Insurers' Carbon Underwriting Policies*

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Abstract

We study the determinants, structure, implementation, and effects of carbon underwriting policies among the world's largest insurers. Adoption is more common among European insurers and less so among specialty and unlisted firms, with coal policies preceding those for oil and gas. Using novel mine-insurance data, we show that implementation is often incomplete, and some insurers expand coal coverage despite commitments. On average, insurers reduce the number of insured mines by 16%, insured coal volumes by 56%, and make continued coverage 13pp less likely. Affected mines are more likely to be abandoned and experience constrained operations.

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"*[T]he insurance sector has a key role to play. [...] We need net zero commitments to cover your underwriting portfolios, and this should include the underwriting of coal—and all fossil fuels.*"

– António Guterres, UN Secretary-General at the Insurance Development Forum 2021

1 Introduction

To combat climate change, some insurers have begun to restrict insurance coverage for coal, oil, and gas projects through formalized "carbon underwriting policies." While expectations for these policies are high, as underscored by the remarks of UN Secretary-General Guterres, it remains ambiguous whether underwriting decisions meaningfully influence decarbonization. On the one hand, insurers have strong incentives to act, as they bear significant costs of climate-related disasters, and possess a powerful lever to shape firm behavior, because insurance coverage is often a legal requirement for carbon-intensive projects. On the other hand, actions by individual insurers may be undermined by coordination and horizon challenges, as the costs of climate change build up in the future, while insurers can still profit from ongoing underwriting in the short run. This paper provides the first systematic analysis of insurers' carbon underwriting policies and their effects on carbon-intensive projects, examining a novel mechanism through which financial institutions influence firm behavior, with potential implications for the net-zero transition.

An empirical analysis of carbon underwriting policies and their effects faces three major challenges. First, carbon underwriting policies are a recent phenomenon in the insurance sector and lack a standardized format, making a systematic assessment difficult. Second, insurance contracts for carbon-intensive projects are not publicly disclosed, complicating the evaluation of whether carbon underwriting restrictions are implemented in line with public commitments. Third, comprehensive data on insured projects are necessary to assess the real effects of carbon underwriting policies, but such data are difficult to obtain.

This study exploits a setting that allows us to make significant progress on each of these three challenges. Specifically, we link information on insurers' carbon underwriting policies to rich data on insured carbon-intensive projects via insurance certificates, enabling empirical analyses of the policies' determinants, structure, implementation, and effects. First, to address the lack of standardization in carbon underwriting policies, we rely on scorecards from Insure Our Future (IOF), a coalition of NGOs. These scorecards provide consistent, comparable measures on the presence, scope, and stringency of carbon underwriting policies across the world's major Property & Casualty (P&C) insurers.[1] Second, to overcome the opacity of insurance contracting, we file Freedom of Information Act (FOIA) requests to obtain insurance certificates for coal mines in the United States, as possessed by state-level regulators. These certificates reveal the identity of the underwriting insurers, allowing us to assess whether insurers' underwriting practices align with public commitments. Third, to examine the real effects of these policies, we match insurer decisions to granular mine-level information from the Mine Safety and Health Administration (MSHA). This allows us to study whether carbon underwriting policies affect project-level outcomes such as production, employment, and the suspension of operations in coal mining—the upstream source of the single largest driver of human-induced climate change (IEA, 2021; ClientEarth, 2022).

We present three main findings. First, we trace the evolution of policies for coal as well as oil & gas projects, examining their prevalence, structure, and stringency. We uncover that such policies have become more common and stringent since 2017. Early adopters in our sample focused primarily on restricting coal underwriting, while restrictions on oil & gas underwriting typically followed a few years later. However, underwriting policies are highly heterogeneous across insurers and often remain vague—for example, by excluding only specific projects from insurance coverage rather than entire carbon-intensive clients. Only a

[1] Green and Vallee (2025) use similar data on the exit policies of banks for fossil fuel lending, which are collected by Reclaim Finance, an NGO that is part of IOF.

minority of insurers commit to a full coal phase-out with a clear transition strategy, and even fewer actively engage clients to support decarbonization. Compared to their European counterparts, U.S. insurers are 48–52% less likely to adopt a coal policy, while Asian insurers are 38–47% less likely, and those from other regions are 25–33% less likely. Specialty insurers are 24% less likely to adopt a policy, and unlisted insurers are 32% less likely, highlighting the role of reputation and transparency in driving policy adoption. We also document that carbon underwriting policies do not simply reflect insurers' ESG-related divestment or screening policies on the investment side.

Second, we study changes in underwriting activity around the adoption of such policies to uncover how coal underwriting policies are implemented. Adoptions of coal policies are associated with a reduction in insurers' coverage of coal projects. On average, policy-adopting insurers reduce the number of insured coal mines by 16% (about 3.3 mines) and the volume of insured coal by 56% (about 3.3 million short tons, MMst), relative to non-adopters. These averages, however, mask important heterogeneity: not all policy-adopting insurers reduce coverage, and some even increase the number of mines they insure. Nonetheless, the aggregate pattern is consistent with a meaningful reduction in coal coverage following policy adoptions.

To address the concern that some of these results reflect time-varying sorting effects between insurers and mines, rather than the causal effects of coal policies, we conduct tests that identify effects from changes in insurer-mine relationships. Specifically, we exploit that mines obtain coverage by multiple insurers at a given point in time, allowing us to compare how different insurers adjust coverage for the same mine around policy adoption. This approach holds constant the mine-insurer match as well as time-varying mine characteristics. Comparing the six quarters before and after policy adoption, we find that the probability of a mine-insurer relationship becoming inactive increases by 12.8 percentage points. Dynamic event-study estimates show no significant pre-trends and a sharp increase in inactivity by

8.4pp in the first quarter immediately after policy adoption. This effect rises to 18.3pp by the fourth quarter, coinciding with the standard duration of insurance policies. These results support a causal interpretation and indicate that coal underwriting policies reduce insurers' willingness to maintain coverage for coal mines. They also suggest that at least some insurers begin implementing their policies upon adoption, even if others defer action through phased commitments or long-term targets.

Reductions in insurance coverage are more pronounced among insurers with more stringent coal policies, suggesting that the extent of implementation increases with policy stringency. The likelihood of an insurer-mine relationship becoming inactive also varies by insurance policy type: insurers are more likely to maintain relationships for coverage lines tied to worker safety and compensation, which allows insurers to maintain business links with mining companies while somewhat reducing reputational risks associated with insuring the core mining activities directly. These findings highlight that underwriting policies are not uniform in their implementation.

