds to the difference in trends between treated and control groups relative to the reference period 2011.

The test of the plausibility of the parallel trend assumption consists of testing whether there are significant pretreatment differences in trends between the two groups, namely if β_s are individually and jointly significant. Interestingly, the right-hand section of Table 3 shows that the pretreatment coefficients are individually insignificant except for the year 2004, and that all the posttreatment coefficients are individually highly significant. We also run a F-test of joint significance for the pretreatment coefficients for the years 1990 to 2012 and we find a value of 0.16 which confirms that these coefficients are jointly insignificant. This finding validates the parallel trend assumption because it appears that there is not a difference in trends between the average number of M&A by State during the pre-period. It validates also the no anticipation assumption, in the sence there is no effect of the treatment on the treated during the pre-period.

In Supporting Information S1: Online Appendix F, we also show that our parallel trend analysis is also robust to the new tests proposed by Roth et al. (2023) and Rambachan and Roth (2023). Our panel is long and large enough to construct weights that make trends parallel.

7 | CAUSALITY ANALYSIS

7.1 | Variable descriptions

7.1.1 | Introduction

To isolate a causal effect related to the separation of life and nonlife insurers' M&As observed after 2012, we have opted, in a first step, for a natural experiment method using the standard DID method. This method is based on two groups: insurers who have received treatment (treatment group) and insurers who have not received treatment (control group). We will also consider three groups in the robustness analysis and two more flexible approaches, the SC model and the SDID model.

7.1.2 | Variables

Given that the purpose of our study is to explain the relative decline in M&As in the US life insurance sector, we have chosen life insurers as our treatment group. We determine the dichotomous variable $\text{Treated}_{\text{L}}$ as equal to 1 for the treatment group and 0 for the control group.

We have created an interaction variable between our two variables of interest, $\text{Treated}_{\text{L}}$ and Post2012, to assess the impact of the treatment on the units in our treatment group. Our interaction variable, $\text{Treated}_{\text{L}} \times \text{Post2012}$, enables us to capture the effect of the treatment administered to the units in the treatment group.

TABLE 4 Description of explanatory variables.

Explanatory variable	Construction method
Treated_L (dichotomous)	Treated_L variable equal to 1 for the treatment group (life insurance sector) and 0 for the control group (nonlife insurance sector).
Post2012 (dichotomous)	Post2012 variable (including the treatment date) that takes the value 0 if the period is before the treatment and the value 1 if the period is after the treatment.
$\text{Treated}_\text{L} \times$ Post2012 (dichotomous)	$\text{Treated}_\text{L} \times$Post2012 interaction variable that captures the effect of the treatment administered to units in the treated group (the life insurance sector) after the treatment.

Note: This table describes the main explanatory variables in the DID estimation and their construction method.

Table 4 provides a detailed description of the explanatory variables introduced into our model (2), together with their construction method. The goal is to use the DID method to empirically verify the difference between M&As in the life and nonlife insurance sectors in the United States.

We posit that the shock that occurred in 2012 weakened the life insurance business performance of insurers (targets and acquirers) in the life insurance sector in the post-2012 period. This weakening has resulted in a decline in the number of M&As per year among targets in the life insurance sector relative to the nonlife insurance sector in the post-2012 period. We expect a negative sign for the coefficient of the variable $\text{Treated}_\text{L} \times$Post2012 on the number of M&A targets per state and per year.

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

$$\text{Nbr M\&A}_{\text{it}} = \alpha_0 + \alpha_1 \text{Treated}_\text{L} \times \text{Post2012} + c_i + \eta_t + \epsilon_{\text{it}}, \tag{2}$$

where Nbr $\text{M\&A}_{\text{it}}$: number of M&As in state i at date t in each sector; $\text{Treated}_\text{L} \times \text{Post2012} = 1$ for the treatment group after the treatment period; $= 0$ otherwise; c_i is the individual effect for state i; η_t is the temporal effect in period t; ϵ_{it} is the random effect in a given state i at a given date t.

7.2 | Results

The results presented in the first column of Table 5 (basic model) indicate that the coefficient of our variable $\text{Treated}_\text{L} \times$Post2012 is negative and statistically significant at 1%. This suggests a causal downward effect on the number of M&As in the treated group in the post-2012 period.

We consider climate risk events as possible covariates that may affect the DID results. Table 5 also shows that climate risk events have no effect on the DID analysis. The events information is from the Verisk database, which documents all climate risk events of $25 M or more of total insured property losses. The number of events is the total number per year and state, and insured losses are the total losses of the insurance industry per year and state (Dionne et al., 2023). Details on data used for this analysis are presented in Supporting Information S1: Online Appendix E1.

TABLE 5 Results of the regression of model (2) using the OLS method with fixed effects on the individual (state) and time (year).

Dependent variable	Number of M&As per year and state (life and nonlife)		
Independent variable	**Basic model**	**With number of events**	**With insured losses**
$Treated_L \times Post2012$	−0.689*** (0.127)	−0.689*** (0.127)	−0.689*** (0.126)
Number of events		0.002 (0.011)	
Insured losses			−1.27e-11 (3.16e-11)
Constant	1.093*** (0.015)	1.086*** (0.041)	1.099*** (0.021)
State fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
Double SE clustering	State/Year	State/Year	State/Year
Observations	3366	3366	3366
Adjusted R-squared	0.5349	0.5536	0.5350

Note: *** $p < 0.01$. Two-way cluster-robust standard errors at the state and year levels. The coefficients of $Treated_L \times Post2012$ measure the treatment effect in the three specifications. The covariates number of events and insured losses, representing climate risk events and corresponding insured losses, are not statistically significant. Data sources: SDC database and Verisk database.

