Insurers' investment similarity and the impact of unaffiliated investment management

Danjela Guxha
University of St. Gallen, Switzerland

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Abstract

We study whether the trend of increased asset management outsourcing in insurance is potentially serving as a channel to enable more interconnectedness through increased portfolio similarity. Increased portfolio similarity has been related to increased systemic risk in the insurance industry. We discuss the way in which investment management outsourcing could be enabling higher portfolio similarity among insurers. We measure portfolio overlap using cosine similarity and find that insurers that outsource the asset management of a large portion of their investment portfolio hold more similar portfolios. Our results help to understand better the effect of asset management outsourcing in the insurance industry as a whole and can help regulators in designing monitoring requirements.

Keywords: asset management outsourcing, portfolio similarity, systemic risk

JEL Codes: G11, G18, G22

1. Introduction

Outsourcing to unaffiliated investment managers has been an increasing trend in the insurance industry over the last decade(s). Reports from the National Association of Insurance Commissioners (NAIC) suggest that this trend became especially pronounced after the financial crisis in 2008 and has persisted in the following years. NAIC (2022) indicates that about 50% of US insurers reported outsourcing to unaffiliated asset managers as of the end of 2020 compared with 22% in 2006, according to the Insurance Asset Manager 2010 Annual Survey of World Trade Executive (Becker and Ivashina (2015)). There are many drivers of the increase in outsourced investment management of general assets of insurers listed in different surveys and market research, including enhancing investment returns, accessing investment expertise (which is not available internally), accessing specialized strategies and expertise, and reducing costs (NAIC (2011), Riding (2019), Andonov (2024)).

NAIC (2011) suggests that more than 90% of all outsourced general assets of insurance firms are managed by 64 investment managers. While market and regulator reports inform on the evolvement of investment outsourcing trends in the insurance industry, there is, to the best of our knowledge, no study on how this increase in outsourcing of investment management of general assets is associated with investment similarity among insurers. This paper aims to fill this gap by studying whether the (partial) outsourcing of the investment management function to a concentrated number of external asset managers is related to increased investment portfolio similarity among insurers.

Investment outsourcing could be affecting investment similarity among insurers in two main ways. First, as reports from the Insurance Outsourcing Exchange and NAIC suggest, most insurers' assets whose management has been outsourced is managed by a limited number of large asset managers who potentially offer similar investment solutions to their clients. Second, they suggest that small and mid-size insurers are more likely to outsource the investment management function to external asset managers. Due to their size, these insurers are considered as having a limited contribution to systemic risk. However, outsourcing investment management could make them more likely to hold an investment portfolio similar to that of larger counterparties and/or more similar among them, thereby making them more likely to propagate systemic risk in case of market shocks.

Furthermore, according to market surveys one of the main reasons that drives outsourcing of investment management of (part) of general assets of insurers is the quest to achieve higher returns by having access to specialty asset classes such as high-yield or private equity. In this analysis I aim at testing whether outsourcing to unaffiliated asset managers is associated with higher exposure to high-risk securities and higher investment similarity among insurers in high-risk assets.

Bernal, Gnabo, and Guilmin (2014) find the insurance sector to be the systemically riskiest financial sector in the U.S., as measured by extending the $\Delta CoVaR$ measure introduced by Adrian and Brunnermeier (2016). In a thorough overview of the literature on systemic risk in insurance, Eling and Pankoke (2016) suggest that funding and investing activities per se have a low contribution to systemic risk in insurance. However, later research has shown that when triggered by regulatory framework and/or market shocks, the investment patterns of insurers can propagate market shocks (Girardi et al. (2021), Ellul et al. (2022), Becker, Opp, and Saidi (2022)). Two aspects of investing considered to be channels of shock transmission in case of a negative market event are portfolio similarity among insurers

and reaching-for-yield strategies (Barucca, Mahmood, and Silvestri (2021), Girardi et al. (2021), Ellul et al. (2022)). Those aspects of insurers' investing could potentially be related to outsourcing asset management. Therefore, assessing the relationship between unaffiliated investment management outsourcing and portfolio similarity among insurers is important to assess adjusting monitoring and reporting requirements for insurers that employ external asset management services.

In this paper, we study whether and how the similarity in investment portfolio holdings among insurers differs depending on whether insurers use external asset management services. We conduct our analysis at the insurance group level to reflect the fact that investment decisions are typically made at the group level (Girardi et al. (2021)). Using security-level holding data of insurers aggregated to the group level, we measure their portfolio overlaps as the pairs' cosine similarity of their holdings aggregated to issuer and asset class level, respectively. Moreover, we make use of information reported by insurers regarding the use of unaffiliated asset management services. We find that pairs in which both insurers use external asset management services to manage their investment portfolios display a higher cosine similarity than other pairs, even after controlling for other factors that affect insurers' investment strategy. The effect is present for portfolio similarity at the issuer level as well as asset class level, and is more pronounced for those pairs of insurers in which both insurers outsource more than 50% of their investment portfolio. Our results could help inform the Financial Stability Oversight Council's (FSOC) activity-based approach of monitoring insurers,[1] and we make some suggestions on how they can be used in this context.

The remainder of the paper is organized as follows: Section 2 provides an overview of the related literature. In section 3, we briefly discuss the way in which outsourcing asset management to unaffiliated asset managers could be related to increased investment similarity among insurers. Section 4 describes the data and methodology. In sections 5 and 6, we present the empirical analysis at the insurer-pair or insurer level, respectively. Section 7 analyzes whether the relationship between asset management outsourcing and increased investment similarity among insurers is mainly driven by increased similarity in the high-risk or low-risk space. Section 8 discusses limitations of our study and concludes with some recommendations as to how our findings could be useful to regulators.

2. Literature Review

The persistent low-interest rate environment in the fixed income market pushed insurance firms to search for yield in nontraditional investments such as structured products, infrastructure, private equity, and high-yield fixed income. Lilley and Rogoff (2020) predicted that the low interest rate environment would persist following the COVID-19 pandemic and the Fed stimulus. Despite the (nominal) interest rate hikes in 2022, the search for yield from insurance companies in non-traditional investments did not slow down,[2] in addition new vulnerabilities surfaced[3]. Investment in non-traditional assets among insurance firms is associated with an increase in unaffiliated investment management outsourcing

[1] See Notice-of-Proposed-Interpretive-Guidance.pdf (treasury.gov)

[2] See https://www.bloomberg.com/news/articles/2022-09-27/blackrock-sees-insurers-with-28-trillion-adding-private-assets

[3] Nonbank Financial Sector Vulnerabilities Surface as Financial Conditions Tighten (imf.org)

(Andonov, 2024).[4] However, to the best of our knowledge, there are few studies to date looking into the potential implications of increased outsourcing of investment management of general assets in the insurance industry. Kim, Leverty and Schmit (2015) study the effect of investment advisors on the investment performance of life insurers. We aim to contribute to this literature by studying potential implications in terms of holdings similarities.

Investment management outsourcing is extensively studied in the mutual funds space. Chen et al. (2013) and Chuprinin, Massa, and Schumacher (2015) argue that outsourced funds underperform internally run funds. Massa and Yadav (2015) suggest that out- or underperformance of externally managed funds depends on the bargaining power of the asset management company. In line with this argument, Gajewski and Tran Dieu (2021) find that in the European mutual fund market, outsourced funds perform at least as well as in-house managed funds. Moreno, Rodriguez, and Zambrana (2014) claim that mutual fund performance can be improved when sub-advisors are selected based on portfolio competencies, whereas Debaere and Evans (2017) find that when accounting for selection bias in a fund's decision to outsource and the advisor's decision to agree, differences in return between in-house and outsourced funds' performances disappears. Clark and Urwin (2017) analyze the principal-agent problem that arises when the chief investment officer is outsourced, whereas Ferreira, Matos, and Pires (2018) address conflicts of interest that affect funds that are managed by asset managers affiliated with commercial banking groups. In the case of general asset investment management outsourcing of insurance companies, due to limited available public data, one cannot isolate the performance of externally managed funds for comparison with in-house managed assets. However, I draw on the findings and methodologies of these studies to analyze the potential implications of outsourcing the management of insurers' general assets on investment similarities.

A large stem of literature addresses the systemic risk that arises from interconnectedness of financial institutions (Gai and Kapadia (2010)). Wagner (2010) shows that diversification increases the likelihood of systemic crises and Wagner (2011) proposes a portfolio choice model that accounts for the trade-off between diversity and diversification. Along the same lines, Ibragimov, Jaffee, and Walden (2011) develop a model that attributes the interconnectedness of financial intermediaries to their diversification efforts. Allen, Babus, and Carletti (2012) and Caccioli et al. (2014) analyze how asset commonality in combination with the short-term debt of banks and leverage, respectively, can generate excessive systemic risk. Greenwood, Landier, and Thesmar (2015) discuss how common exposures can serve as transmission channels that propagate fire sale shocks across banks. Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015) propose a model that suggests that diversification can provide resilience or propagate risk in the financial system depending on the propensity of shocks. Caccioli et al. (2015) study the interaction of two channels of contagion (direct and indirect interconnection) in financial networks and Gualdi et al. (2016) propose a method to assess statistical significance of common exposures. Clerc et al. (2016) highlights the importance of assessing systemic risk holistically, considering also channels of indirect contagion. Furthermore, Giudici, Sarlin, and Spelta (2020) introduce a measure of interconnectedness that accounts for both direct and common exposures and Poledna et al. (2021) propose an approach that quantifies systemic risk arising from overlapping portfolios. Nanda and Wei (2018) find evidence of "active" overlap management among mutual funds, which limits

[4] https://www.ft.com/content/a109ea46-1143-43f8-8d70-cba80b540f3f

interconnectedness and the exposure to liquidity risk. Bräuning and Fillat (2019) discuss findings of increased similarity among large banks in the United States subject to stress testing and argue that rebalancing after bad stress testing result in further increases in similarity. Analogously, Delpini et al. (2020) argue that rebalancing can be associated with increased portfolio similarity in the case of mutual funds. Moreover, Hawley and Wang (2021) find evidence of increased similarity in the credit portfolios of U.S. banks following the Covid-19 pandemic.