Third, we examine whether adoptions of coal underwriting policies are associated with subsequent operational changes of insured mines. Initial results show that non-renewal of insurance, regardless of cause, is associated with a higher likelihood of mine abandonment and reductions in output and employment. To isolate policy-driven effects, we exploit heterogeneity in mine-level exposure based on whether a mine was insured at the beginning of our sample period by an insurer that later adopts a coal policy. The results suggest that mines are 3.6pp more likely to be abandoned in the quarters following policy adoption. This effect is particularly consequential because mine abandonment is rarely reversed in our data, implying that such closures are typically long-term or permanent. Among mines that remain productive throughout our period of study, employment declines by about 15%. Effects on

production are smaller and less precisely estimated.[2] Overall, the results plausibly indicate that policy-induced reductions in insurance coverage can constrain coal mining activity.

We complement this baseline analysis with a shift-share (Bartik) design that captures variation in the exposure intensity to coal underwriting policies, thereby exploiting that additional insurers adopt policies over time. Specifically, we construct a continuous exposure measure for each mine based on the share of its insurers at the beginning of our sample period with a policy in a given quarter. Estimated effects are similar to the baseline regressions: coal policy exposure increases the likelihood of mine abandonment, and, conditional on a mine remaining operational, leads to declines in production and employment. The effect on mine abandonment is directionally and economically consistent with the baseline analysis, but estimated with greater imprecision. This shift-share analysis provides additional evidence of a link between adoptions of policies and mine operations.

We examine cross-sectional heterogeneity in mine outcomes to assess whether the effects of coal policy adoptions depend on mine characteristics or the structure of insurer relationships. Abandonment decisions do not systematically vary with mine productivity or size, suggesting that opportunity costs play a limited role in how coal policy adoptions affect mine operations. In contrast, outcomes vary meaningfully with the structure of insurer relationships: mines more dependent on a single insurer are more likely to be abandoned, whereas those with access to a broader set of alternative providers are less likely to be affected. These findings indicate that insurer dependency amplifies, and insurer substitutability mitigates, the impact of coal policies on mine operations.

Finally, we examine insurer-level outcomes around the adoption of coal underwriting poli-

[2]The estimates for production are not statistically significant across all specifications, and those for employment show some anticipation effects. Mines may have expected policy adoption with some probability, plausibly leading to pre-treatment adjustments in employment. These anticipation effects are attenuated, and post-treatment estimates become cleaner when restricting to long-lasting insurer relationships, which likely generate more meaningful exposure.

cies. Gross written premiums remain unchanged. Annual return on assets and stock prices, adjusted for market-wide movements and measured over the two-day window surrounding adoption announcements, decline by about 0.5 percentage points, though the effects are not statistically significant. Solvency ratios show no systematic change. The number of yearly environmental incidents decreases slightly, potentially because the media reports more favorably once coal underwriting policies are in place. Overall, given the small samples, limited statistical power, and the fact that insurer-level outcomes reflect a wide range of activities beyond coal underwriting, these tests do not provide conclusive evidence of consequences at the insurer level.

Our paper provides the first systematic evidence on insurers' carbon underwriting policies and their impact on carbon-intensive projects. Our results suggest that while such policies have become more prevalent, their implementation remains heterogeneous, with insurers differing in their commitment and enforcement levels. Insurance non-renewals and coal policy adoptions are associated with subsequent reductions in operating activity at insured projects, suggesting that insurers can influence decarbonization through underwriting restrictions. This interpretation is supported by anecdotal reports of mine operators caught off guard by non-renewals from insurers that had adopted carbon underwriting policies, as well as by regulatory filings in which mining companies cite the potential loss of insurance due to climate-related underwriting restrictions as a material threat to continued operations. Although our analysis focuses on coal mining, the mechanisms we document may extend to other carbon-intensive sectors, as underwriting policies for oil & gas projects exhibit similar adoption patterns and determinants. At a broader level, the effectiveness of such policies ultimately depends on the degree of coordination across insurers, since substitution opportunities can limit the reach of individual actions. However, assessing these broader effects systematically requires greater transparency on underwriting practices and insured projects, particularly because the consequences of such policies are difficult to observe at the aggregate insurer level.

We contribute to three streams of literature. First, we add to the literature on how financial institutions manage climate-related risks. While much of the existing work has either examined financial services firms in general (e.g., Gasparini, 2025) or focused specifically on banks (e.g., Houston and Shan, 2022; Kacperczyk and Peydró, 2022; Haushalter et al., 2023; Sastry et al., 2024b; Giannetti et al., 2024; Morse and Sastry, 2024; Berg et al., 2025; Green and Vallee, 2025; Hasan et al., 2025), scholars have increasingly called for greater attention to the role of insurance companies (e.g., Acharya et al., 2023). However, research on insurers remains limited, with existing studies primarily quantifying insurers' exposures to and pricing of climate risks (e.g., Ge, 2022; Jung et al., 2024; Sastry et al., 2024a; Boomhower et al., 2025; Ge et al., 2025a,b; Kim et al., 2025; Oh et al., 2025). We are the first to study insurers' carbon underwriting decisions, a potentially powerful yet understudied tool of financial institutions to manage climate risks and contribute to the net-zero transition. Unlike banks, insurers often hold direct operational leverage: liability insurance is legally required to obtain or maintain permits for carbon-intensive projects, giving insurers the ability to constrain or halt operations by withdrawing coverage.

Second, we contribute to the literature on how providing insurance shapes firm behavior. While theoretical work highlights the potential role of insurers as private regulators (e.g., Ben-Sahar and Logue, 2012), empirical evidence remains limited. Existing studies focus largely on insurers' responses to immediate environmental risks (e.g., Yin et al., 2011) or their role in mitigating judgment-proof problems, where firms in hazardous industries take on excessive environmental risks while limiting liability through bankruptcy protection (e.g., Shavell, 1982, 2000, 2005; Boomhower, 2019). We extend this literature by showing that insurers can address systemic and long-term risks posed by firms through underwriting decisions, thereby acting as an external form of governance that disciplines firm behavior.