Table 6 presents an additional test for considering climate risk events (Kranz, 2022). The test takes into account time-varying covariates. Note that the first regression in Panel A in Table 6 omits observations with a treatment status equal to zero. The regression in Panel B uses the results of Panel A estimation to define the dependent variable. The estimated effect of a given climate risk variable on the number of M&A per state and year, obtained in Panel A, is subtracted from the original dependent variables in the two sectors to create a new dependent variable in Panel B. We observe in Panel B that the results remain stable when compared to those of Table 5, even if the number of events is statistically significant in Panel A to explain mergers and acquisitions when the treatment status is equal to zero.

We did also consider the variable Life expectancy by state and year as a possible time-varying covariate that may affect the DID result. Again, we observe, in Table D8 in Supporting Information S1: Online Appendix D, that the results of Table 5 remain stable when considering a change in Life expectancy over time. Note that the period of analysis ends in 2021 because the values of Life expectancy were not available for the year 2022 in all states.

7.3 | Robustness analysis[5]

We now investigate whether our conclusions are robust to alternative econometric causal methodologies. We use recent and more flexible econometric approaches that are less reliant on the parallel trends assumption, namely, the SDID and the SC methods of estimation.

[5] A more detailed analysis of this section is presented in Supporting Information S1: Online Appendix D.

TABLE 6 Additional test of the effect of climate risk on DID analysis for the 1990–2022 period.

Panel A: Regression of the effect of climate risk variables on the number of M&As per year for observations with a treatment status equal to zero			
Dependent variable	**Number of M&As per year and per state**		
Independent variable	**Coefficient**	**Coefficient**	**Coefficient**
Events	0.030** (0.013)		
Losses (in $ billion)		0.000 (0.000)	
Log (1 + losses)			0.021 (0.024)
Constant	Y	Y	Y
Observations	1683	1683	1683
Adjusted R-squared	0.576	0.576	0.575
Panel B: Estimation of the average treatment parameter using the DID model for the 1990–2022 period			
Dependent variable	**Number of M&As per year and per state in the two sectors**		
Independent variable	**Climate events**	**Insured climate losses**	**Log of climates insured losses**
$\text{Treated}_L \times \text{Post2012}$	−0.689*** (0.129)	−0.689*** (0.130)	−0.689*** (0.126)
Constant	0.991*** (0.016)	1.077*** (0.016)	1.012*** (0.015)
Observations	3366	3366	3366
Adjusted R-squared	0.520	0.526	0.527

Note: ***$p < 0.01$, **$p < 0.05$. Each regression includes two-way fixed effects for State and Year. Two-way Cluster-Robust Standard Errors at the State and Year levels are reported. Results in Panel B support the robustness of those obtained in Table 5 with a different method of introducing covariates for climate risk in the basic model. Data sources: SDC database and Verisk database.

The SC method was introduced in a series of seminal articles by Abadie and coauthors (Abadie, 2003; Abadie & L'Hour, 2021; Abadie et al., 2010, 2015). This method aims to generate a single SC group using a weighting of the potential control units, in such a way that this SC is as closely matched as possible to the treated units in pretreatment outcomes. Unlike the standard DID framework, where control units are equally weighted, the SC approach reweights control units. These generated weights for control units are fixed over time and could be zero for some control units and large for others.

The second alternative econometric approach is the SDID, recently introduced in the literature by Arkhangelsky et al. (2021). SDID is a very flexible methodology that can be applied in panel datasets and that aims to link the standard DID and the SC methods to combine their attractive features. The SDID method allows a different trending for treated and control units before the event of interest, and like the SC method, the SDID reweights control units to generate an optimal matched control unit, which helps relax the standard parallel trends assumption.

Besides the weighting scheme for control units, the SDID assigns different weights for preperiods. Control units' weights ensure that the average outcome for the treated units is approximately parallel to the weighted average for control units during the preperiods. Time weights are such that the average posttreatment outcome for each of the control units differs by a constant from the weighted average of the pretreatment outcomes for the same control units. Our panel is long and large enough to construct weights that make trends parallel.

Table 7 reports the results for the two additional methods where we no longer aggregate in Panel B the M&As in the health and the P&C sectors. Instead, we consider them as two different control groups. For comparison, we also present in the table the standard DID results with the two control groups having constant equal weights over time. These robustness tests show that the standard DID estimation of Table 5 remains in the range of the different coefficients we find with more flexible econometric methodologies. We also observe in Panel B that the SDID and the DID estimations for the treatment effect are more stable than the estimation by the SC method when comparing results in both panels. It seems that the SC method performs less well with long-range historical data. Additional results with covariates are presented in Supporting Information S1: Online Appendix D.

8 | EFFECTS OF THE 2012 SHOCK IN THE LIFE INSURANCE MARKET

8.1 | Effects on written premiums

We proposed that the economic difficulties in the life insurance sector (particularly in variable annuity business) observed in the post-2012 period, explained by low interest rates, could have been a cause of the difference in the number of M&As of target insurers in the life insurance sector relative to the number of M&As of target insurers in the nonlife insurance sector. The new monetary policy motivated by the 2007–2009 financial crisis could have been the root of the economic and financial difficulties in the life insurance sector. Indeed, the very low interest rates may have significantly affected the investment benefits of annuities for

TABLE 7 Estimation of the average treatment effect using the DID, SDID, and SC models for the 1990–2022 period.

Dependent variable	**Number of M&As per year and state**		
Independent variable	**DID**	**SDID**	**SC**
Panel A: One control group			
$Treated_L \times Post2012$	−0.689***	−0.689***	−0.712***
	(0.117)	(0.108)	(0.150)
Observations (state-year)	3366	3366	3366
Panel B: Two control groups			
$Treated_L \times Post2012$	−0.680***	−0.651***	−0.614***
	(0.112)	(0.135)	(0.166)
Observations (state-year)	5049	5049	5049

Note: Robust standard error ***$p < 0.01$. Each regression includes a constant effect and a fixed effect for state and time. Standard errors were computed from the bootstrapping method clustered at the state level. Same results were obtained with the Jacknife method. The results in Panel B support the robustness of those obtained in Table 5 with two more flexible causality models, the SDID and the SC. The data source is the SDC database.

insureds in the life insurance industry during the period under analysis and reduced the bid opportunities in the M&A market.