When addressing the increased similarity among financial institutions, several authors stress the role that insurance firms play and how that role has evolved. Neale et al. (2012) claim that insurance becoming more interrelated with other financial service firms is mostly driven by financial guarantees and life insurers. Cummins and Weiss (2014) provide an overview of potential sources of systematic risk in the U.S. insurance sector and stress the importance of a form of interconnectedness unique to the insurance sector —through reinsurance. Kartasheva (2014) discuss how financial innovation has changed the insurance business and altered the relationships of insurance companies to other financial intermediaries. Schwarcz and Schwarcz (2014) criticize the Dodd–Frank Act for overlooking the potential systemic risk stemming from correlation among individual insurance companies. Harrington (2016) highlights the negative consequences of designating individual life insurers as systematically relevant and argues for an activity-based approach to systemic risk monitoring. Whereas Chiang and Niehaus (2020) find that the correlated buying and selling of individual corporate bonds, which occurs among U.S. life insurers, is more pronounced in trades among systemically important financial institutions (SIFIs)[5] designated insurers. Barucca, Mahmood, and Silvestri (2021) conduct an empirical analysis of the interconnectedness between open-ended funds, banks, and insurance companies and discuss how that can serve as a channel of contagion in the event of fire sales. Girardi et al. (2021) provide evidence that portfolio similarity among insurance firms can be used to predict common selling. They argue that regulatory capital requirements and market stress can magnify this relationship. Jourde (2022) claims that interconnectedness in the insurance sector, unlike in other sectors, has strengthened over time.

The literature emphasizing the increased portfolio similarity among insurers and the potential risk stemming from it asks for a better understanding of the factors and channels that lead to increased similarity among insurers, as well as between insurers and other financial intermediaries. Reports from the Insurance Asset Outsourcing Exchange show that most insurers choose a few unaffiliated investment managers. Moreover they reveal that few asset managers gather most of mandates from different insurance firms, due to the requirement that an asset manager should fulfill (Insurance Asset Outsourcing Exchange (2016, 2020, 2022). If the same (external) asset managers are in charge of the management of the funds of different insurance firms, this could lead to more synchronization in the investment strategies of the outsourced assets. Barbu, Fricke, and Moench (2021) sustain that institutional fund managers trade procyclically and this could be a further indication of a different investment pattern for insurers that employ external asset managers. This paper contributes to this field of literature by studying whether an increase in unaffiliated asset management outsourcing is associated with a higher degree of common asset holding among insurers.

[5] A designation of the U.S. Department of the Treasury. See Designations | U.S. Department of the Treasury

A growing stem of literature has emphasized the important impact that insurers' portfolio choices have on asset prices (Koijen and Yogo (2022)). Ellul, Jotikasthira, and Lundblad (2011) show that the regulatory-induced sale of downgraded corporate bonds put downward pressure on their prices. Becker, Opp, and Saidi (2022) provide evidence that insurers crowd out other investors in new issuances of (high-yield) mortgage-backed securities (MBSs) following regulatory changes regarding the capital buffer for this asset class. Ellul et al. (2022) study how variable annuity guarantees in the U.S. life insurance industry provide an incentive for overweighting high-yield and illiquid bonds. They argue that these contracts and the induced allocation exacerbate fire sales in cases of market shock, leading thereby to an increased systemic risk (Ellul et al. (2022)). Jensen et. al (2024) show that procyclical behavior of pension funds facing liquidity risk affect the prices of short-term government bonds. Besides emphasizing the important impact of insurers' investment choices, in our context this literature is especially interesting in light of the NAIC reports on U.S. Insurance Industry Unaffiliated Investment Management. These reports state that one of the most common reasons insurance firms choose to outsource the management of some of their general asset is to have access to specialized strategies as high-yield bonds (NAIC (2011), NAIC (2017a), NAIC (2018), NAIC (2020)). This study aims to contribute to the existing literature by shedding some light on the impact that the trend of unaffiliated investment management in insurance has on the industry in terms of enhancing investment similarities in high-risk assets among insurers.

3. How could asset management outsourcing affect investment similarity in the insurance market?

Insurance firms have different organizational structure that are responsible for the various functions related to the management of their assets. In this paper, we study a specific aspect of insurers' asset management, namely, the decision to manage assets internally or to outsource the management of at least some of the assets to unaffiliated asset managers. We investigate whether the decision to outsource is associated with more similar investment portfolios among insurers, as measured by the cosine similarity of their holdings. To isolate the effect of the use of unaffiliated asset managers we need to consider other factors that drive the portfolio choices of insurers, such as their liabilities and the applicable regulatory requirements (NAIC (2017b)).

Typically, the investment strategy of an insurance firm is defined by its board and committees. However, insurers often outsource at least part of the implementation of their investment strategy to unaffiliated asset managers. In some cases, especially smaller insurers who may lack internal capacities, may choose to fully outsource their investment strategy and implementation; analog to what Clark and Urwin (2017) describe in the case of pension funds.

Insurance firms are important institutional investors (IMF (2002), ECB (2022), Koijen and Yogo (2022)), and many asset managers offer specialized insurance solutions. A large fraction of insurers has opted to use those external services and have their assets managed by specialized unaffiliated asset managers (NAIC (2022)). However, to the best of our knowledge there is no research studying whether investment solutions offered by external asset managers result in more investment similarity among insurers.

There are two main ways in which outsourcing asset management could be related to increased investment similarity among insurers. First, several insurers could be using the investment solutions provided by a few asset managers and this might lead to more similar investment decisions. This would then result in more aligned portfolio holdings among insurers than if the investment strategy decisions, as well as the implementation, were carried out independently by the internal teams of each insurer. Our hypothesis is not based on the assumption that asset managers offer one-size-fits-all solutions to insurers, and we are not aware of any literature suggesting that this might be the case. It is fair to believe that the asset allocation of an insurer is primarily determined by its liabilities, regardless of whether investment decisions are taken by internal or external asset managers. Yet, when the investment decisions of several insurers are taken by the same unaffiliated asset managers, the knowledge, expertise, and methodology used to reach those decisions is likely to be similar, if not the same. Second, the decision to outsource asset management might be related to the active decision of the insurer to invest in a more diverse portfolio that would not be accessible in a cost-efficient way if the assets were managed in-house. That would mean that outsourcing to external asset managers is a signal that the insurer is pursuing a more diverse investment strategy or is attempting to invest more in non-traditional asset classes. The trade-off between higher diversification and interconnectedness in terms of common holdings has been discussed in the banking context (Ibragimov, Jaffee, and Walden (2011), Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015)), and it is fair to consider that diversification attempts could be resulting in more similar investment portfolios in the insurance industry as well.

In this paper, we test empirically whether the use of unaffiliated asset manager services affects the resulting investment holdings of insurers by increasing their overlap. Although it is not possible to establish to what degree each of the two scenarios discussed above is linking asset management outsourcing to increased portfolio similarity, it is still informative to test the existence of this link empirically.

4. Data and methodology

Our analysis focuses on life, and property and causality insurers in the United States. We use security holding data from Schedule D filings to the NAIC as provided by the S&P Capital IQ. Schedule D provides data on the security holdings of the insurer at the calendar year-end. For each insurer, the securities held at year-end are listed at par value and book value. Part I of schedule D lists treasury, government, and corporate bonds and includes detailed information on the date they were acquired, maturity date, NAIC designation, and other information. Schedule D Part II, sections 1 and 2, list preferred stocks and common stocks held and provide details on their book value and market value, as well as the year they were acquired, NAIC designation, and other information. There are several measures of similarity proposed in the literature (Sias, Turtle, and Zykaj (2016), Bräuning and Fillat (2019), Girardi et al. (2021)). We consider cosine similarity to be suitable for our context and use it to measure the similarity of insurers' assets held. We use the sample period 2009 to 2021 to calculate the holding similarity among insurers. However, because of the shortest timeseries of availability of unaffiliated asset outsourcing data, the baseline analysis only employ data for the years 2016 to 2021.

To control for determinants of holdings' similarity among insurers, we use net asset (excluding separate accounts in the case of life insurers) and investment portfolio data from their annual financial

reports and filer type, as provided by S&P Capital IQ. In line with Girardi et al. (2021) we conduct the investment similarity analysis on a group level. For that, we aggregate data to the insurance group level using NAIC group numbers as provided by S&P Capital IQ, which results in a total sample of 1438 different insurers operating in P&C or life insurance. We classify insurer groups as life or P&C based on whether the group has more than 50% of its assets in the given type. We exclude insurance groups that are partly operating in health lines, as our study compares only investment holdings of life and P&C insurers. To proxy for the liability structure of insurers, we use premium data by minor line of business as classified and provided by S&P Capital IQ. Moreover, we construct an indicator to differentiate those insurer groups that had total assets (excluding separate accounts) of $50 billion[6] or more in at least one year between 2009 – 2021,[7] which results in 42 insurer groups designated as large in our sample.

We conduct the investment similarity analysis on the issuer and asset class levels, analogous to what Girardi et al. (2021) propose. The first 6 digits of the CUSIP are used to classify based on issuer; in order to classify based on asset class, first the information provided in Schedule D regarding the type of asset is used; furthermore, we make use of asset category information from Refinitiv. Subsequently, corporate bonds, equities, and preferred equities are classified in economic sectors based on Refinitiv Business Classification data, whereas municipal bonds are classified based on purpose, general purpose, or other (a detailed list of asset classes is given in Table A1 in the appendix). Holdings have been aggregated to the issuer or asset class level using par values for fixed income securities and book values for shares, and only positive holding values are considered.

Insurers in the United States were required to report the advisors with authority to make investment decisions on their behalf since year-end 2011. Starting with the year-end 2016 reporting, they were required to disclose whether investment managers were affiliated or unaffiliated, and if a single unaffiliated advisor managed more than 10% or more than 50% of their total assets. As NAIC and Insurance Investment Outsourcing Exchange report that insurers typically have 1- 4 unaffiliated asset managers, the indicator of percentage of assets managed by any single unaffiliated advisor is a good proxy for the percentage of total assets managed by unaffiliated firms. We make use of this indicator for the time period 2016-2021 to construct a measure of investment outsourcing on the insurance group level. The questions regarding unaffiliated asset managers are reported at the firm level, so we create a measure of unaffiliated asset management at the group level, calculated as follows:

$$P_g^{UAM} \geq \sum_{i \subset g} \frac{IP_i}{\sum_{i \subset g} IP_i} * I_i^{UAM} \tag{1}$$

$$\text{where } I_i^{UAM} = \begin{cases} 0.5 & if \geq 50\% \text{ of insurer i total assets are managed by an unaffiliated asset manager} \\ 0.1 & if \geq 10\% (< 50\%) \text{ of insurer i total assets are managed by an unaffiliated asset manager} \\ 0 & otherwise \end{cases}$$

The fraction of total investment portfolio holdings of insurer i, IP_i, over the total investment portfolio holdings of the group g is multiplied to 0.5 for each insurer in the group that reported that at least 50% of its assets are managed by unaffiliated asset managers, to 0.1 for each insurer in the group that reported that at least 10% (but not 50%) of its assets are managed by unaffiliated asset managers,

[6] The $50 billion threshold has been used by regulators for SIFI designation. See (Harrington (2014)).
[7] Considering also as "large" the insurer groups with total assets above the threshold in the years prior to the start of our sample allows us to be more conservative; however, the impact is minimal, as only two groups are affected.

and to zero otherwise. We sum over all insurers in the group to obtain the group level measure P_g^{UAM}.