Finally, we contribute to a separate strand of literature on how terminating insurance

can serve as an enforcement tool when legal authority is limited. Maritime shipping is a prominent example: it underpins global trade but often evades regulation through fragmented ownership and flags of convenience (Vuillemey, 2020). These features complicate the enforcement of sanctions, most recently against Russia, Iran, Venezuela, North Korea, and Syria (e.g., Fernandez-Villaverde et al., 2025). In response, policymakers targeted insurers, prohibiting coverage for vessels involved in sanctions evasion (e.g., Smith and Dempsey, 2022; Triebert et al., 2024). To the best of our knowledge, no study has systematically examined the use of insurance withdrawal as a policy enforcement tool. Our results support the logic of these strategies: coverage reductions have real consequences, suggesting that insurance-based interventions can exert meaningful leverage where legal tools such as sanctions fall short.

2 Design and adoption of carbon underwriting policies

2.1 Data and sample

We use data on the underwriting policies of carbon-intensive projects by the world's leading insurance groups in the P&C business from 2017 to 2023.[3] The data are made available to us by IOF, a global coalition of NGOs. IOF publishes annual reports that include a scorecard evaluating insurers' carbon underwriting policies in a quantitative and standardized way.[4] Green and Vallee (2025) use similar data on banks' exit policies for fossil fuel lending obtained from Reclaim Finance, an NGO that is part of IOF and performed some of the data collection. One of IOF's goals in publishing the scorecards is to put pressure on insurers to restrict the underwriting business of carbon-intensive projects, which is why it focuses on underwriting policies for coal and oil & gas projects. The data are assembled from insurers' responses to an IOF survey and a manual review of publicly available information. During our sample period, IOF evaluates the underwriting policies of 37 insurance groups. According to IOF,

[3]We use "insurance groups" and "insurers" interchangeably. When relevant, we ensure that the data are consolidated at the group level, which is where the underwriting policies are formulated.

[4]IOF also collects data on the policies for coal and oil & gas projects in insurers' investment portfolios.

these insurers represent the leading carbon-sector underwriters in the global P&C business.[5] The number of insurers evaluated by IOF varies across sample years, ranging from 24 to 30.

We construct two sets of variables for each insurer and year based on IOF's scorecards. The first set consists of two dummy variables that indicate the presence of a coal or oil & gas policy, respectively. Since 2017, the IOF scorecards provide information on coal policies, and since 2020, IOF also scores oil & gas policies. The second set consists of scores that reflect the stringency of the underwriting policies. The scores range from 0 to 10, with higher values denoting more restrictive policies. The scores assess insurer policies along five dimensions, capturing, among other features, whether insurers exclude all or only certain carbon-intensive projects, the degree of exclusion for high-emission projects, or whether emissions reduction targets are specified for new or ongoing projects (see Table IA.1 for details). Coal stringency scores are available from 2018 onward, and oil & gas scores from 2020.

We supplement the IOF data with hand-collected information on the introduction dates of insurers' underwriting policies. These dates are sourced from insurer websites and news articles referencing the public announcements.[6] As coal policies are adopted earlier than oil & gas policies, the first policy pertains to coal. While the timing of announcements does not always indicate when underwriting restrictions are fully implemented—some insurers commit to gradual phase-outs or long-term targets—we treat these introduction dates as the relevant starting point for our analysis. This choice reflects our empirical objective: to test whether policy introduction translates into reduced underwriting activity and downstream effects in

[5] According to IOF, the insurers covered by the scorecard are compiled based on a market analysis of the key players in the carbon underwriting business. A 2023 market study by S&P Global, listing the top 50 global P&C insurers by insurance premiums, includes 25 insurers that are in our sample (S&P Global, 2023). Insurers missing from the sample but included in the S&P list typically focus on businesses unrelated to the underwriting of carbon-intensive projects. Conversely, insurers in our sample but absent from the S&P study are specialty line insurers, such as Axis Capital, which focus on specific corporate insurance lines.

[6] We are able to identify precise dates for 23 out of 25 insurers that have policies in place according to IOF. For Aviva, no specific introduction date could be determined. For Ping An, we found no official public announcement or media reports. The missing data for these two insurers do not affect the coal mining analysis, as they do not underwrite risks of U.S. coal mines in our sample.

coal mining. In addition, we enrich the IOF data with insurer-level characteristics that are from ORBIS or hand-collected. Table IA.2 reports policy introduction dates and key insurer characteristics.

2.2 Prevalence and components of carbon underwriting policies

In Table 1, we list the presence of coal underwriting policies from 2017 to 2023 among insurers in IOF's scorecards. For each year and insurer, we report the dummy variable that indicates whether a coal policy is in place. Missing values reflect that an insurer was either not included in IOF's scorecard in a year or its policies were not assessed by IOF. Only four insurers—AXA, SCOR, Swiss Re, and Zurich—maintain a coal policy throughout the entire sample period. In contrast, Berkshire Hathaway, PICC, Sinosure, and WR Berkley never implemented such a policy (and are in the sample for at least three years). By 2023, 24 out of 30 insurers (80%) had implemented some form of coal policy.

In Table IA.3, we provide the corresponding statistics for oil & gas policies. Compared to coal, restrictions on oil & gas projects are less prevalent and generally appear a few years later. One explanation is that coal underwriting typically accounts for a smaller share of total premiums written, making it less costly for insurers to restrict underwriting of coal. In addition, as coal combustion generates more carbon emissions than oil or gas (MIT Climate Portal, 2022), the "social license to operate" for coal may erode earlier.[7]

In Figure 1, we plot the number of insurers with coal policies and decompose these policies into key structural components. Over time, coal policies have become more specific. Early policies were relatively generic, but more recent ones increasingly feature explicit commitments such as not insuring new coal projects or, less commonly, terminating coverage for clients in the coal sector altogether. Insurers now more frequently pledge to phase out certain

[7]These observations are based on the insurers included in our sample. Our coding of oil & gas policies follows IOF's scorecards, which began systematically reporting such policies in 2020.

coal clients (e.g., those generating a large share of their revenues from coal), while a smaller subset commits to adopting detailed phase-out plans over time. Engagement strategies aimed at the closure of certain coal projects remain rare.

In Figure IA.1, we plot the corresponding dynamics for oil & gas policies. Compared to coal, oil & gas policies have evolved more slowly. Their structure is less standardized, with the only consistently observed feature being a commitment to not insure new oil & gas projects.

Overall, we document a gradual increase in the adoption of coal underwriting policies since 2017. These policies have become more specific over time, increasingly including explicit exclusions for new projects and, in some cases, commitments to phase out existing clients. In contrast, oil & gas policies began to emerge in 2020, remain less prevalent and less standardized, and typically restrict only the underwriting of new projects.