Table 8 presents the effect of the Fed interest rate on annuity sales. We observe a significant negative effect of the Fed interest rate on the variable annuity premiums sold after 2012. The fixed annuity market continued to growth, perhaps as a substitution effect between the two markets. These results were obtained from a panel of the 20 largest life insurers that offered variable annuities during the 2008–2022 period. They account for about 90% of the market. The analysis started in 2008 because this data source does not separate fixed and variable annuity sales before 2008. More details on this data source are presented in Supporting Information S1: Online Appendix E2.

The interest rate factor explains the drop in variable annuity sales during the post-2012 period, with a coefficient of −36.74. Table 9 presents a robustness analysis of the results in Table 8 from a different panel of data. This panel from the NAIC (National Association of Insurance Commissioners) includes all insurers that offered non-negative net written premiums of annuities during the 2010–2022 period. Again, the Post2012 monetary policy had a negative effect on variable annuity sales (coefficient equal to −2.745).

In conclusion, the Fed interest rate factor had a negative effect on variable annuity sales in the post-2012 period. The negative interest rate differential (market interest rate and guaranteed 3% return), representing interest rate risk management costs assumed by life insurers during the post-2012 period, exerted downward pressure in the market. Life insurers with variable annuities had their stocks return with a negative exposure to interest rate during this period (Hartley et al., 2016). Many insurers stopped offering the option of minimum return guaranties; other left the market.

TABLE 8 Effect of Fed interest rate on direct written premiums in annuity markets, 2008–2022.

Dependent variable: Direct written premiums Independent variable	**Variable annuity coefficient**	**Fixed annuity coefficient**
Post2012	−406.4*** (0.461)	−2.524*** (0.244)
Fed interest rate	34.18*** (0.296)	0.196 (0.207)
Post2012 × Fed interest rate	−36.74*** (0.269)	1.979*** (0.658)
Annuity price index	11.72*** (0.021)	−0.040 (0.090)
Life expectancy	3.749*** (0.041)	−1.630*** (0.145)
Constant	−2079*** (0.018)	137.2*** (0.061)
Insurer fixed effect	Y	Y
Year fixed effect	Y	Y
Double SE clustering	Insurer/year	Insurer/year
Observations	300	300
Adjusted R-squared	0.7555	0.6681

Note: Robust standard errors. $^{***}p < 0.01$. Variables are described in Supporting Information S1: Online Appendix. Dependent variable and data source: Direct written premiums for individual annuity contracts issued by the 20 top-ranked annuity sales companies surveyed by LIMRA. We observe a negative effect of the variable Post2012 × Fed interest rate on variable annuity sales.

TABLE 9 Effect of Fed interest rate on net written premiums in annuity markets, 2010–2022.

Dependent variable: Net written premiums Independent variable	Variable annuity coefficient	Fixed annuity coefficient
Post2012	−31.76*** (0.045)	0.333 (2.944)
Fed interest rate	2.545*** (0.017)	−8.419 (5.349)
Post2012 × Fed interest rate	−2.745*** (0.021)	8.612 (5.174)
Annuity price index	−0.064*** (0.003)	0.005 (0.010)
Post2012 × annuity price index	0.186*** (0.000)	−0.023 (0.032)
Life expectancy	0.217*** (0.004)	−0.183 (0.207)
GDP ($ billion)	0.081** (0.027)	−0.078 (0.077)
Constant	−7.983*** (0.001)	17.73 (12.27)
Insurer fixed effect	Y	Y
Year fixed effect	Y	Y
Double SE clustering	Insurer/year	Insurer/year
Observations	1530	4411
Adjusted R-squared	0.8466	0.5354

Note: Robust standard errors. $^{***}p < 0.01$. Variables are described in Supporting Information S1: Online Appendix. Dependent variable and data source: Net written premiums for individual and group annuity contracts issued by insurance companies filing with the NAIC on the life, accident & health annual statement blanks. We observe a negative effect of the variable Post2012 × Fed interest rate on variable annuity sales. Separation of fixed and variables annuity sales started in 2010 in this data source.

8.2 | Combined ratio and net gain from operations

We consider that M&A transactions are positively correlated with the performance of insurance business. The better the insurance business performs, the more M&As should occur in the insurance industry, particularly in the same business sector, as documented in the literature review. Targets are more attractive and acquirers are more wealthy. One of the best indicators of insurer performance is the combined ratio. This consists of the ratio of premiums paid (payments + operating expenses) to premiums collected (insurance policies and annuities sold). This indicator determines whether premiums collected are sufficient to cover expenses paid (including claims and operating expenses). Clearly, the most obvious risk for insurers is that the premiums collected (sales) are insufficient to pay policyholders and cover expenses. Arguably, the higher the combined ratio, the more the premiums collected will be insufficient to cover claims paid and operating expenses, and the more target and bidder insurers will find themselves in financial difficulty. The more the target insurer is in financial difficulty, the less it will be able to obtain interesting M&A conditions, which would reduce the number of M&A transactions. Moreover, the more a potential bidder in the same sector is in financial difficulties, the less he will be able to offer interesting bids.[6] In other words, a high combined ratio should have a negative impact on M&As in the life insurance sector.

[6] See Figure D13 in the Supporting Information S1: Online Appendix D. We observe very few transactions between life acquirers and life targets after 2012.