Table 1: Summary statistics of insurers' portfolio composition.

	All (N=1154)			Life (N=245)			P&C (N=909)			Large (N=42)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Insurers' characteristics (billion $)												
Total assets incl. Separate accounts	7.941	0.111	41.107	27.132	0.481	77.169	2.768	0.083	20.478	167.344	105.350	137.702
Total assets excl. Separate accounts	5.658	0.110	28.219	16.656	0.413	45.720	2.693	0.083	20.199	114.611	78.485	95.682
Investment Portfolio	4.073	0.066	20.060	11.819	0.301	32.017	1.986	0.052	14.661	81.546	56.831	67.699
IP asset allocation (in %)												
Corporate bonds	34.27	32.48	21.72	46.29	48.67	22.58	31.03	29.40	20.31	40.26	38.45	14.67
GSE	7.44	3.45	10.37	7.07	2.50	12.56	7.53	3.73	9.70	5.15	3.73	4.67
Municipal bonds	16.43	9.46	19.24	10.23	6.09	13.18	18.10	11.71	20.25	8.92	6.01	9.02
US Government securities	12.26	6.09	16.64	9.95	2.87	18.33	12.89	7.33	16.10	7.42	4.04	8.64
ABS	3.31	0.33	6.02	4.70	1.12	8.84	2.94	0.19	4.94	6.34	4.51	5.94
CMBS	1.81	0.00	2.91	2.28	0.48	3.16	1.68	0.00	2.83	4.07	4.08	2.79
RMBS	0.90	0.00	2.63	1.68	0.23	4.04	0.69	0.00	2.06	2.98	1.40	4.24
Sovereign bonds	0.43	0.00	1.65	0.52	0.02	2.11	0.40	0.00	1.50	1.72	1.05	2.63
Equity	8.80	1.68	15.02	5.72	0.42	13.69	9.63	2.98	15.27	4.98	0.87	13.42
Preferred equity	1.27	0.00	4.48	2.16	0.29	6.93	1.03	0.00	3.51	0.51	0.29	0.74
Fund shares	8.84	1.82	16.76	2.79	0.14	7.44	10.48	3.29	18.14	0.41	0.08	0.71
Private placements	4.24	0.03	8.48	6.61	1.71	9.28	3.60	0.00	8.14	17.24	16.11	8.98
Issue / Issuer composition												
Number of Issues	695	204	1627	1387	402	2267	509	185	1348	6915	5472	4348
Number of Issuers	432	170	730	805	344	1073	332	154	566	3077	2889	1266
Concentration												
Concentration asset class	0.225	0.157	0.184	0.195	0.120	0.189	0.233	0.167	0.182	0.117	0.107	0.037
Concentration issuer	0.070	0.026	0.118	0.062	0.012	0.145	0.072	0.032	0.110	0.015	0.005	0.021

Note: This table presents summary statistics of some measures of asset composition in our sample for the period 2016 - 2021. The summary statistics are presented for the entire sample and for the subsamples of life insurers, P&C insurers, and large insurers. An insurer group is classified as a life insurer if more than 50% of its total assets come from operating in life lines of business and as P&C otherwise[8]. An insurer group is classified as large if its total assets (excluding separate accounts) were at least $50 billion at any year's end between 2009-2021. Investment portfolio is the dollar value of end-of-year holdings reported in Schedule D. Asset class allocations are based on the percentage of the dollar value invested in a certain asset class as a fraction of the total value of the investment portfolio at year's end. The number of issues is based on the number of unique CUSIP-s held, whereas the number of issuers is based on the first 6 digits of CUSIP. Concentration is measured as the Herfindahl-Hirschman Index based on weights allocated in each asset class or issuer, respectively. Mean, median, and standard deviation of the cross-sectional distribution of insurers' time series average are presented.

[8] Insurers classified as life in some years and P&C in other years are included only in the subsample where they are classified more often in the presentation of summary statistics, although we let them change classification over years in our analysis.

Note that this measure has the limitation of ignoring outsourcing from individual insurers that outsource management of less than 10% of their investment portfolio to unaffiliated asset managers. We will not use the continuous values of these measures, as they show only the minimum fraction of assets from the investment portfolio of the group managed by unaffiliated asset managers, but rather create two indicators at cutoff points. The first indicator takes the value 1 if the group reported any positive asset management outsourcing to unaffiliated asset managers, that is, P_g^{UAM}>0, and 0 otherwise; the second indicator takes the value 1 if the group has at least 50% of its investment portfolio managed by unaffiliated asset managers, that is, $P_g^{UAM} > 0.5$, and 0 otherwise.

Combining data on investment holding and outsourcing to unaffiliated asset managers allows us to test whether outsourcing investment management to unaffiliated asset managers enabled insurance companies to hold a more similar investment portfolio.

Table 1 provides an overview of the summary statistics of the characteristics of assets of insurers[9] in our sample. For each insurer, we compute the time-series average of each variable and present the cross-sectional mean, median, and standard deviation. The average total assets (excluding separate accounts) of insurers in our sample is $5.658 billion, with substantial differences between life insurers having an average of $16.656 billion and P&C insurers having an average of $2.693 billion. The average insurer in the sample has an investment portfolio of $4.073 billion, while the average large insurer has an investment portfolio of $81.546 billion.

The asset class composition of the investment portfolios is also presented in Table 1. As one would expect, the largest portion (76.85%) of the investment portfolio of insurers is invested in fixed income securities. Corporate bonds and municipal bonds constitute the asset classes with the largest single allocation, 34.27% and 16.43% for the average insurer, respectively. Life insurers in the sample allocated on average 46.29% of their investment portfolios to corporate bonds, whereas P&C insurers allocated on average 18.10% of their investment portfolio to municipal bonds. The average insurer in our sample invested 23.15% of its investment portfolio in equity, funds, and private placements, with equities and funds making up most of this allocation. We notice that allocation in private placements is substantially larger for large insurers with 17.24% on average,[10] while allocation to funds is only 0.41%.

The average number of issuers and issues held by insurers in our sample is also presented in Table 1. We use the first 6 digits of the CUSIP to identify issuers, and the full CUSIP to identify issues. The average number of issues held by insurers in our sample is 695 from an average of 432 different issuers, while large insurers hold on average 6915 issues from an average of 3077 issuers. Life insurers appear to hold substantially more issues and issuers on average (1387 and 805, respectively) compared to P&C insurers, who hold on average 509 issues from 332 different issuers. The difference likely comes from the fact that life insurers have larger investment portfolios on average.

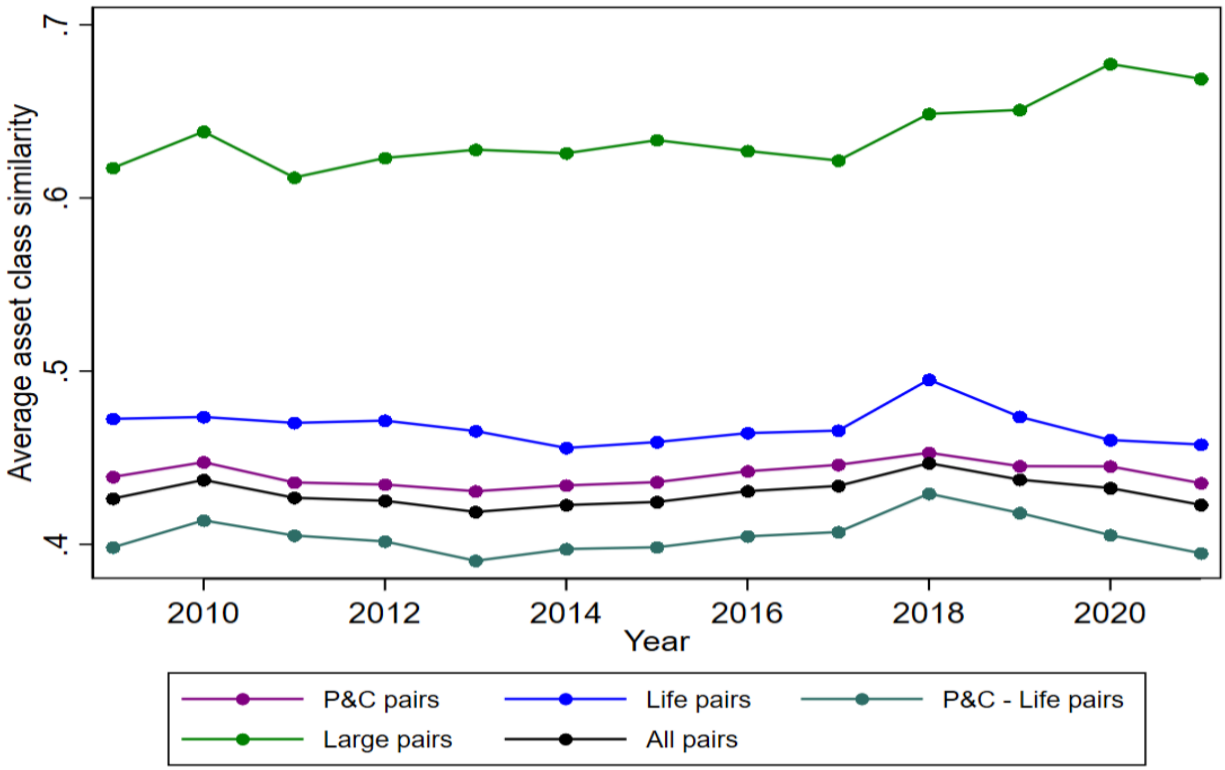
Finally, we present in Table 1 the average concentration index at issuer and asset class level, calculated as the Herfindahl-Hirschman Index.[11] Instead of the market share in the original formula,

[9] From here on, we will use the term "insurer" when referring to insurer groups and not individual insurers.
[10] Note that apart from the securities identified as private placements through the CUSIP number, we have also considered loans as part of the asset class private placements due to their liquidity characteristics.
[11] See Rhoades ((1993)).