2.3 Stringency of carbon underwriting policies

Some insurers may adopt underwriting policies primarily to signal environmental commitment without imposing material restrictions on their business activities. It is therefore important to assess variation in the stringency of underwriting policies. In Table 2, we report the stringency scores of coal policies by insurer and year, ranking insurers based on their 2023 scores from high to low. Allianz, AXA, and Swiss Re lead the ranking, achieving scores close to the maximum value of 10 in 2023—scores in earlier years are generally lower. Many insurers' scores fall below 10 due to exceptions that weaken the policies' strictness. For instance, Lloyd's coal policy received a score of 0 in 2022 because it was not binding[8], while Chubb's 2021 policy scored 1.47 due to numerous exceptions, including carve-outs for regions lacking near-term alternative energy sources.

[8]Lloyd's of London is technically not an insurance company but a marketplace in which underwriters pool risk by forming syndicates. Lloyd's ability to impose binding restrictions on underwriting is limited, because it cannot prohibit syndicates from writing certain types of business. This is likely the reason why Lloyd's coal policy received a stringency score of 0. We nevertheless keep Lloyd's in our sample because the IOF scorecards include it, and our results remain unchanged if Lloyd's is excluded.

Table IA.4 presents corresponding statistics for oil & gas policies. These policies are less restrictive overall—even the top-ranked insurer, Generali, scores a value of only 4 by 2023.

In Figure 2, we plot the stringency scores of coal policies over time. For each year, we display average scores and scores by insurer. There is a clear upward trajectory in policy stringency since 2020, but also substantial variation across insurers. The mean coal policy scores declined between 2018 and 2019, largely due to the entry of insurers with weaker policies (Aviva, HDI, and Ping An). While policy heterogeneity persists, some insurers have emerged as leaders or laggards. Allianz, for instance, became the leader for coal policy stringency between 2021 and 2023, after having matched the industry average between 2018 and 2020. Insurers such as Generali followed Allianz's lead with a lag of about one year.

In Figure IA.2, we display the dynamics for oil & gas policies. In contrast with coal policies, the stringency of oil & gas policies increased only modestly, remaining at a low average level. Dispersion in stringency has widened over time, suggesting a lack of global convergence in the adoption of strict underwriting policies. The stringency of the oil & gas policies of insurers with strict coal policies, such as Allianz and Generali, shows only modest improvements over time. In contrast, insurers like Liberty Mutual and Lloyd's exhibit persistently low scores, with little evidence of policy tightening throughout the sample period.

Taken together, there is substantial heterogeneity in the stringency of carbon underwriting policies. While coal policies have generally become stricter since 2020, many insurers still maintain weak or non-binding commitments. Oil and gas policies remain notably less stringent, underscoring a lack of convergence in underwriting standards.

2.4 Carbon underwriting and investment policies

Insurers hold large investment portfolios (see, e.g., Koijen and Yogo, 2023; Knox and Sørensen, 2024; Kubitza, 2025) and could manage climate risks through their investment decisions (see,

e.g., Ge and Weisbach, 2021). In Table IA.5, we report correlations between insurers' underwriting and investment policies for coal and oil & gas. Panel A shows correlations based on the existence of such policies, while Panel B examines their stringency. Correlations in both panels are positive but far from perfect, suggesting substantial within-insurer variation in how carbon policies are adopted on the asset (investment) and liability (underwriting) side of the balance sheet. Figure IA.3 offers a more granular perspective, plotting individual insurers' underwriting and investment policy stringency for 2023. For some insurers, observed combinations of policy stringency lie close to the diagonal, indicating that they align closely across underwriting and investment activities, such as for AXA's coal policies (Panel A) or Generali's oil & gas policies (Panel B). In other cases, either underwriting policies (e.g., Allianz's coal policies in Panel A) or investment policies are stronger (e.g., SCOR's oil & gas policies in Panel B). These patterns highlight that underwriting policies do not merely reflect ESG-related divestment or screening strategies on the investment side.[9]

2.5 Determinants of carbon underwriting policies

The substantial variation in carbon underwriting policies documented above calls for a systematic analysis of their determinants. We therefore construct an annual insurer panel and estimate regressions of two measures of carbon underwriting policies on a range of potential determinants. The dependent variable is either the dummy variable indicating whether an insurer has a coal policy or the score capturing the stringency of the coal policy. We estimate the same regressions for oil & gas policies. As determinants, we examine (i) time trends, (ii) regional patterns, (iii) whether the insurer has committed to aligning its underwriting port-

[9] A potential concern is that our results could partly reflect insurers' investment rather than underwriting policies. Two points mitigate this concern. First, the analysis on coverage reductions around the adoption of coal underwriting policies exploits within-mine variation in insurance relationships, which helps absorb coinciding mine-level shocks related to insurers' investment activities. Second, while mine-level outcomes could in principle be influenced by insurers' investment policies, the within-insurer variation across the asset and liability sides documented in this section suggests that underwriting decisions constitute an independent channel.

folio with net-zero emissions,[10] (iv) whether the insurer is primarily a specialty insurer (i.e., focused on corporate business lines), (v) listing status, (vi) size, and (vii) profitability.[11]

Table 3 presents results for coal policies. Columns 1 to 3 analyze the extensive margin—whether an insurer has a coal policy in place—over the 2017-2023 period. Four main insights emerge. First, coal policy adoption has risen steadily over time: by 2023, insurers are 58.9%, 63.8%, and 71.0% more likely to have adopted a policy compared to 2017, depending on specification. Second, adoption is significantly more common among European insurers. U.S. insurers are 51.6% and 48.2% less likely to adopt a policy relative to European insurers; insurers from Asia are 37.8% and 46.8% less likely; and insurers from the rest of the world are 32.7% and 25.0% less likely, respectively. These differences may reflect green preferences in the home country or among the local labor force (Dechezleprêtre et al., 2025). Third, determinants are consistent with reputation and stakeholder pressure: specialty and unlisted insurers, which face weaker public and capital-market scrutiny, are 24.3% and 31.6% less likely to have a coal policy. Even NZIA members are 16.4% less likely, potentially because insurers continued to adopt policies even after the alliance was dismantled following legal threats of antitrust investigations (see, e.g., Wilkes et al., 2023). Fourth, coal policies are negatively associated with profitability.

Columns 4–6 examine the intensive margin—policy stringency conditional on adoption—over the 2018-2023 period. U.S. and Asian insurers have less stringent policies compared to their European counterparts and listed insurers exhibit stricter policies. Different from the extensive margin results, policy stringency is unrelated to a retail customer base and profitability. The lower scores observed in 2019 and 2020, relative to 2018, reflect a temporary

[10] As a proxy for such commitments, we use membership in the Net-Zero Insurance Alliance (NZIA), which was launched in 2021.