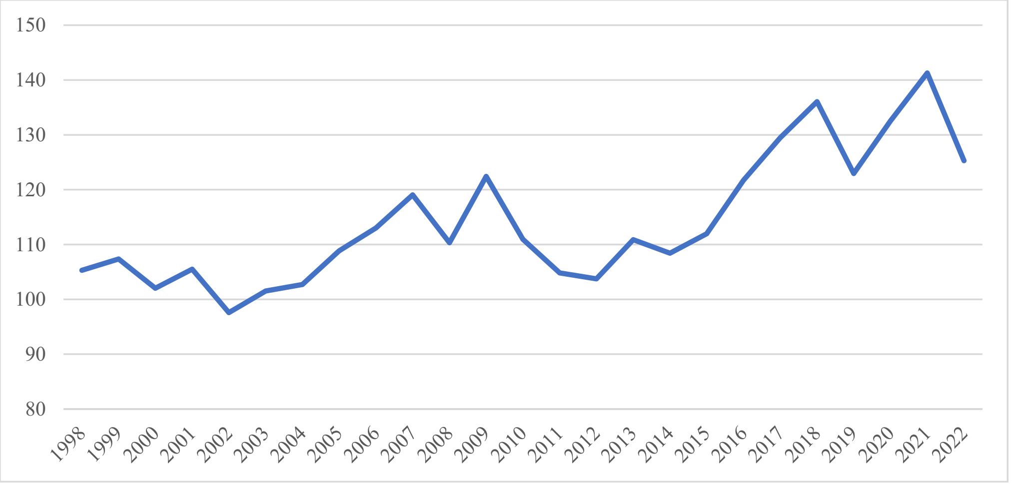

FIGURE 7 Trend in the combined ratio for the US life insurance sector, 1998–2022. The vertical axis indicates values of the annual combined ratio while the horizontal axis indicates the corresponding years. Formula of combined ratio = (claims costs + management expenses)/premiums collected. The data source is NAIC.

Figure 7 shows that the combined ratio in the life insurance sector has increased in recent years. The year 2012 represents the emblematic starting point for this increase. There are two potential explanations for this rise in the combined ratio, observed during the post-2012 period. First, payments may have grown faster than the premiums collected in the post-2012 period, which would push up the combined ratio. Second, premiums collected (sales) may have fallen significantly, making it difficult to cover total payments effectively.

We now study each component of the combined ratio. The drop in premiums is explained by a decline in sales of life insurance products after 2012. For example, a Life Insurance Marketing and Research Association (LIMRA) survey found that total annuity sales fell by 6% in the first quarter of 2013. Bernard and Moenig (2019) maintain that the decline in annuity sales began in 2013 because of the high fees charged to policyholders. They argue that financial advisors have resisted investing in variable annuities because of the high fees charged on these products. We might suspect that the life insurance market as a whole experienced a downturn after 2012 due to the high costs of products sold.

The results in Table 10 show the positive influence of the Fed interest rate on the combined ratio after 2012. They confirm the results in Tables 8 and 9 related to the reduction in sales, because the coefficient of Total expenses after 2012 is not significant for the variable annuity line. The results clearly show that the negative shock in interest rates drove the combined ratio in the life insurance sector upward during the post-2012 period, a variation well explained by the Fed interest rate policy.

Table 11 reinforces the preceding results by showing the negative impact of the Fed interest rate on the net gain from operations in the life annuity market. Net gains from operations are used in NAIC statements to measure profitability in the insurance business.

8.3 | Mergers and acquisitions

Table 12 shows a direct negative effect by the Fed interest rate on M&As during the post-2012 period in the life sector, while Table 13 confirms the DID analysis carried out in Section 6,

TABLE 10 Impact of Fed interest rate on the combined ratio in the life insurance sector, 2010–2022.

Dependent variable: Combined ratio		
Independent variable	**Variable annuity coefficient**	**Fixed annuity coefficient**
Lag combined ratio	0.127 (0.117)	0.156** (0.057)
Post2012	7.290*** (0.264)	−0.375*** (0.066)
Fed interest rate	−14.08*** (0.887)	−0.980*** (0.246)
Post2012 × Fed interest rate	13.90*** (0.868)	1.041*** (0.244)
Annuity price index	−0.305*** (0.007)	0.004*** (0.001)
Life expectancy	0.109*** (0.026)	−0.062*** (0.005)
Total expenses ($ billion)	0.026** (0.009)	0.004 (0.003)
Post2012 × total expenses ($ billon)	−0.003 (0.003)	0.017** (0.005)
Constant	41.59*** (1.021)	5.482*** (0.258)
Insurer fixed effect	Y	Y
Year fixed effect	Y	Y
Double SE clustering	Insurer/year	Insurer/year
Observations	1111	3124
Adjusted R-squared	0.4478	0.4109

Note: Robust standard errors. ***$p < 0.01$, **$p < 0.05$. Variables are described in Supporting Information S1: Online Appendix. We observe a positive effect of the Post2012 × Fed interest rate variable on the life sector combined ratio in both the variable and fixed annuity markets with a greater effect in the variable annuity market. The data source is NAIC.

where Treated_L is equal to 1 for the life insurance sector and equal to 0 otherwise. These two results confirm the causally negative effect of the Fed monetary policy on M&As in the life insurance sector after 2012.

8.4 | Insurance business in the two sectors

8.4.1 | Premiums to GDP

We have just demonstrated that it was the significant decline in premiums collected (sales) observed in the variable annuity line after 2012 that caused the combined ratio to rise in the post-2012 period, thus reducing the profitability of insurers in the life insurance sector. The decline in interest rates caused the decline in premiums collected in the variable annuity

TABLE 11 Effect of Fed interest rate on net gain from operations in the life annuity market, 2010–2022.