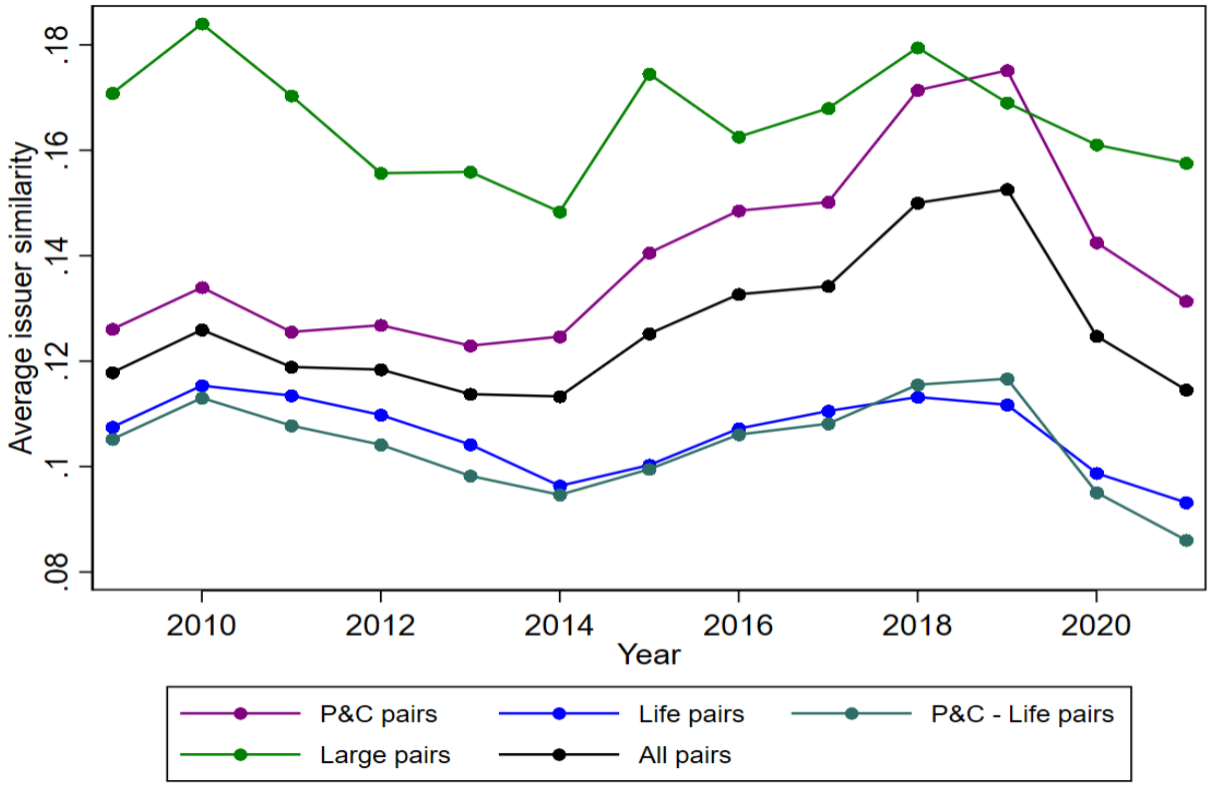
we use the weights of issuers and asset classes, respectively, in the portfolio of a given insurer. The average insurer in our sample displays an issuer concentration of 0.07 and an asset class concentration of 0.225, reflecting the fact that we have around 50,000 issuers in our sample and only 52 asset classes. Average values of the concentration index at issuer and asset class levels are much smaller for large insurers, (0.015 and 0.117, respectively), suggesting they hold more diversified portfolios. There are no meaningful differences in concentration measures between life and P&C insurers.

5. Asset management outsourcing and portfolio similarity – pairwise analysis

To be able to assess whether investment similarity is affected by outsourcing to unaffiliated asset managers, we need to measure investment similarity and account for other factors that affect it. We measure portfolio overlap using cosine similarity, as used by Sias, Turtle, and Zykaj (2016), Girardi et al. (2021) and Hoshi and Wang (2021). When using cosine similarity to measure overlap, it is important to define the granularity level of measurement. There is a trade-off between applying a very granular security-level analysis, which may not adequately reflect risk exposure and a very general asset allocation analysis, which may not be informative when it comes to investment similarities among insurers. We follow the approach of Girardi et al. (2021) and conduct the analysis on two levels of granularity: issuer and asset class. Insurance firms that outsource only a small part of their investment portfolio management typically retain the asset allocation function and primarily outsource the security selection function, whereas those that outsource the management of a larger fraction of their investment portfolio are more likely to also outsource the chief investment officer functions (Clark and Urwin (2017)). Therefore, the two levels of granularity considered should allow for adequate assessment of the relationship between investment management outsourcing to unaffiliated asset managers and investment similarities.



(a) Portfolio similarity at asset class level.



(b) Portfolio similarity at issuer level.

Figure 1: Average portfolio similarity through time.

This figure shows the average portfolio similarity as measured by cosine similarity at (a) asset class level and (b) issuer level at year's end for life and P&C insurers for the period 2009-2021. P&C pairs are those pairs in which both insurers have more than 50% of their total assets (excluding separate accounts) in P&C lines of businesses. Life pairs are those pairs in which both insurers have more than 50% of their total assets (excluding separate accounts) in life lines of businesses. P&C-life pairs are those pairs in which one of the insurers has more than 50% of its total assets (excluding separate accounts) in P&C lines of businesses, whereas the other has more than 50% of its total assets (excluding separate accounts) in life lines of businesses. Large pairs are those in which both insurers had total assets of $50 billion or more in at least one year over the period 2009-2021 (not necessarily in the same year).

Figure 1 presents the average portfolio similarity among different types of insurer pairs over the period 2009-2021; part (a) depicts cosine similarity at the asset class level, and part (b) depicts cosine similarity at the issuer level. We notice that the subsample of large pairs - that is, pairs of two insurers that are both classified as large - have a higher cosine similarity than the average pair in our sample at both the asset class and the issuer level. Cosine similarity at asset class level, which can be seen as an outcome of asset allocation decisions, displays an increasing trend for large insurers, while it is somehow stable for the average insurer pair in the overall sample. Average cosine similarity at the issuer level, which can be seen more as an outcome of security selection, is more volatile but does not display a clear trend over the years. Pairs where both insurers are of the same type, whether life or P&C, display a higher similarity at asset class compared to pairs where one is a life insurer and the other a P&C insurer. Meanwhile issuer level similarity seems to be lower on average for pairs of two life insurers or of one life and one P&C insurer than for other pairs in the sample.

Table 2: Determinants of portfolio similarity.

Panel A: Similarity on asset class level

	[1]	[2]	[3]	[4]	[5]
P&C pair	0.0565***	0.0272	0.0565***		
	(0.0027)	(0.0160)	(0.0027)		
Life pair	0.0383***	0.1094***	0.0373***		
	(0.0020)	(0.0128)	(0.0021)		
Prod size	0.0089***	0.0228***	0.0089***	0.0097***	0.0162***
	(0.0001)	(0.0030)	(0.0001)	(0.0005)	(0.0014)
Large pair	0.0848***			-0.0064	0.0696***
	(0.0134)			(0.0067)	(0.0130)
Prod conc AC	-0.8638***	-15.2189***	-0.8634***	-0.7735***	-1.1792***
	(0.0277)	(0.9555)	(0.0277)	(0.0227)	(0.1005)
Constant	0.1113***	-0.3548*	0.1111***	0.1356***	-0.1299*
	(0.0060)	(0.1462)	(0.0060)	(0.0181)	(0.0574)
Year FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.10	0.33	0.10	0.08	0.21
N	2,814,986	4,541	2,810,445	1,748,874	125,672

Panel B: Similarity on issuer level

	[1]	[2]	[3]	[4]	[5]
P&C pair	0.0556***	0.0884***	0.0555***		
	(0.0028)	(0.0082)	(0.0028)		
Life pair	-0.0052*	0.0973***	-0.0061**		
	(0.0022)	(0.0103)	(0.0022)		
Prod size	0.0052***	-0.0189***	0.0052***	0.0077***	0.0054***
	(0.0005)	(0.0033)	(0.0005)	(0.0009)	(0.0004)
Large pair	-0.0027			-0.0394**	0.0497***
	(0.0082)			(0.0118)	(0.0082)
Prod conc I	1.4332***	3.4349	1.4335***	1.4671***	1.2373***
	(0.2046)	(7.3939)	(0.2046)	(0.2232)	(0.2426)
Constant	-0.0917***	1.0471***	-0.0918***	-0.1304**	-0.1045***
	(0.0207)	(0.1662)	(0.0207)	(0.0334)	(0.0149)
Year FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.04	0.1	0.04	0.03	0.07
N	2,814,986	4,541	2,810,445	1,748,874	125,672

Note: The table presents OLS regression estimates for insurer pairs in the time period 2016-2021. The dependent variable is the cosine similarity between the pairs' portfolio weights at the asset class level in Panel A and the cosine similarity between the pairs' portfolio weights at the issuer level in Panel B. P&C pair is an indicator equal to one if both insurers in a pair are P&C insurers, and zero otherwise. Life pair is an indicator equal to one if both insurers in a pair are life insurers, and zero otherwise. Prod size is equal to the natural logarithm of the product of the pairs' investment portfolios' dollar value. Large pair is an indicator equal to one if both insurers in a pair are large insurers, and zero otherwise. Prod conc AC is the product of the pairs' Herfindahl-Hirschman Index calculated at the asset class level. Prod conc I is the product of the pairs' Herfindahl-Hirschman Index calculated at the issuer level. Column [1] presents the results for all pairs in the sample. Columns [2] and [3] present the results of large pairs and non-large pairs only, respectively. Columns [4] and [5] present estimates for P&C pairs and life pairs only, respectively. Year fixed effects have been controlled for. Standard errors clustered by year are presented in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively.