[11] Table IA.6 presents descriptive statistics on the variables, and definitions are provided in Table A.1. The numbers show, for example, that 44% of all observations pertain to insurers from Europe, 25% from the U.S., and 20% from Asia. About 15% of the observations are from unlisted insurers and 23% from specialty insurers. Insurers in the sample have total assets of around $300 billion and achieve a return on assets of about 1.5%.

decline in policy stringency during the early sample years (see Figure 2).

In Table IA.7, we present the corresponding results for oil & gas policies, which can be studied from 2020 onward and over a smaller sample due to their later and less frequent adoption. The determinants of policy adoption and stringency are similar to those for coal. This alignment suggests that the same institutional and strategic factors shape underwriting behavior across carbon-intensive sectors, and that the mechanisms we document in the coal mining analysis may generalize to other carbon-intensive sectors.

This section shows that coal underwriting policies have become more widespread and stringent since 2017, while oil & gas policies remain less developed. Policy adoption and stringency vary across insurers and regions, with non-European, unlisted, and specialty insurers more likely to adopt and implement restrictive policies.

3 Implementation and consequences of carbon underwriting policies

3.1 Motivation for U.S. coal mining context

The previous section documents the rise of carbon underwriting policies across insurers. Yet, it remains unclear whether these policies are meaningfully implemented and whether they have real effects on carbon-intensive projects. On the implementation side, announcements of policy adoptions do not always mark the start of actual restrictions—some insurers adopt immediate limitations, while others commit to phased actions or long-term targets. On the consequences side, it is unclear whether a reduction in insurance coverage—if it occurs—has tangible impacts on the operations of carbon-intensive projects.

We address these questions in the context of coal mining in the United States, which represents an ideal setting to study whether carbon underwriting commitments translate into real changes in underwriting behavior and impact carbon-intensive projects. First, coal

mining is a critical upstream activity for coal combustion, the single largest source of human-induced climate change (IEA, 2021; ClientEarth, 2022), and insurance coverage is required for mine operations under U.S. law, as described in detail below. Second, coal underwriting policies are more prevalent and generally emerge a few years before those targeting oil & gas, increasing the availability of data. Third, the U.S. provides unusually detailed mine-level information, including quarterly production, employment, and insurance relationships, which, despite being difficult to obtain, enable a direct link between insurer decisions and project-level outcomes.

3.2 Data and empirical setting

3.2.1 Data on coal mines and their liability insurance

Data on U.S. coal mines come from the Mine Safety and Health Administration (MSHA). Under federal regulation, the MSHA collects data on coal production, employment, operating status, and other operational metrics at the mine-quarter level.[12] We construct a quarterly panel dataset of all coal mines that report at least one quarter of non-zero coal production between 2014Q1 and 2024Q2. By starting in 2014, we include data prior to the introduction of coal underwriting policies to compare mine behavior before and after policy adoptions.

Coal mine operators in the U.S. are required to maintain liability insurance as a condition for obtaining or renewing their operating permits. This mandate is enforced by state mine regulators under the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and Title 30 of the Code of Federal Regulations. Operators must also meet minimum coverage standards set by relevant state agencies, typically covering workplace injuries, third-party claims, and environmental risks. Because proof of adequate coverage is a legal prerequisite for continued operation, insurers hold substantial influence over coal mines: by choosing whether to issue or renew policies, they can effectively determine whether a mine is allowed

[12]We obtain the data directly from MSHA's Mine Data Retrieval System. For further information on these data, see Charles et al. (2022), Gilje and Wittry (2022), Qiu et al. (2025), and Chen and Wittry (2025).

to operate. Leveraging this institutional feature, we filed FOIA requests with the relevant agencies to obtain information on mines' insurance coverage.[13] Specifically, we requested the release of Certificates of Liability Insurance for all mines in the MSHA database since 2014. These mines span 25 states, of which eight states supplied the requested certificates in the form of standardized ACORD 25 filings. Among the mines in these states, 313 (68.64%) are located in West Virginia, 71 (15.57%) in Virginia, 26 (5.70%) in Illinois, 16 (3.51%) in Wyoming, 11 (2.41%) in Utah, 8 (1.75%) in Colorado, 6 (1.32%) in Montana, and 5 (1.10%) in North Dakota. The states that did not supply data play a negligible role in U.S. coal mining. Using MSHA data, we calculate that the sampled insurance certificates refer to mines responsible for 78% of U.S. coal production from 2014Q1 to 2024Q2.[14] We also collect data from the relevant state agencies to identify whether a certificate pertains to a specific mine or to an operator covering multiple mines.

Figure IA.4 shows the ACORD 25 insurance certificate for the Black Butte Coal Mine in Wyoming. Each certificate comprises three main sections. The top section lists the insurance broker ("producer"), the insured entity ("insured"), and the insurers ("insurer(s) affording coverage").[15] The middle section details policy-level information, including the start and end dates of coverage. Insurance policies are categorized into one of four types: commercial and general liability, automobile liability, workers' compensation and employer's liability,

[13] A FOIA request is a formal petition for access to public records. FOIA provisions vary across U.S. states in terms of scope and eligibility. For our sample of states, Alabama, Arkansas, Kansas, Kentucky, Oklahoma, Pennsylvania, and Tennessee do not accept FOIA requests from non-U.S. citizens/residents or out-of-state requesters. We are grateful to the two requesters and FOIA advocacy groups who assisted us in obtaining records from these states. We verified that the obtained data can be used by non-U.S. citizens/residents.

[14] We exclude Maryland and New Mexico because they only provided the most recent certificates and no historical records, despite follow-up efforts. We also exclude Alaska, Arizona, Arkansas, Kansas, Louisiana, Missouri, Mississippi, Oklahoma and Tennessee—states that each have five or fewer mines—as we did not receive a response to the FOIA requests. We exclude Ohio, Kentucky, and Texas because their agencies do not use standardized certificate forms, making their data difficult to compare with that of other states. Indiana did not provide any information. Our requests in Alabama and Pennsylvania are still pending.

[15] Mining companies may opt for self-insurance, also known as captive insurance. We identify such cases either when the top section of the certificate explicitly mentions a captive insurance company or when it explicitly states that the mine is self-insured. Fewer than 20 certificates in our sample indicate self-insurance. This low number may reflect substantial costs and regulatory requirements associated with establishing and maintaining captive insurers.

and umbrella/excess liability (which includes other liability types such as pollution liability). The bottom section identifies the regulatory agency responsible for oversight and compliance.