Dependent variable: Net gain from operations Independent variable	Variable annuity coefficient	Fixed annuity coefficient
Lag Net gain from operating	−0.177 (0.203)	−0.163 (0.208)
Post2012	−16.23*** (1.162)	0.228*** (0.034)
Fed interest rate	42.85*** (3.195)	0.513*** (0.132)
Post2012 × Fed interest rate	−42.32*** (3.148)	−0.597*** (0.126)
Annuity price index	0.761*** (0.011)	−0.008*** (0.000)
Life expectancy	−0.360*** (0.082)	0.093*** (0.010)
Total expenses ($ billon)	−0.112 (0.070)	0.054** (0.020)
Post2012 × total expenses ($ billon)	0.070* (0.036)	−0.054 (0.031)
Constant	−99.01*** (7.204)	−6.361*** (0.770)
Insurer fixed effect:	Y	Y
Year fixed effect:	Y	Y
Double SE clustering	Insurer/year	Insurer/year
Observations	1111	3124
Adjusted R-squared	0.5362	0.3462

Note: Robust standard errors. ***$p < 0.01$, **$p < 0.05$. Variables are described in Supporting Information S1: Online Appendix. We observe a significant negative effect of the Post2012 × Fed interest rate variable on net gain from operations in both annuity markets with a greater effect in the variable annuity market. The data source is NAIC.

TABLE 12 Effect of Fed interest rate on mergers and acquisitions in the life insurance industry, 1990–2022.

Dependent variable: M&As Life Independent variable	Coefficient
Post2012	−1.075*** (0.112)
Fed interest rate	0.180*** (0.010)
Post2012 × Fed interest rate	−0.381*** (0.038)
GDP ($ billion)	0.163*** (0.006)
Constant	1.511*** (0.026)
State fixed effect	Y
Year fixed effect	Y
Observations	1683
Adjusted R-squared	0.4892

Note: Robust standard errors. ***$p < 0.01$. Variables are described in Supporting Information S1: Online Appendix. We observe a direct negative effect of the Post2012 × Fed interest rate variable on mergers and acquisitions in the life insurance industry. The data source is SDC database.

market and had a negative effect on M&As in the life sector. To conclude the analysis, we now focus on the link between M&A transactions and the performance of the insurance business, measured by the ratio of premiums collected (sales), as a % of GDP. The ratio of premiums collected (sales) to GDP is known as a penetration rate and is often used by insurance

TABLE 13 Impact of Fed interest rate on mergers and acquisitions in the two insurance sectors during the 1990–2022 period.

Dependent variable: M&As in life and nonlife Independent variable	Coefficient
Post2012	−5.568*** (1.169)
$Treated_L \times$ Fed interest rate	0.017 (0.0174)
Post2012 × $Treated_L \times$ Fed interest rate	−0.402*** (0.113)
GDP ($ billion)	0.349*** (0.070)
Constant	1.414*** (0.475)
State fixed effect:	Y
Year fixed effect:	Y
Double SE clustering	State/Year
Observations	3366
Adjusted R-squared	0.5206

Note: Robust standard errors. ***$p < 0.01$. Variables are described in Section 5 and in Supporting Information S1: Online Appendix. This table confirms the DID analysis presented in Table 5 with an explicit indication that the Fed interest rate policy caused the treatment effect on mergers and acquisitions in the US insurance industry. The data source is the SDC database.

professionals. It is an interesting indicator for assessing the importance of the insurance business sector in a country's economy. It shows whether insurance business as a proportion of the GDP is increasing or decreasing. In fast-growing economies, there is often an increase in demand for insurance products, which translates into a higher penetration rate. The growth of the insurance industry can then exceed that of the overall GDP. Conversely, a drop in demand for insurance products may translate into a lower penetration rate.

8.4.2 | Analysis of the relationship between insurance business and M&A activity in the two insurance sectors

Our econometric results presented in Table 14 confirm the negative impact of life insurance business activity, as measured by premium % of the GDP, on M&A transactions after 2012. Thus, one could argue that the loss of the parallel M&A trend observed between the two insurance sectors in the post-2012 period is driven by a loss of parallel trends in the insurance business market.

Figure 8 shows parallel time trends in the evolution of the premium % of the GDP for the two main insurance groups (life and nonlife) up to 2012 (especially from 2002 to 2012). Post-2012, insurance business diverges between the two groups. Figure 8 also indicates that insurance business declined as a proportion of the GDP for the life insurance sector from 2012 onwards, while it increased slightly as a proportion of the GDP for the nonlife insurance sector from 2012 onwards, thus creating a breakpoint in the parallel temporal trends in the evolution of insurance business for our two main insurance groups (life and nonlife) up to 2012. The stability in the nonlife insurance sector is explained, in part, by strong increases in premiums and reinsurance demand to compensate for climate risk losses (Dionne & Desjardins, 2022).

TABLE 14 M&A and Premium % of GDP in the life sector, 2001–2022.

Dependent variable: M&A in the life sector Independent variable	Total life sector Coefficient	Annuity business line Coefficient	Life insurance line Coefficient
Post2012	−1.705*** (0.350)	−1.526*** (0.361)	−1.343*** (0.422)
LifeSectorPremiumByStateBill	0.016 (0.021)	0.002 (0.005)	0.012 (0.009)
Post2012LifeSectorPremiBill	−0.066*** (0.020)	−0.020*** (0.005)	−0.034*** (0.008)
Lifeexpectancy	−0.274*** (0.003)	−0.262*** (0.004)	−0.293*** (0.005)
GDP ($Bill)	0.143*** (0.022)	0.127*** (0.023)	0.114*** (0.026)
Constant	20.53*** (0.007)	19.81*** (0.008)	22.16*** (0.014)
State fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y
Double SE clustering	State/year	State/year	State/year
Observations	1122	1122	1122
Adjusted R-squared	0.53	0.53	0.54

Note: Robust standard errors. ***$p < 0.01$. Variables are described in Supporting Information S1: Online Appendix. We observe a negative relationship between the variable Premium % of GDP and mergers and acquisitions in the life insurance sector, after 2012. The data source are the reports compiled annually by the NAIC. 1991–2019: Statistical compilation of annual statement information for life/health insurance companies compiled annually by the NAIC; 2020–2022: US Life and A&H Insurance Industry: Annual Results.