In order to study whether the decision to (partly) outsource asset management to unaffiliated asset managers is enabling insurance companies to hold a more similar investment portfolio, we first examine other factors mentioned in the literature as potentially driving investment similarity among insurers such as insurer type, size of investment portfolio, concentration, and being a large firm or not (potentially subject to different regulation) (Girardi et al. (2021)). Jing and Zhang (2021) find as well (online) social networks to explain corporate investment similarity; however, we do not have the data necessary to control whether this is true in the case of US insurers. As Jing and Zhang (2021) explain, one would not expect this effect to be as pronounced in a developed market. Furthermore, there is no evidence that social networks and outsourcing to unaffiliated asset managers could be correlated; therefore, not accounting for online social networks as an explanatory of investment similarity is not likely to bias our results.

A baseline analysis of determinants of investment portfolio similarity among insurers in our sample, which we will use as control variables, will allow us to check how unaffiliated investment management outsourcing combines with other explanatory variables. Table 2 presents the OLS estimators of the regression of cosine similarity at the asset class and issuer level, respectively, on an indicator of whether both insurers are life insurers, an indicator of whether both insurers are P&C insurers, the natural logarithm of the dot product of their investment portfolio holdings' value, an indicator of whether both insurers are classified as large, and the product of the concentration indexes measured at the asset class and issuer level, respectively. We use the logarithmic transformation of the product of investment portfolio holdings' value to address possible multicollinearity stemming from the correlation of investment portfolio holdings' value and the 'large' indicator; the point biserial correlation of the 'large' indicator with the dot product of investment portfolio value is -0.558, whereas that with the logarithmic form is -0.129.

The results in Table 2 mostly confirm the results of Girardi et al. (2021).[12] Differences are seen in the coefficient of the large pair indicator on asset class similarity, which is positive and significant in our results, while non-significant in Girardi et al. (2021). In the regression of cosine similarity at the issuer level, we find the effect of the large pair indicator to be negative but not statistically significant at 10%. We also run the regression for the sub-samples of life and P&C insurers separately, and find the large pair indicator to have a positive and statistically significant effect in explaining both asset class and issuer level similarity among life insurers, but a negative and less significant coefficient in explaining investment similarity among P&C insurers.

Using the variables from the baseline regressions as control variables, we can investigate the role of unaffiliated asset management outsourcing in explaining investment similarity among insurers. We construct to indicators of unaffiliated management outsourcing. The first indicator, UAM pair, takes the value 1 only if both insurers in the pair have used unaffiliated asset management, that is, the measure calculated in (1) is positive for both groups; the second indicator, UAM 50% pair, is 1 only if both insurers in the pair have outsourced the asset management of at least 50% of their investment portfolio to unaffiliated asset managers. We use these indicators at two cut-off points instead of the continuous value of $\mathbf{P_g^{UAM}}$ calculated in (1), as the measure per se is only measured as an approximation of the

[12] Their sample included US insurers in the time period 2002-2014 (Girardi et al. (2021)).

minimal value of the percentage of investment portfolio, whose management has been outsourced to unaffiliated asset managers.[13]

Panel A of Table 3 presents the results of including the indicators of unaffiliated asset management usage in explaining investment similarity among insurers at the asset class and issuer level, respectively. Firms that use unaffiliated asset management in managing their investment portfolio display a higher cosine similarity at both the asset class and issuer level; in either case, the results are statistically significant at 1%. This relationship is more pronounced among pairs of insurers that outsource the management of at least 50% of their investment portfolio. This suggests that insurers that have outsourced a larger portion of their investment portfolio invest more similarly both at the asset class and issuer level. Moreover, we observe that the coefficient of the second unaffiliated asset management indicator is larger in the regression of cosine similarity at the asset class level compared to that at the issuer level. A possible explanation for this could be that insurers who outsource the management of more than half of their investment portfolio could also delegate part of the asset allocation function to unaffiliated managers. All variables in our regression have Variance Inflation Factors (VIF) of less than two, which suggests that our regressions are not subject to multicollinearity. Nevertheless, as a robustness check,

Table 3: Unaffiliated Asset Management as a Determinant of Portfolio Similarity.
Panel A: Baseline analysis

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C pair	0.0485***	0.0487***	0.0479***	0.0481***
	(0.0025)	(0.0026)	(0.0026)	(0.0026)
Life pair	0.0434***	0.0429***	-0.0002	-0.0006
	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Prod size	0.0090***	0.0096***	0.0050***	0.0054***
	(0.0001)	(0.0001)	(0.0005)	(0.0005)
Large pair	0.0913***	0.0867***	0.0057	0.0024
	(0.0144)	(0.0140)	(0.0083)	(0.0081)
Prod conc I			1.5187***	1.5356***
			(0.2112)	(0.2111)
Prod conc AC	-0.8048***	-0.7957***		
	(0.0284)	(0.0291)		
UAM pair	0.0442***	0.0310***	0.0426***	0.0323***
	(0.0031)	(0.0023)	(0.0030)	(0.0033)
UAM 50% pair		0.0356***		0.0275***
		(0.0026)		(0.0032)
Constant	0.0906***	0.0700***	-0.0985***	-0.1130***
	(0.0059)	(0.0062)	(0.0223)	(0.0213)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.10	0.11	0.05	0.05
N	2,814,986	2,814,986	2,814,986	2,814,986

[13] Our results are robust to using other cut-off points, distant enough to allow for some variation in the data so as to avoid multicollinearity, and to using the continuous measure. Interpretation is more difficult in the latter case, given the nature of the measure.

Panel B: Controlling for liability similarity

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C pair	0.0410***	0.0412***	0.0506***	0.0508***
	(0.0024)	(0.0024)	(0.0028)	(0.0028)
Life pair	0.0327***	0.0321***	0.0036*	0.0031
	(0.0020)	(0.0019)	(0.0016)	(0.0016)
Liability similarity	0.0391***	0.0394***	-0.0140***	-0.0138***
	(0.0010)	(0.0009)	(0.0026)	(0.0027)
Prod size	0.0087***	0.0093***	0.0051***	0.0055***
	(0.0001)	(0.0001)	(0.0006)	(0.0005)
Large pair	0.0895***	0.0849***	0.0063	0.0030
	(0.0145)	(0.0141)	(0.0082)	(0.0080)
Prod conc I			1.5170***	1.5339***
			(0.2107)	(0.2106)
Prod conc AC	-0.8021***	-0.7929***		
	(0.0283)	(0.0290)		
UAM pair	0.0449***	0.0317***	0.0423***	0.0321***
	(0.0031)	(0.0023)	(0.0029)	(0.0033)
UAM 50% pair		0.0358***		0.0274***
		(0.0026)		(0.0033)
Constant	0.1001***	0.0794***	-0.1021***	-0.1165***
	(0.0060)	(0.0063)	(0.0229)	(0.0220)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.11	0.11	0.05	0.05
N	2,814,986	2,814,986	2,814,986	2,814,986

Note: The table presents OLS regression estimates for insurer pairs in the time period 2016-2021. In Columns [1] and [2], the dependent variable is the cosine similarity between the pairs' portfolio weights at asset class level. In Columns [3] and [4], the dependent variable is the cosine similarity between the pairs' portfolio weights at the issuer level. P&C pair is an indicator equal to one if both insurers in a pair are P&C insurers, and zero otherwise. Life pair is an indicator equal to one if both insurers in a pair are life insurers, and zero otherwise. Prod size is equal to the natural logarithm of the product of the pairs' investment portfolios' dollar value. Large pair is an indicator equal to one if both insurers in a pair are large insurers, and zero otherwise. Prod conc I is the product of the pairs' Herfindahl-Hirschman Index calculated at the issuer level. Prod conc AC is the product of the pairs' Herfindahl-Hirschman Index calculated at the asset class level. UAM pair is an indicator equal to one if both insurers in the pair reported asset management outsourcing to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM}}$>0, and zero otherwise. UAM 50% pair is an indicator equal to one if both insurers in the pair reported outsourcing management of at least 50% of their investment portfolio to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM}}$>0.5, and zero otherwise. Liability similarity is the cosine similarity of pairs' weights of the premiums collected in each line of business versus the total collected premiums. Year fixed effects have been controlled for. Standard errors clustered by year are presented in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% level, respectively.

in Panel A of Table A3 in the appendix we present the results of the regressions omitting the indicator for large pair, and there are no meaningful changes observed either in estimator values or on their significance levels.

One of the main drivers of an insurer's asset management are undoubtedly its liabilities. While the indicators of life or P&C pairs partially capture possible similarities on the liability side, they are not a fully accurate reflection of insurers' similarities on the liability side. This is especially true in the case of larger insurers that operate in different lines of business. We calculate a measure of liability similarity to capture more closely the structure of liabilities that insurers face and to control for it. This measure is constructed as the cosine similarity of the weights of the premiums that the group collects in each line of business[14] versus the total collected premiums. The results of including liability similarity as a control variable in the regression of determinants of portfolio similarity are presented in Table 3, Panel B. We notice that the estimated coefficients on the liability similarity are positive and statistically significant at 1% in explaining portfolio similarity at the asset class level, but are negative and significant at 1% in explaining portfolio similarity at the issuer level. Being cautious in interpreting the coefficients on the issuer similarity regression, we perform a multicollinearity test and obtain a Variance Inflation Factor (VIF) of less than two for all variables in our regression. Furthermore, we calculate the point biserial correlation between the cosine similarity of liabilities and the life pair and P&C pair indicators and obtain the values -0.127 and -0.244. These tests suggest that our estimates are unlikely to suffer from multicollinearity; nevertheless, we also run the regressions excluding the life pair and P&C pair indicators and present the results in Panel B of Table A3 in the appendix.

In either case, including a control variable that measures similarity in liability structure between the insurers in a pair does not affect the coefficients on the outsourced asset management indicators, which remain positive, of a comparable magnitude, and statistically significant at 1%. This indicates that the differences observed in portfolio similarity at the asset class and issuer level between insurers that outsource the management of part of their investment portfolio to unaffiliated asset managers and those who do not cannot be explained by differences in the liabilities that those insurers face.