Our dataset comprises 9,745 insurance policies across 456 coal mines. We define a policy as a unique insurer-policy type combination listed on a certificate. A single mine may thus hold multiple policies providing different types of coverage from different insurers. Around 37% of all policies cover commercial and general liability, 30% umbrella/excess liability, 17% automobile liability, and 16% workers' compensation and employer's liability. Roughly 90% of all policies have a duration of one year, with additional bunching around quarters and full years.

3.2.2 Linking mine data to insurer-level policies

We link mine-level data from the MSHA with insurer-level coal underwriting policies using the Certificates of Liability Insurance to create a mine-quarter-insurance policy panel. This task requires mapping the insurers listed on the certificates to their corresponding insurance groups.[16] Although insurance certificates specify the start and end dates for each insurance policy, the MSHA data are at the mine-quarter level. To merge the two datasets, we assume a mine is covered by a given policy in a quarter if the insurance policy's coverage includes the start date of that quarter.[17] For mines listed in MSHA that lack insurance certificates or exhibit coverage gaps following our initial FOIA request, we submitted follow-up FOIA requests targeted at the missing data. These follow-ups yielded additional filings.

The final dataset covers 456 coal mines insured between 2014Q1 and 2024Q2 by 46 insurance groups. Among these insurers, 15 appear in the IOF scorecards, with 11 of them

[16]This is a nontrivial task as insurance groups typically operate through subsidiaries whose names often do not indicate their group affiliation. We perform this mapping using the 5-digit NAIC company codes provided on the certificates, cross-referenced with group affiliations from NAIC's semiannual publication *Listing of Companies* as of June 2017, prior to the announcement of any carbon policies. We evaluate the possibility of ownership changes after 2017 (e.g., through mergers and acquisitions) and find these to be rare. In fact, only one coal mine-insuring subsidiary changes group affiliation after this date. Policies that cannot be matched to an insurance group are excluded, though such cases are rare (fewer than 2% of all policies).

[17]This rule effectively lags mine-level outcomes by up to one quarter, since coverage is assigned based on whether the quarter's start date falls within the coverage period.

introducing a coal underwriting policy during the sample period. We assume that the 31 insurance groups not covered by IOF do not adopt such policies, an assumption supported by extensive news searches. Hence, a total of 35 insurance groups do not have a coal policy (four categorized and 31 uncategorized). While the sample may miss some insurers from the IOF scorecards that may insure coal mines outside of the U.S. or implement underwriting restrictions differently in other markets, it reliably captures the primary actors in U.S. coal mine insurance.

3.2.3 Summary statistics

Table 4 reports descriptive statistics for the sample at different levels of aggregation. The raw dataset is at the mine-quarter-policy level, identifying for a given mine-quarter which insurance policies are active and which insurance group provides coverage.

Panel A reports statistics at the mine-quarter-insurance level, enabling us to track mine-insurer relationships over time and distinguish periods of active and inactive coverage. For each mine, we include all observed insurer relationships and populate inactive quarters—i.e., when a certificate does not indicate coverage—whenever we have liability insurance information available for that mine. The average relationship lasts 14.2 quarters, or roughly 3.5 years. In 47% of all observations, the insurer has a coal policy in place and in 57% of observations, the relationship is inactive, that is, the mine is not insured by the respective insurer.

Panel B provides statistics at the insurer-quarter level, which we use to study insurer-level changes around policy adoptions. On average, an insurer underwrites about 20 coal mines, corresponding to 6 MMst of coal per quarter. A coal policy is in place in 28% of insurer-quarter observations.

Finally, Panel C presents statistics at the mine-quarter level, which is used to analyze operational outcomes of coal mines. In 12% of mine-quarters, a mine is classified as aban-

doned (i.e., it is abandoned or abandoned and sealed). In our data, abandonment is rarely reversed; thus, it is effectively an absorbing state. On average, a mine produces 0.39 MMst of coal and employs 79 workers per quarter.[18] In 7% of mine-quarters an insurance contract is not renewed. Around four insurers provide coverage in a given quarter.

3.3 Do insurers reduce coverage following coal policy adoption?

3.3.1 Trends in insurance coverage by coal policy status

To provide initial evidence on the reduction of coverage following the adoption of coal underwriting policies, Figure 3 plots the number of coal mines insured by insurers that adopted a coal policy at some point during the sample period (Panel A), and by those that never did (Panel B). In Panel A, the number of insured mines remains relatively stable at around 200 throughout most of the sample period. However, there is considerable heterogeneity within this group, particularly in the cases of AIG and Zurich. AIG, which dominates the market in the early sample years alongside Chubb, insures fewer mines over time, while Zurich emerges as the main insurer in later years due to increased insurance activity.[19] In Panel B, among the insurers that never adopt a coal policy, the number of insured mines increases steadily and almost linearly, from about 100 at the beginning of the sample period to nearly 300 by the end. Houston and BrickStreet are the primary underwriters in this group throughout the sample period. However, there is also heterogeneity within the group of non-adopters. For example, Berkshire Hathaway—one of the larger insurers in this group in the early years—reduced its coverage considerably. The contrasting trends in the two panels offer suggestive evidence that many—but not all—insurers with coal policies reduced their coverage of coal mines,

[18] Production and employment are typically zero when a mine is abandoned. However, active mines can also report zero production and employment in some quarters.

[19] There is a visible shift in the number of insured mines from AIG to Zurich in 2019Q4. We manually reviewed these entries and found no indication that Zurich acquired a subsidiary of AIG. A more likely explanation for this shift is that AIG chose not to renew policies covering a substantial number of mines, and Zurich subsequently stepped in to provide coverage (we find that Zurich provides coverage for over 75% of the mines that AIG drops). The increase in Zurich's insurance coverage may reflect exceptions in its coal policies, for instance, cases where less than 30% of a firm's revenues originate from thermal coal.

while those without such policies expand their underwriting activity, albeit with exceptions.

In Figure IA.5, we find similar aggregate patterns using the volume of insured coal production. In Panel A, which reports dynamics among insurers with a coal policy, Chubb reduces insured coal volume most strongly over time. AIG's coverage reduction based on the number of insured mines does not translate into lower insured coal volume, and the same holds for the increase in coverage by Zurich. This suggests that Chubb primarily exits, and Zurich enters, coverage for smaller mines.