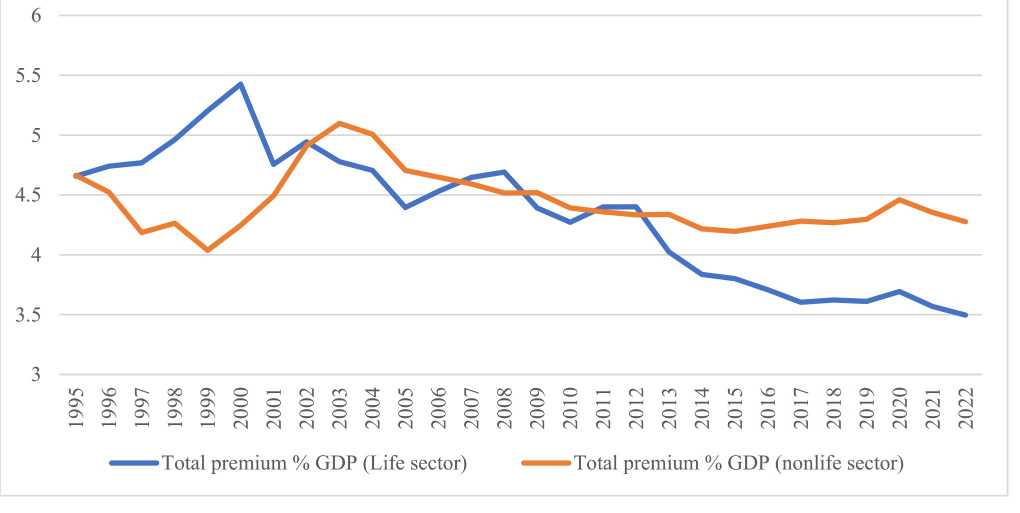

FIGURE 8 Evolution of the premium % of GDP ratio for the life and nonlife insurance sectors in the United States, 1995–2022. The vertical axis indicates the annual premiums percentage of GDP in life and nonlife insurance sectors while the horizontal axis indicates the corresponding years. We observe a significant decrease of the ratio in the life sector after 2012. The data source is AM Best.

9 | CONCLUSION

In this paper, we present evidence that life insurers had fewer mergers and acquisitions after 2012 because of low interest rates: there is a strong negative statistical relationship between interest rate and mergers and acquisitions after 2012.

We use a DIDs analysis for identifying the causal relationship between QE monetary policy and mergers and acquisitions in the insurance sectors. We find that treated life insurance firms reduce their mergers and acquisitions after 2012 in an economically and statistically significant effect. This result is robust to more recent causal models such as SC and SDID.

The significant drop in M&As observed in the life insurance sector after 2012 is mainly explained by a decline in the variable annuity business. This result is due to a significant reduction in interest rates after the financial crisis, which increased the cost of risk management for life insurance companies offering variables annuities. It became too costly for the life insurance industry to offer the 3% minimum return guarantee on variable annuity products after 2012.

Low interest rates reduced the benefit of variable annuities and reduced the demand for these annuities. This unanticipated reduction in interest rates for a long period of time by the life insurance industry caused the low profitability of life insurers. Target life insurers became less attractive for mergers and acquisitions after 2012 and potential life insurers acquirers did not have the necessary resources to offer interesting bids.

Further evidence suggests that the relation between QE monetary policy and mergers and acquisitions is not due to various alternative hypotheses. In particular, our results are not due to climate risk events, since P&C insurers increased their premiums and their reinsurance coverage for these losses. Life expectancy did not affect the relative variations of M&A during the period of analysis.

Understanding the determinants of mergers and acquisitions is important for the stability of the insurance sectors. Our findings have important implications for the planning of insurers risk management and of mergers and acquisitions in function of monetary policy. It seems that life insurers did not quickly anticipate the future reductions in interest rates and their potential consequences on their risk management activities. It was quite clear for many observers, however, that the Fed was willing to maintain its policy of low interest rates for an extended period after the 2007–2009 financial crisis (see Krishnamurthy & Vissing-Jorgensen, 2011, for example). Forward-looking risk management is still an open issue in the insurance industry.

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REFERENCES

Abadie, A. (2003). Semiparametric instrumental variable estimation of treatment response model. *Journal of Econometrics*, *113*, 231–263.

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, *105*(490), 493–505.

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, *59*(2), 495–510.

Abadie, A., & L'Hour, J. (2021). A penalized synthetic control estimator for disaggregated data. *Journal of the American Statistical Association*, *116*(536), 1817–1834.

Akhigbe, A., & Madura, J. (2001). Intra-industry signals resulting from insurance company mergers. *The Journal of Risk and Insurance*, *68*, 489–506.

Amel, D., Barnes, C., Panetta, F., & Salleo, C. (2004). Consolidation and efficiency in the financial sector: A review of the international evidence. *Journal of Banking & Finance*, *28*, 2493–2519.

Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W., & Wager, S. (2021). Synthetic difference-in-differences. *American Economic Review*, *111*(12), 4088–4118.

Berdin, E., & Gründl, H. (2015). The effects of a low interest rate environment on life insurers. *The Geneva Papers on Risk and Insurance - Issues and Practice*, *40*(3), 385–415.

Berends, K., McMenamin, R., Plestis, T., & Rosen, R. J. (2013). The sensitivity of life insurance firms to interest rate changes. *Economic Perspectives*, *37*(2), 47–78.

Bernard, C., & Moenig, T. (2019). Where less is more: Reducing variable annuity fees to benefit policyholder and insurer. *Journal of Risk and Insurance*, *86*(3), 761–782.

Betton, S., Eckbo, B. E., & Thorburn, K. (2009). Merger negotiations and the toeholds puzzle. *Journal of Financial Economics*, *91*(2), 158–178.