These results suggest that investment management outsourcing might serve as a channel that leads to more similar holdings among insurers. In the case of investment similarity at the asset class level, it is not possible to determine from the available data whether the decision to invest in a more similar fashion is driven by the insurer's internal decision-making or is purely an outcome of outsourcing part of the investment portfolio management to unaffiliated asset managers. It is possible that the insurer has decided (internally) to diversify more among asset classes, and that this is leading to (on average) higher portfolio similarity at the asset class level with other insurers. The use of unaffiliated asset management enables investing in asset classes where internal investment expertise is not available. In the case of issuer-level similarity in the investment portfolio of insurers, it seems more plausible to think that management of (part of) the investment portfolio by unaffiliated asset managers leads to more similarities in security selection and thereby also in issuer similarity. However, it is not possible to rule

[14] Statutory lines of business as defined by S&P are as following. For Life Insurance: group accident and health, credit accident and health (group, individual), other accident and health, individual annuities, group annuities, industrial life, credit life (group, individual), ordinary life, group life, and supplementary contracts. For P&C insurance: private auto, homeowners and farm-owners, other and product liability lines combined, fire and allied lines combined, commercial auto, workers' compensation, commercial multiple peril, marine lines combined, medical professional liability, other commercial, fidelity and surety, accident and health, financial and mortgage guaranty, aircraft (all perils), and reinsurance nonproportional assumed.

out completely that the insurers that use unaffiliated asset management aim at diversifying more among issuers and use unaffiliated asset management to reach this goal possibly more cost-efficiently.

We note that insurer pairs that use unaffiliated asset managers display a lower joint portfolio concentration at both the asset class and issuer level. However, since we do not study or control for other possible drivers of portfolio concentration, we cannot claim a causal relationship. Nevertheless, this could indicate that insurers that use unaffiliated asset managers to manage (part of) their investment portfolio eventually hold portfolios that are more diversified, but also more similar to the investment portfolios of other insurers.

6. Asset management outsourcing and portfolio similarity – insurer-level analysis

In the previous section, we provide evidence that investment portfolios of insurer pairs that outsource the management of (part of) their investment portfolio to unaffiliated asset managers display a higher cosine similarity. In this section, we translate the pairs' portfolio similarity to an insurer level metric analogously to Girardi et al. (2021). This way we identify on the insurer level the impact of outsourcing (part of) investment portfolio management to unaffiliated asset managers on interconnectedness with other insurers. The insurer level measure is obtained by averaging an insurer's similarity with all other P&C and life insurers at a given point in time; in our case, for insurer i at year-end t, we have:

$$Similarity_Avg_{it} = \frac{\sum_{i \neq g} Cosine\ Similarity_{i,g}}{G-1} \quad (2)$$

where G is the number of insurers at year-end t. The same method is used for calculating insurer-level measures of investment portfolio similarity at the asset class and issuer level, as well as for the similarity of net underwritten premiums.

Our hypothesis is that those insurers that (partly) outsource the management of their investment portfolios to unaffiliated asset managers hold (on average) more similar portfolios to other P&C and life insurers. To test this hypothesis, we regress our average portfolio similarity measure at the asset class and issuer level on the indicators of unaffiliated asset management outsourcing. When doing so, we control for other variables that may affect insurers' average portfolio similarity with other insurers such as insurers' type, the size of its investment portfolio, whether it classifies as a large insurer, and concentration at the asset class or issuer level, respectively. The results presented in Panel A of Table 4 suggest that outsourcing to unaffiliated asset managers is positively related to average similarity with other insurers, measured both at the asset class and issuer level. This means that those insurers that choose to use unaffiliated asset managers are on average more connected to other insurers. We note that coefficients on the large indicator are negative in the regression of asset class similarity as well as in the regression of issuer similarity. We must be cautious in interpreting these results, since the point biserial correlation between the large indicator and the natural logarithm of the investment portfolio dollar value (IP size) is 0.468. Although the Variance Inflation Factor (VIF) is less than two for all variables in our regression (for all four regressions in Panel A of Table 4), we perform some additional robustness checks. Omitting the indicator variable "large" lowers the estimated coefficient on the natural logarithm of the investment portfolio dollar value (IP size), but has minimal effect on the magnitude and significance of other coefficients, whereas omitting the natural logarithm of the investment portfolio

dollar value (IP size) turns the estimated coefficients on the large indicator positive and significant in the regressions of average similarity at the issuer level, but has minimal effect on the estimated coefficients for the unaffiliated asset management outsourcing indicators. Therefore, it seems reasonable to assume that although the correlation between the indicator large and the natural logarithm of the investment portfolio dollar value IP size) might affect the estimated coefficients of these two variables, the evaluation of the effect of unaffiliated asset management remains robust.

Analogous to the previous section, we also consider the average similarity in liability structure as measured by the average similarity in net premiums underwritten by line of business as a possible explanatory variable of average similarity in investment portfolio. Estimation results presented in Panel B of Table 4 indicate that including an additional liability similarity measure does not affect the coefficients on asset management outsourcing measures. We notice that average liability similarity itself seems to be negatively related to average investment portfolio similarity at the issuer level, while it is not statistically significant in explaining average investment portfolio similarity at the asset class. Here again we exert some caution in interpreting the results and consider potential correlation between the average liability similarity measure and the P&C indicator. We note that their point biserial correlation is 0.42, and the Variance Inflation Factors (VIF) do not point to multicollinearity issues; however, we also look at the results of the regressions when omitting the P&C indicator. When omitting the P&C indicator we see that the coefficients on average liability similarity become statistically significant in explaining average investment portfolio similarity at the asset class level while remaining significant at 5% and 10%, respectively, in the two specifications of the regression of average investment portfolio similarity at the issuer level. All other estimated coefficients change only marginally when omitting the P&C indicator.

Table 4: Unaffiliated Asset Management as a Determinant of Portfolio Similarity on insurer level
Panel A: Baseline analysis.

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C	0.0291***	0.0294***	0.0349***	0.0355***
	(0.0023)	(0.0024)	(0.0022)	(0.0022)
IP size	0.0060***	0.0068***	0.0074***	0.0084***
	(0.0004)	(0.0003)	(0.0009)	(0.0009)
Large	-0.0622***	-0.0626***	-0.0285***	-0.0288***
	(0.0053)	(0.0051)	(0.0043)	(0.0041)
Concentration I			0.1942***	0.2002***
			(0.0300)	(0.0303)
Concentration AC	-0.3380***	-0.3345***		
	(0.0044)	(0.0049)		
UAM	0.0161***	0.0056**	0.0350***	0.0213***
	(0.0025)	(0.0020)	(0.0026)	(0.0028)
UAM 50%		0.0175***		0.0225***
		(0.0018)		(0.0025)
Constant	0.3684***	0.3541***	-0.0589**	-0.0758**
	(0.0077)	(0.0069)	(0.0199)	(0.0197)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.44	0.44	0.11	0.11

N	5,803	5,803	5,803	5,803

Panel B: Controlling for liability similarity

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C	0.0236***	0.0231***	0.0498***	0.0493***
	(0.0019)	(0.0021)	(0.0030)	(0.0031)
Avg liability similarity	0.0578***	0.0676***	-0.1595***	-0.1490***
	(0.0110)	(0.0111)	(0.0230)	(0.0234)
IP size	0.0056***	0.0064***	0.0086***	0.0094***
	(0.0004)	(0.0004)	(0.0010)	(0.0010)
Large	-0.0615***	-0.0618***	-0.0307***	-0.0308***
	(0.0053)	(0.0052)	(0.0044)	(0.0043)
Concentration I			0.1866***	0.1924***
			(0.0285)	(0.0287)
Concentration AC	-0.3359***	-0.3319***		
	(0.0042)	(0.0046)		
UAM	0.0172***	0.0063**	0.0320***	0.0199***
	(0.0025)	(0.0020)	(0.0023)	(0.0026)
UAM 50%		0.0185***		0.0203***
		(0.0018)		(0.0026)
Constant	0.3706***	0.3558***	-0.0669**	-0.0816**
	(0.0076)	(0.0068)	(0.0209)	(0.0207)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.44	0.44	0.12	0.12
N	5,803	5,803	5,803	5,803

Note: The table presents OLS regression estimates for insurer in the time period 2016-2021. In Columns [1] and [2], the dependent variable is the average portfolio similarity at the asset class level. In Columns [3] and [4], the dependent variable is the average portfolio similarity at the issuer level. P&C is an indicator equal to one for P&C insurers, and zero otherwise. IP size is equal to the natural logarithm of the investment portfolios' dollar value. Large is an indicator equal to one if the insurer had total assets (excluding separate accounts) of at least $50 billion at least once during 2009-2021, and zero otherwise. Concentration I is the Herfindahl-Hirschman Index calculated at the issuer level. Concentration AC is the Herfindahl-Hirschman Index calculated at the asset class level. UAM is an indicator equal to one if the insurer reported asset management outsourcing to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM} > 0}$, and zero otherwise. UAM 50% is an indicator equal to one if the insurer reported outsourcing the management of at least 50% of its investment portfolio to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM}}$>0.5, and zero otherwise. Liability similarity is the average similarity of net underwritten premiums. Year fixed effects have been controlled for. Standard errors clustered by year are presented in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% level, respectively.

We return to the interpretation of the coefficients of unaffiliated asset management outsourcing in the regressions of average investment portfolio similarity. We find that use of unaffiliated asset management (UAM) has a higher coefficient as a determinant of average investment portfolio similarity at the issuer level versus investment portfolio similarity at asset-class level. However, when adding an additional indicator of whether 50% or more of the investment portfolio is managed by unaffiliated asset managers (UAM 50%), its coefficient is slightly lower than the coefficient of UAM in explaining issuer-level similarity, but is much larger than the coefficient of UAM in explaining asset class-level similarity. This result can be interpreted as supporting the argument that outsourcing the management of a smaller part of the investment portfolio to unaffiliated asset managers primarily implies the outsourcing of (part

of) the security selection function and therefore affects more similarity at the issuer level, whereas outsourcing the management of more than half of the investment portfolio to unaffiliated asset managers is likely related to outsourcing not only (part of) security selection functions, but also (part of) asset allocation decision-making and therefore has a more pronounced relationship with increased average similarity at the asset class level. Repeating the analysis using the interaction term of the two indicators of unaffiliated asset management sustains these findings.

Lastly, we divide our sample in two parts to study separately the investment similarity of those insurers that switch from not using to using unaffiliated investment management outsourcing within our study period and the investment similarity of those insurers that neither initiate nor terminate the use of outsourced investment managers within our study period. This approach allows us to check the robustness of our findnings.