3.3.2 Insurer-level effects of coal policy adoption

To formally test whether coal underwriting activity declines following the adoption of coal policies, we estimate the following OLS regression at the insurer-quarter level:

$$Coal\ insurance_{i,t} = \beta \times Post\ coal\ policy_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t}, \tag{1}$$

where i indexes an insurer and t a quarter. *Coal insurance* denotes the log of either the number of insured coal mines (*# Coal mines insured*) or the volume of produced coal at insured mines (*Coal volume insured*). *Post coal policy* equals one for insurer-quarters after a coal underwriting policy is introduced, and zero otherwise. α_i and α_t are insurer and time fixed effects, respectively. We use robust standard errors. The coefficient β captures the change in coal underwriting activity among insurers that adopt a coal policy, relative to those that do not, at the same point in time. If insurers adjust their underwriting activity in line with public commitments, we expect β to be negative and statistically significant.

Table 5 reports estimates of Eq. 1. In Column 1, which uses *# Coal mines insured*, the estimate for β is negative and statistically significant, indicating that insurers, on average, reduce the number of insured coal mines by about 16% (or 3.3 mines) following policy adoption. In Column 2, using *Coal volume insured*, the estimate continues to be negative and statistically significant, implying a reduction in the volume of insured coal by about 56% (or 3.3 MMst)

after policy adoption. Hence, coal policies substantially reduce coal underwriting activity.

A limitation of the analysis in Columns 1 and 2 is that we observe whether insurance contracts are renewed, but not the reason why insurance coverage ends. In particular, we cannot distinguish whether coverage ends due to insurer decisions or because the mine operator chooses not to renew, perhaps due to operational or financial considerations. To address this limitation, Columns 3 and 4 restrict the sample to mines that remain operationally active throughout the sample period. The continued negative and significant estimates confirm that results are not driven by changes in mine operating status.

3.3.3 Mine-insurer relationship effects of coal policy adoption

The results in the previous section do not allow for a causal interpretation for two main reasons. First, they do not account for the endogenous matching of coal mines to insurers, and we cannot rule out that insurers adopt coal policies because of the specific mines they insure. Second, they do not control for time-varying mine characteristics that could influence insurers' renewal decisions, for example, deteriorating mine performance or rising operational risk. To address these concerns, we exploit that mines obtain coverage by multiple insurers at a given point in time, allowing us to compare how different insurers adjust coverage for the same mine around an insurer's policy adoption. This approach holds constant the mine-insurer match and time-varying mine characteristics.

We implement this identification strategy using a stacked difference-in-differences (DiD) design (see, e.g., Gormley and Matsa, 2011; Baker et al., 2022). A stack is defined as one policy-adopting insurer and the set of coal mines it insures. For each mine-insurer pair within that stack, we construct a balanced panel of 13 quarterly observations, six quarters before and six quarters after the policy adoption quarter. These mine-insurer pairs constitute the treated observations in the stack. Control observations are all other mine-insurer pairs involving the same mines but insurers that never adopt a coal policy, thereby avoiding concerns about an-

ticipatory effects. Intuitively, each stack tracks how mine–insurer relationships evolve around the adoption of a policy by one insurer, comparing changes in coverage between the adopting insurer and insurers that never adopt a policy. We repeat this procedure for each of the 11 policy-adopting insurers and stack the resulting samples to estimate the average effect of coal policies on the likelihood of observing inactive insurer-mine relationships. Specifically, we estimate the following OLS regression:

$$Inactive\ insurance_{s,m,i,t} = \sum_{t=-6}^{t=6} \beta_t \times Coal\ policy_i \times Event\ quarter_{s,t} + \alpha_{s,m,i} + \alpha_{s,m,t} + \epsilon_{s,m,i,t}, \tag{2}$$

where s indexes a stack, m indexes a mine, i an insurer, and t a quarter. *Inactive insurance* equals one if an insurer does not insure a mine in a given quarter, and zero if it does. *Coal policy* equals one for insurer-mine pairs involving a policy-adopting insurer, and zero otherwise. *Event quarter* are dummies indicating quarters relative to policy adoption. $\alpha_{s,m,i}$ are stack-mine-insurer fixed effects, while $\alpha_{s,m,t}$ are stack-mine-time fixed effects. These fixed effects ensure that we compare the evolution of mine-insurer relationships within the same mine and time across insurers, thereby controlling for the match of mines to insurers as well as unobservable time-varying mine characteristics.[20] Standard errors are clustered at the insurer-stack level. If insurers adjust their underwriting activity in line with public commitments, we expect the β_t coefficients to be indistinguishable from zero prior to adoption and significantly positive afterwards.

Figure 4 presents the estimated quarterly regression coefficients from Eq. 2, relative to the omitted quarter preceding policy adoption. In the quarters leading up to adoption and in the adoption quarter, there are no significant differences in the likelihood of inactive insurance relationships, supporting the parallel trends assumption. Starting in the first post-adoption quarter, however, relationships between mines and policy-adopting insurers are significantly

[20]The fixed effects absorb the standalone effect of *Coal policy* and the *Event quarter* dummies.

more likely to become inactive. This likelihood increases steadily, from 8.4pp in the first quarter to 18.3pp by the fourth quarter. The effect then levels off, consistent with the typical one-year duration of insurance policies, by which time most non-renewals would have taken effect. The sharp discontinuity around policy adoption provides compelling evidence that coal policies drive changes in underwriting activity, and it suggests that at least some insurers begin to implement their policies upon introduction, even though others commit only to phased actions or long-term targets. This interpretation is supported by anecdotal reports that some coal mines were caught off guard by non-renewals.[21]

To complement the dynamic estimates in Figure 4, we define a post-adoption indicator (*Post*) that equals one for the quarters after the introduction of a coal policy, and interact it with the *Coal policy* indicator. We then estimate the following OLS regression:

$$Inactive\ insurance_{s,m,i,t} = \beta \times Coal\ policy_i \times Post_{s,t} + \alpha_{s,m,i} + \alpha_{s,m,t} + \epsilon_{s,m,i,t}. \quad (3)$$

Table 6 reports estimates of Eq. 3. In Column 1, the coefficient on the interaction term indicates that relationships between a mine and a policy-adopting insurer are 12.8pp more likely to become inactive in the six quarters following adoption. In Column 2, among mines that remain active throughout the sample, the estimate increases to 13.7pp. These results suggest that non-renewals reflect changes in insurer behavior, rather than cancellations initiated by the mines themselves.