Bonis, G., Ihrig, J., & Wei, M. (2017). The effect of the Federal Reserve's securities holdings on longer-term interest rates. FEDS Notes, Washington: Board of Governors of the Federal Reserve System. https://doi.org/10.17016/2380-7172.1977.

Boubakri, N., Dionne, G., & Triki, T. (2008). Consolidation and value creation in the insurance industry: The role of governance. *Journal of Banking & Finance*, *32*, 56–68.

Brockman, P., & Yan, X. (2009). Block ownership and firm-specific information. *Journal of Banking & Finance*, *33*(2), 308–316.

Chahboun, I., & Hoover, N. (2019). Variable annuities: Underlying risks and sensitivities. Federal Reserve Bank of Boston, 39 p.

Chamberlain, S. L., & Tennyson, S. (1998). Capital shocks and merger activity in the property-liability insurance industry. *The Journal of Risk and Insurance*, *65*, 563–595.

Chung, H., Laforte, J. P., Reifschneider, D., & Williams, J. C. (2011). Have we underestimated the likelihood and severity of zero lower bound events? FRBSF Working Paper 2011-01. http://www.frbsf.org/publications/economics/papers/2011/wp11-01bk.pdf

Cummins, D., & Weiss, M. (2004). Consolidation in the European insurance industry: Do mergers and acquisitions create value for shareholders? Working Paper, The Wharton Financial Institutions Center.

Cummins, J. D., Tennyson, S., & Weiss, M. A. (1999). Consolidation and efficiency in the US life insurance industry. *Journal of Banking & Finance*, *23*, 325–357.

Cummins, J. D., & Xie, X. (2008). Mergers and acquisitions in the US property-liability insurance industry: Productivity and efficiency effects. *Journal of Banking & Finance*, *32*(1), 30–55.

D'Amico, S., English, W., Lopez-Salido, D., & Nelson, E. (2012). The Federal Reserve's large scale asset purchase programs: Rationale and effects. *Economic Journal*, *122*(564), 425–446.

D'Amico, S., & King, T. B. (2013). Flow and stock effects of large-scale Treasury purchases: Evidence on the importance of local supply. *Journal of Financial Economics*, *108*(2), 425–448.

Denis, D. K., & McConnell, J. J. (2003). International corporate governance. *The Journal of Financial and Quantitative Analysis*, *38*, 1–36.

Dionne, G., & Desjardins, D. (2022). A re-examination of the US insurance market's capacity to pay catastrophe losses. *Risk Management and Insurance Review*, *25*(4), 515–549.

Dionne, G., Fenou, A., & Mnasri, M. (2023). Consolidation of the US property and casualty insurance industry: Is climate risk a causal factor for mergers and acquisitions? Report submitted to the SCOR Foundation for Science.

Dionne, G. (2025). Causality in empirical analyses with emphasis on asymmetric information and risk management. In G. Dionne (Ed.), *Handbook of insurance* (Vol. 1, 3rd ed.). Springer.

Dionne, G., La Haye, M., & Bergerès, A. S. (2015). Does asymmetric information affect the premium in mergers and acquisitions? *Canadian Journal of Economics/Revue canadienne d'économique*, *48*(3), 819–852.

Egan, M. L., Ge, S., & Tang, J. (2021). Conflicting interests and the effect of fiduciary risk—Evidence from variables annuities. NBER Working Paper 27577, 105 p.

Engen, E., Laubach, T., & Reifschneider, D. (2015). The macroeconomic effects of Federal Reserve's unconventional monetary policies. FEDS 2015-005, January.

Estrella, A. (2001). Mixing and matching: Prospective financial sector mergers and market valuation. *Journal of Banking & Finance*, *25*, 2367–2392.

Floreani, A., & Rigamonti, S. (2001). Mergers and shareholders' wealth in the insurance industry. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=267554

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2010). Large-scale asset purchases by the federal reserve: Did they work? FRB New York Staff Reports 441 (March). http://www.ny.frb.org/research/staff_reports/sr441.html.

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). The financial market effects of the Federal Reserve's large-scale asset purchases. *International Journal of Central Banking*, *7*(1), 3–43.

Gatzert, N., & Schmeiser, H. (2025). Life insurance financial products. In G. Dionne (Ed.), *Handbook of insurance* (3rd ed.). Springer.

Guest, P. M. (2021). Risk management in financial institutions: A replication. *The Journal of Finance*, *76*(5), 2689–2707.

Hamilton, J. D., & Wu, J. C. (2012). The effectiveness of alternative monetary policy tools in a zero lower bound environment. *Journal of Money, Credit and Banking*, *44*, 3–46.

Hartley, D., Paulson, A. L., & Rosen, R. J. (2016). Measuring interest rate risk in the life insurance sector: The US and the U.K. Working Paper Series WP-2016-2, Federal Reserve Bank of Chicago.

Holsboer, J. H. (2000). The impact of low interest rates on insurers. *The Geneva Papers on Risk and Insurance - Issues and Practice*, *25*(1), 38–58.

Imbens, G. W., & Angrist, J. D. (1994). Identification and estimation of local average treatment effects. *Econometrica*, *62*(2), 467–475.

Imbens, G. W., & Wooldridge, J. M. (2009). Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, *47*(1), 5–86.

Kahn-Lang, A., & Lang, K. (2020). The promise and pitfalls of differences-in-differences: Reflections on 16 and pregnant and other applications. *Journal of Business & Economic Statistics*, *38*(3), 613–620.

Koijen, R. S. J., & Yogo, M. (2021). The evolution from life insurance to financial engineering. *The Geneva Risk and Insurance Review*, *46*, 89–111.

Kranz, S. (2022). Synthetic difference-in-differences with time-varying covariates. Mimeo, Ulm University, 8 pages.

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The effects of quantitative easing on long-term interest rates. Brookings Papers on Economic Activity, Fall.