6.1. Effect of initiating the use of outsourced investment management on investment similarity

Work in progress…

6.2. Investment similarity of insurance groups that do not initiate/ terminate the use of outsourced investment management in the sample period

Work in progress…

7. High-risk versus low-risk investment similarity – which one is related to the insurers' outsourcing of asset management?

In this section we analyze whether the use of unaffiliated asset management services is associated with more investment similarity among insurers in securities and asset classes that are considered low-risk or high-risk. We classify insurers' holdings in a similar fashion to Girardi et al. (2021) and Ellul et al. (2022).[15] We consider equity, preferred equities, fund shares, and US government securities as low-risk and private placements, RMBS, CMBS, and ABS as high-risk. Moreover, we classify corporate bonds, municipal bonds, GSE securities, and sovereign bonds as low-risk if they have a NAIC designation of two or less[16], and as high-risk otherwise. To that end, we use NAIC designation data as disclosed in the NAIC Schedule D reports of insurers, and, when not available, use S&P ratings as provided by Wharton Research Data Services. The conversion of S&P rating to NAIC designation is done as per NAIC disclosed instructions.

We calculate the pairs' cosine similarities and the product of Herfindahl-Hirschman Indexes in the high-risk and low-risk space separately. For the sake of comparison, we exclude those insurers that are invested only in high-risk or only in low-risk securities. This reduces our sample to 1'872'537 pairs.

Estimates form the OLS regression, presented in Table 5, show how the role of different indicators in explaining cosine similarity among insurer pairs differs in the low-risk versus high-risk space. Pairs

[15] See the classification into „liquid" or "illiquid" in Ellul et al. ((2022)).
[16] Or equivalent rating when NAIC designation data are not available.

of two P&C insurers, in comparison to other pairs, seem to display a higher similarity in their holdings of low-risk securities. The large pair indicator is not statistically significant in explaining asset class level similarity in low-risk holdings, and only significant at 5% in explaining issuer level similarity in low-risk holdings, while highly significant and of a greater magnitude in explaining similarity at both asset class and issuer level in high-risk holdings. On the one hand, the product of the concentration indexes at issuer level, plays a bigger role in explaining issuer similarity in low-risk holdings while of a lower magnitude and only significant at 5% in explaining issuer similarity in high-risk holdings. On the other hand, the product of the concentration indexes at asset class level is associated with a lower asset class similarity in low-risk holdings but a higher asset class similarity in high-risk holdings.

Table 5: Unaffiliated Asset Management as a Determinant of Portfolio Similarity by risk group.
Panel A: Portfolio similarity in the low-risk space.

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C pair	0.0360***	0.0362***	0.0711***	0.0712***
	(0.0031)	(0.0032)	(0.0033)	(0.0034)
Life pair	0.0681***	0.0673***	0.0114***	0.0112***
	(0.0023)	(0.0023)	(0.0028)	(0.0028)
Liability similarity	0.0316***	0.0322***	-0.0206***	-0.0204***
	(0.0033)	(0.0032)	(0.0041)	(0.0041)
Prod size	0.0098***	0.0104***	0.0105***	0.0106***
	(0.0003)	(0.0004)	(0.0008)	(0.0008)
Large pair	-0.0175	-0.0218*	0.0394**	0.0383**
	(0.0099)	(0.0094)	(0.0103)	(0.0104)
Prod conc I			4.5765***	4.5852***
			(0.3760)	(0.3781)
Prod conc AC	-1.5770***	-1.5706***		
	(0.0428)	(0.0435)		
UAM pair	0.0585***	0.0479***	0.0583***	0.0556***
	(0.0024)	(0.0019)	(0.0031)	(0.0034)
UAM 50% pair		0.0315***		0.0080
		(0.0033)		(0.0045)
Constant	0.1298***	0.1091***	-0.2905***	-0.2956***
	(0.0126)	(0.0131)	(0.0296)	(0.0299)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.11	0.11	0.09	0.09
N	1,872,537	1,872,537	1,872,537	1,872,537

Panel B: Portfolio similarity in the high-risk space.

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C pair	0.0136**	0.0138**	0.0026**	0.0026**
	(0.0034)	(0.0035)	(0.0009)	(0.0009)
Life pair	-0.0322***	-0.0330***	0.0089***	0.0089***
	(0.0028)	(0.0029)	(0.0007)	(0.0007)
Liability similarity	0.0604***	0.0610***	0.0203***	0.0204***
	(0.0037)	(0.0038)	(0.0011)	(0.0011)
Prod size	0.0319***	0.0324***	-0.0013***	-0.0013***
	(0.0006)	(0.0007)	(0.0001)	(0.0001)
Large pair	0.1029***	0.0986***	0.0261***	0.0256***
	(0.0058)	(0.0066)	(0.0019)	(0.0018)
Prod conc I			0.1279**	0.1323**
			(0.0378)	(0.0370)
Prod conc AC	6.1867***	6.2520***		
	(1.2808)	(1.2744)		
UAM pair	0.0879***	0.0771***	0.0041**	0.0030
	(0.0024)	(0.0034)	(0.0014)	(0.0015)
UAM 50% pair		0.0319***		0.0033***
		(0.0073)		(0.0003)
Constant	-0.9459***	-0.9658***	0.0598***	0.0577***
	(0.0204)	(0.0247)	(0.0046)	(0.0044)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.13	0.14	0.02	0.02
N	1,872,537	1,872,537	1,872,537	1,872,537

Note: The table presents OLS regression estimates for insurer pairs in the time period 2016-2021. In Columns [1] and [2], the dependent variable is the cosine similarity between the pairs' portfolio weights at asset class level among low-risk securities in Panel A and among high-risk securities in Panel B. In Columns [3] and [4], the dependent variable is the cosine similarity between the pairs' portfolio weights at the issuer level among low-risk securities in Panel A and among high-risk securities in Panel B. P&C pair is an indicator equal to one if both insurers in a pair are P&C insurers, and zero otherwise. Life pair is an indicator equal to one if both insurers in a pair are life insurers, and zero otherwise. Prod size is equal to the natural logarithm of the product of the pairs' investment portfolios' dollar value. Large pair is an indicator equal to one if both insurers in a pair are large insurers, and zero otherwise. Prod conc I is the product of the pairs' Herfindahl-Hirschman Index calculated at the issuer level, among low risk securities in Panel A and among high risk securities in Panel B. Prod conc AC is the product of the pairs' Herfindahl-Hirschman Index calculated at the asset class level, among low risk securities in Panel A and among high risk securities in Panel B. UAM pair is an indicator equal to one if both insurers in the pair reported asset management outsourcing to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM}}$>0, and zero otherwise. UAM 50% pair is an indicator equal to one if both insurers in the pair reported outsourcing management of at least 50% of their investment portfolio to unaffiliated asset managers, that is, $\boldsymbol{P_g^{UAM}}$>0.5, and zero otherwise. Liability similarity is the cosine similarity of pairs' weights of the premiums collected in each line of business versus the total collected premiums. Year fixed effects have been controlled for. Standard errors clustered by year are presented in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% level, respectively.

The use of unaffiliated asset management by both insurers in the pair is associated with a higher cosine similarity at asset class level. The estimated coefficients on the unaffiliated asset management outsourcing indicators are positive and significant in explaining cosine similarity at asset class level in both low-risk as well as high-risk holdings, with of a higher magnitude in high-risk holdings. When it

comes to explaining cosine similarity at issuer level, we notice that, in low-risk holdings, the estimated coefficient on the unaffiliated asset management outsourcing is positive and significant. However, the entire effect seems to be captured by the indicator of whether both insurers in the pair use outsourced asset management at any level, and the coefficient on the indicator of whether both insurers outsourced the management of more than 50% of their investment portfolio is not significant. In the high-risk space the estimated coefficient on the indicator of the use of unaffiliated asset management seem to be lower and less significant. However, the coefficient on the indicator of the use of unaffiliated asset management for more than 50% of the investment portfolio remains significant. A possible explanation for the lower role of unaffiliated asset management use in explaining cosine similarity at issuer level in the high-risk space, could be the use of unaffiliated asset managers in managing strategies such as private placements which mostly by construction do not display overlaps in holdings at issuer level.

8. Regulatory implications and outlook

While the recent literature has emphasised the importance of increasing interconnectedness of the insurance sector and the systemic risk potential stemming from it, there are limited studies on what is driving and enabling this increased interconnectedness. We are the first to study unaffiliated asset management outsourcing, a persistent trend in the insurance industry since the financial crises of 2008, as a potential channel that enables insurance firms to hold more similar investment portfolios. Asset management outsourcing has been extensively studied in the mutual fund space, but little is known about the specifics of its use in the insurance sector, although it has been recognised in the literature that insurers act as (shadow) asset managers.

In this paper, we investigate whether unaffiliated asset management outsourcing can be associated with higher investment portfolio similarity among insurers. We use pairs' cosine similarity as a measure of investment portfolio similarity and calculate it at two granularity levels: asset class and issuer. Developing a measure of unaffiliated asset management outsourcing, we create two indicators that identify whether an insurer outsources to unaffiliated asset managers and whether the portion of the investment portfolio whose asset management is outsourced to unaffiliated asset managers exceeds 50%.

Our measure of investment portfolio similarity is based on holding values of insurers' portfolios and partly relies on book values. The use of book values is an imperfect reflection of actual portfolio allocation as, for instance, it does not consider hidden reserves. However, unlike other measures of interconnectedness, it does not rely on market prices and therefore can also be calculated for non-public insurers as long as they disclose security (issuer or asset class) level data. Another limitation of our study comes from approximating the percentage of the investment portfolio of insurers that is managed by external asset managers. A fully accurate measure is currently not available, given that insurers are not required to report the percentage or amount of their assets that are managed by external asset managers.

We provide evidence that insurer pairs' similarity of investment portfolio holdings is positively related to the use of unaffiliated asset management. Furthermore, our results indicate that while outsourcing to unaffiliated asset managers among insurers is more strongly related to investment similarity at the issuer level, insurers that outsource the management of a higher portion of their investment portfolio to unaffiliated asset managers also display a higher similarity in holdings at the asset class level.