Meaning, J., & Zhu, F. (2011). The impact of recent Central Bank asset purchase programmes. BIS Quarterly Review, Bank for International Settlements, December.

Meaning, J., & Zhu, F. (2012). The impact of Federal Reserve asset programs: Another twist. BIS Quarterly Review, Bank for International Settlements, March.

Moeller, S., & Schlingemann, F. (2005). Global diversification and bidder gains: A comparison between cross-border and domestic acquisitions. *Journal of Banking & Finance*, *29*, 533–564.

Pelizzon, L., & Sottocornola, M. (2018). The impact of monetary policy interventions on the insurance industry. SAFE Working paper no 204, Goethe University, Frankfurt.

Rambachan, A., & Roth, J. (2023). A more credible approach to parallel trends. *Review of Economic Studies*, *90*, 2555–2591.

Roberts, M. R., & Whited, T. M. (2012). Endogeneity in empirical corporate finance. In G. Constantinides (Ed.), *Handbook of the economics of finance* (2, pp. 493–572). Elsevier North-Holland, Amsterdam.

Roll, R. (1986). The hubris hypothesis of corporate takeovers. *The Journal of Business*, *59*, 197–216.

Rossi, S., & Volpin, P. F. (2004). Cross-country determinants of mergers and acquisitions. *Journal of Financial Economics*, *74*, 277–304.
Roth, J. (2022). Pretest with caution: Event-study estimates after testing for parallel trends. *American Economic Review: Insights*, *4*(3), 305–322. https://doi.org/10.1257/aeri.20210236
Roth, J., Sant'Anna, P. H. C., Bilinski, A., & Poe, J. (2023). What's trending in difference-in-differences? A synthesis of the recent econometrics literature. *Journal of Econometrics*, *235*(2), 2218–2244.
Sun, J., Shevchenko, P. V., & Fung, M. C. (2018). The impact of management fees on the pricing of variable annuity guarantees. *Risks*, *6*, 103. https://doi.org/10.3390/risks6030103
Swanson, E. T. (2011). Let's twist again: A high-frequency event-study analysis of operation twist and its implications. Brookings Papers on Economic Activity, Spring, 151-188.
Verani, S., & Yu, P. C. (2021). What's Wrong with Annuity Markets? Finance and Economics Discussion Series 2021-044. Washington: Board of Governors of the Federal Reserve System. https://doi.org/10.17016/FEDS.2021.044.
Wedow, M., & Kablau, K. (2011). Gauging the impact of low-interest rate environment on German life insurers. Deutsche Bundesbank Discussion Papers, 2.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX: VARIABLES USED IN SECTION 7

(See Appendix Table 15)

TABLE 15 Variables, data sources, and descriptions.

Variable	Description	Measure	Data source
Total Expenses Annuity ($ billion) (Variable or Fixed annuity)	Annuity payments + Expenses Annuity Annuity payments of Annuity business line include benefit payments from annuity contracts and other contract payments. (Expenditures) Operating expenses of Annuity business line include commissions to agents, home-and field-office expenses, taxes, and investment expenses. (Expenditures)	Total Expenses	NAIC database
Variable Annuity contracts premium ($ billion) paid by insured	Variable annuity contracts allow the policy owner to allocate contributions into various subaccounts of a separate account based upon the risk appetite of	Variable Annuity premium	NAIC database LIMRA database

TABLE 15 (Continued)

Variable	Description	Measure	Data source
	the annuitant. The contributions can be invested in stocks, bonds or other investments. Income payments in the annuitization phase can be fixed or fluctuate with the investment performance of the underlying subaccounts of the separate account.		
Fixed Annuity contracts premium ($ billion) paid by insured	For immediate fixed annuity contracts, annuitants receive a fixed income stream based, in part, on the interest rate guarantee at the time of purchase.	Fixed Annuity premium	NAIC database LIMRA database
Annuity business line contracts premium ($ billion)	Variable Annuity contracts premium + Fixed Annuity contracts premium.	Annuity business line premium	NAIC database LIMRA database
Producer Price Index (PPI) by Industry: Direct Life Insurance Carriers: Annuities (Index Dec 1998 = 100)	The Producer Price Index (PPI) program measures the average change over time in the selling prices received by domestic producers for their output.	Annuity price index	US Bureau of Labor Statistics database
Short-term interest rates (%)	Short-term interest rates are the rates at which short-term borrowings are affected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Short-term interest rates are generally averages of daily rates, measured as a percentage. Short-term interest rates are based on 3-month money market rates where available. Typical standardized names are “money market rate” and “treasury bill rate.”	Fed interest rate	World Bank database
Combined ratio	Combined ratio is the sum of the payments and the expense to premiums received. (Expenditures ratio)	Combined ratio	NAIC database
Net gain from operations before dividends to policyholders and federal taxes	The Net Operating Gain is the sum of Net premium income, net investment income, and miscellaneous income less benefit payments, expenses, reserve changes, but before policyholder dividends federal income taxes, and realized capital gains/losses.	Net gain from operations	NAIC database
S&P 500 price index	The Standard and Poor's 500, or simply the S&P 500, is a stock market index	S&P 500 price index	Macrotrends database

(Continues)

TABLE 15 (Continued)

Variable	Description	Measure	Data source
	tracking the stock performance of 500 of the largest companies listed on stock exchanges in the United States. It is one of the most followed equity indices and includes approximately 80% of the total market capitalization of US public companies.		
Life expectancy (number of years)	Life expectancy at birth used is the average number of years a newborn is expected to live if mortality patterns at the time of its birth remain constant in the future.	Life expectancy	World Bank database
Gross domestic product ($ billion)	Gross domestic product (GDP) represents the sum of value added by all its producers. Value added is the value of the gross output of producers less the value of intermediate goods and services consumed in production, before accounting for consumption of fixed capital in production.	GDP	World Bank database