Our results indicate the importance of unaffiliated asset management outsourcing in shaping or reflecting insurers' investment decisions that lead to increased investment portfolios' holding similarity between P&C and life

insurers. In light of research affirming that higher portfolio similarity leads to larger common sales in cases of market distress (Girardi et al. (2021)), identifying channels that enable higher portfolio similarity serves in informing regulators. Currently insurers are required to disclose the full list of parties that can make investment decisions on their behalf and to disclose whether any of the unaffiliated entities manage more than 10% or 50% of their invested assets. Our results underline the need for more detailed reporting and serve as an argument for requesting insurers to disclose the percentage of their invested assets that are managed by unaffiliated asset managers to allow for better monitoring. Regulatory institutions could also request insurers to report security holding data identifying whether they are managed by unaffiliated asset managers at least to monitoring institutions, if not publicly. This would allow for an assessment of the role of unaffiliated asset management in more detail.

In the context of the FSOC's activity-based approach of monitoring non-financial institutions, our results suggest that the degree of using unaffiliated asset management can be used to screen for insurers whose investment portfolios display high portfolio similarity with those of other insurers. While holding an investment portfolio that has a certain similarity to that of other insurers need not be an issue per se, it can be a channel of systemic risk transmission in the event of a market shock and/or in conjunction with regulatory capital constrains. In that respect, the percentage of invested assets managed by unaffiliated asset managers can serve as an ex-ante signal of further monitoring needs.

In this paper, we study only the relationship between use of unaffiliated asset managers by insurers and higher portfolio similarity. Our results cannot be seen as suggesting restricting the use of unaffiliated asset management. There are other aspects in which unaffiliated asset management could affect the investment portfolio of insurers that have not been studied here. Considering the literature on the trade-off between diversification and interconnectedness would be of interest for future research studying the impact of use of unaffiliated asset management on insurers' investment portfolio diversification. Furthermore, it would be of interest to study whether the use of unaffiliated asset managers alters the risk-return profiles of insurers.

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Appendix

Table A1: Asset classes

Asset backed securities (other than CMBS and RMBS)
Commercial mortgage-backed securities
Corporate bonds: Academic & Educational Services
Corporate bonds: Basic Materials
Corporate bonds: Consumer Cyclicals
Corporate bonds: Consumer Non-Cyclicals
Corporate bonds: Energy
Corporate bonds: Financials
Corporate bonds: Government Activity
Corporate bonds: Healthcare
Corporate bonds: Industrials
Corporate bonds: Institutions, Associations & Organizations
Corporate bonds: Others
Corporate bonds: Real Estate
Corporate bonds: Technology
Corporate bonds: Utilities
Equity: Academic & Educational Services
Equity: Basic Materials
Equity: Consumer Cyclicals
Equity: Consumer Non-Cyclicals
Equity: Energy
Equity: Financials
Equity: Government Activity
Equity: Healthcare
Equity: Industrials
Equity: Institutions, Associations & Organizations
Equity: Others
Equity: Real Estate
Equity: Technology
Equity: Utilities
Government sponsored entity mortgage
Municipal bonds: General purpose
Municipal bonds: non-general purpose
Mutual fund shares
Preferred equities: Academic & Educational Services
Preferred equities: Basic Materials
Preferred equities: Consumer Cyclicals
Preferred equities: Consumer Non-Cyclicals
Preferred equities: Energy
Preferred equities: Financials
Preferred equities: Government Activity
Preferred equities: Healthcare
Preferred equities: Industrials
Preferred equities: Institutions, Associations & Organizations
Preferred equities: Others
Preferred equities: Real Estate
Preferred equities: Technology
Preferred equities: Utilities
Private Placements
Residencial mortgage-backed securities
Sovereign bonds
US government securities (including securities guaranteed by US government and those issued by federal agencies)

Table A2: Variable definition.

Variable	Definition
Avg cosine similarity AC	The average of an insurer's cosine similarities AC with all other insurers.
Avg cosine similarity I	The average of an insurer's cosine similarities I with all other insurers.
Avg liability similarity	The average of an insurer's cosine similarities of underwritten premiums with all other insurers.
Concentration AC	Asset class level Herfindahl Hirschman index of an insurer's investment portfolio.
Concentration I	Issuer level Herfindahl Hirschman index of an insurer's investment portfolio.
Cosine similarity AC	Insurer pairs' cosine similarity of asset class level weights of the investment portfolio.
Cosine similarity I	Insurer pairs' cosine similarity of issuer level weights of the investment portfolio.
G	The number of insurers at year-end t.
I_i^{UAM}	Categorical variable equal to 0.5 if the insurer i has reported that more than 50% of assets in its investment portfolio are managed by a single unaffiliated asset manager; equal to 0.1 if the insurer i has reported that more than 10% but less than 50% of assets in its investment portfolio are managed by a single unaffiliated asset manager, and 0 otherwise.
IP size	Natural logarithm of the dollar value of insurers' investment portfolios.
Large	Indicator variable that equals 1 if insurers' total assets excluding separate accounts were at least $50 billion at least once in the time period 2009-2021, and 0 otherwise.
Large pair	Indicator variable that equals 1 if both insurers in the pair had total assets (excluding separate accounts) of at least $50 billion at least once in the time period 2009-2021, and zero otherwise.
Liability similarity	Insurer pairs' cosine similarity of underwritten premiums.
Life pair	Indicator variable equal to 1 if both insurers in the pair have more than 50% of total assets (excluding separate accounts) in life lines of business and 0 otherwise.
P_g^{UAM}	Weighted average of I_i^{UAM} for individual insurers in an insurance group, where weights are the dollar value of the investment portfolio of an individual insurer over the total dollar value of the investment portfolios of all insurers in the insurance group.
P&C	Indicator variable equal to 1 if more than 50% of insurers' total assets (excluding separate accounts) are in P&C lines of business, and 0 otherwise.
P&C pair	Indicator variable equal to 1 if both insurers in the pair have more than 50% of total assets (excluding separate accounts) in P&C lines of business, and 0 otherwise.
Prod conc AC	Dot product of Concentration AC of insurers in the pair.
Prod conc I	Dot product of Concentration I of insurers in the pair.
Prod size	Natural logarithm of the product of the dollar values of investment portfolios of insurers in the pair.
UAM	Indicator variable equal to 1 if $P_g^{UAM} > 0$ and 0 otherwise.
UAM 50%	Indicator variable equal to 1 if $P_g^{UAM} > 0.5$, and 0 otherwise.
UAM 50% pair	Indicator variable equal to 1 if both insurers in the pair have $P_g^{UAM} > 0.5$, and 0 otherwise.
UAM pair	Indicator variable equal to 1 if both insurers in the pair have $P_g^{UAM} > 0$, and 0 otherwise.

Table A3: Unaffiliated Asset Management as a Determinant of Portfolio Similarity – robustness checks.

Panel A: Baseline analysis, excluding large pair indicator.

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
P&C pair	0.0485***	0.0487***	0.0479***	0.0481***
	(0.0025)	(0.0026)	(0.0026)	(0.0026)
Life pair	0.0443***	0.0437***	-0.0001	-0.0006
	(0.0021)	(0.0020)	(0.0020)	(0.0020)
Prod size	0.0091***	0.0097***	0.0050***	0.0054***
	(0.0001)	(0.0001)	(0.0005)	(0.0005)
Prod conc I			1.5190***	1.5357***
			(0.2109)	(0.2108)
Prod conc AC	-0.8027***	-0.7937***		
	(0.0285)	(0.0292)		
UAM pair	0.0441***	0.0308***	0.0426***	0.0323***
	(0.0031)	(0.0023)	(0.0030)	(0.0033)
UAM 50% pair		0.0358***		0.0275***
		(0.0026)		(0.0032)
Constant	0.0859***	0.0654***	-0.0987***	-0.1131***
	(0.0063)	(0.0068)	(0.0219)	(0.0210)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.10	0.11	0.05	0.05
N	2,814,986	2,814,986	2,814,986	2,814,986

Panel B: Controlling for liability similarity, excluding insurer-type indicators.

	Asset Class		Issuer	
	[1]	[2]	[3]	[4]
Liability similarity	0.0601***	0.0394***	0.0087**	0.0089**
	(0.0017)	(0.0009)	(0.0026)	(0.0026)
Prod size	0.0079***	0.0093***	0.0037***	0.0041***
	(0.0001)	(0.0001)	(0.0005)	(0.0005)
Large pair	0.0906***	0.0849***	-0.0007	-0.0040
	(0.0149)	(0.0141)	(0.0086)	(0.0083)
Prod conc I			1.5148***	1.5311***
			(0.2219)	(0.2216)
Prod conc AC	-0.7915***	-0.7929***		
	(0.0261)	(0.0290)		
UAM pair	0.0511***	0.0317***	0.0512***	0.0413***
	(0.0029)	(0.0023)	(0.0033)	(0.0037)
UAM 50% pair		0.0358***		0.0266***
		(0.0026)		(0.0033)
Constant	0.1534***	0.0794***	-0.0255	-0.0392
	(0.0047)	(0.0063)	(0.0214)	(0.0200)
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.10	0.11	0.04	0.04
N	2,814,986	2,814,986	2,814,986	2,814,986

Note: The table presents OLS regression estimates for insurers' pairs in the time period 2016-2021. In Columns [1] and [2], the dependent variable is the cosine similarity between the pairs' portfolio weights at the asset class level. In Columns [3] and [4], the dependent variable is the cosine similarity between the pairs' portfolio weights at issuer level. P&C pair is an indicator equal to one if both insurers in a pair are P&C insurers, and zero otherwise. Life pair is an indicator equal to one if both insurers in a pair are life insurers, and zero otherwise. Prod size is equal to the natural logarithm of the product of the pairs' investment portfolios' dollar value. Prod conc I is the product of the pairs' Herfindahl-Hirschman Index calculated at the issuer level. Prod conc AC is the product of the pairs' Herfindahl-Hirschman Index calculated at the asset class level. UAM pair is an indicator equal to one if both insurers in the pair reported asset management outsourcing to unaffiliated asset managers, that is, $P_g^{UAM}>0$, and zero otherwise. UAM 50% pair is an indicator equal to one if both insurers in the pair reported outsourcing the management of at least 50% of their investment portfolio to unaffiliated asset managers, that is, $P_g^{UAM}>0.5$, and zero otherwise. Liability similarity is the cosine similarity of a pairs' weights of the premiums collected in each line of business versus the total collected premiums. Large pair is an indicator equal to one if both insurers in a pair are large insurers and zero otherwise. Year fixed effects have been controlled for. Standard errors clustered by year are presented in parentheses. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% level, respectively.