3.3.4 Heterogeneity in mine-insurer relationship effects of coal policy adoption

We explore two dimensions of cross-sectional heterogeneity to better understand how coal policy adoption affects insurer-mine relationships. First, we assess whether the incidence of inactive insurance relationships varies with the stringency of the coal policy. To do so,

[21]For example, several member companies of the Lignite Energy Council (LEC), a trade association for the coal industry in the United States, reported receiving non-renewal notices from multinational insurers such as Chubb and Zurich. One company was forced to scramble for alternative coverage within months (see Guidehouse Inc., 2022).

we augment Eq. 3 by interacting our baseline post-adoption indicator with two measures of policy strength: (i) *First coal policy score*, capturing an insurer's policy score at adoption[22], and (ii) *Max coal policy score*, capturing the highest policy score observed for a given insurer during the sample period. These interaction terms allow us to gauge whether the likelihood of an inactive relationship increases with the ambition of the insurer's commitment. Table 7, Columns 1 and 2 present the results. The positive and significant coefficients on the interaction terms indicate that a one-standard deviation increase in coal policy stringency is associated with a 2.6 to 4.2 percentage points higher likelihood of an inactive relationship following policy adoption. This suggests that the extent of implementation increases with policy stringency.

Second, we explore whether the likelihood of inactive insurance relationships varies across policy types, that is, commercial and general liability, umbrella and excess liability, automobile liability, and workers' compensation. To assess these differences, we first replicate the stacked DiD specification at the policy type level. The static estimates in Column 3 of Table 7, and the dynamic estimates in Figure IA.6, closely mirror the baseline analysis, indicating that the aggregate pattern, on average, holds across policy types. Next, Table 7, Column 4, reports results when adding interaction terms with dummies for specific policy types. The results show that relationships involving workers' compensation insurance are significantly less likely to become inactive relative to relationships covering commercial and general liability (the omitted category). Specifically, while the baseline post–policy effect of coal policy stringency is positive (0.125), the triple interaction for workers' compensation is -0.135, offsetting this effect. This result suggests that insurers do not withdraw coverage types related

[22] As the first IOF scorecard, published in 2017, does not include stringency scores, we use the 2018 stringency scores for insurers that adopted a policy in 2017.

to worker safety and compensation, a conclusion confirmed by a joint test of significance.[23]

Overall, the findings show that coal underwriting policies lead to meaningful reductions in insurance coverage for coal mines, particularly among insurers with stronger policy commitments. The effects also vary systematically across insurance policy types, suggesting that insurers selectively implement coverage reductions based on the nature of the coverage, which allows them to maintain business links with mining companies while somewhat reducing reputational risks associated with insuring the core mining activities directly.

3.4 Do coal underwriting policies affect coal mine operations?

3.4.1 Does insurance non-renewal affect coal mine operations?

Having established that insurers reduce the underwriting of carbon-intensive projects following the adoption of coal policies, we now examine the consequences for insured projects. As a starting point, we test whether the end of insurance coverage, regardless of whether it is driven by policy adoption or other factors, is associated with subsequent changes in mine operations by estimating the following OLS regression at the mine-quarter level:

$$Coal\ mine\ outcome_{m,t} = \sum_{k=1}^{k=4} \beta_k \times Non\text{-}renewed\ insurance_{m,t-k} + \alpha_m + \alpha_t + \epsilon_{m,t}, \quad (4)$$

where m indexes a mine and t a quarter. *Coal mine outcome* is one of three measures: (i) a dummy for whether a mine is abandoned (*Abandoned*), (ii) the volume of coal produced (*Production*), or (iii) the number of employees (*# Employees*).[24] *Non-renewed insurance* equals one if, in quarter $t-k$, with $k \in [1,4]$, at least one of the mine's insurers did not renew coverage, and zero if all insurers maintain coverage. α_m and α_t are mine and time fixed effects,

[23] These results are consistent with anecdotal evidence suggesting that insurers are willing to maintain certain types of coverage for social or safety reasons even when restricting others. For example, in the press release announcing its carbon underwriting policy, SCOR explicitly carved out exceptions for coverage related to worker and community protection: "*SCOR will not issue insurance or facultative reinsurance that would specifically encourage new greenfield thermal coal mines or stand-alone lignite mines or plants. The only exception to this rule would be the implementation of cover for the benefit of the local community or workers.*" (see, e.g., SCOR, 2017). Similarly, Zurich's latest coal underwriting policy exempts "*workers' compensation, other employee protections, or considerations, which have positive impact on human health and the environment.*" (see, e.g., Zurich, 2025).

[24] We do not observe mine-level profitability, which would offer a direct measure of economic performance.

respectively. Standard errors are clustered at the mine level. The β_k coefficients capture how mine outcomes change in each of the four quarters following non-renewal, relative to other mines in the same quarters. If non-renewals negatively affect operations, we expect positive coefficients on abandonment and negative coefficients on production and employment.

Table 8 reports estimates of Eq. 4. Column 1 shows that the likelihood of being abandoned increases significantly by up to 1.4pp over the four quarters after non-renewal. The effects in the first three quarters after non-renewal are also positive, but are estimated more noisily. Columns 2 and 3 reveal that active mines reduce output and employment after coverage ends. Coal production declines by about 4 to 11% over the four-quarter window, although only the second-quarter estimate is statistically significant. Employment falls by about 5 to 11%, with all four estimates being statistically significant. These results suggest that non-renewals—regardless of the reason—are associated with a higher likelihood of mine abandonment and reduced operational activity. Combined with our earlier findings that insurer-mine relationships are more likely to end following policy adoption, this provides initial evidence that underwriting policies can translate into meaningful real effects.

3.4.2 Do coal underwriting policies affect coal mine operations?

While the preceding results show that insurance non-renewal, regardless of its underlying cause, is associated with changes in coal mine operations, they do not distinguish between the underlying drivers of non-renewal. To examine the direct implications of coal policy adoptions, we study operating outcomes of mines that are "coal policy exposed," that is, mines insured at the beginning of the sample period, before any coal policies were introduced, by at least one insurer that subsequently adopted a coal policy, in a DiD framework. This approach has two benefits: it ensures that treatment is predetermined relative to later mine outcomes, and controls for the selection of mines into the underwriting portfolios of policy-adopting insurers. For each group of insurers adopting a coal policy in the same quar-

ter, we construct a stack comprising all their mines if they are affected for the first time, observed over a symmetric 13-quarter window around policy adoption. Control observations are drawn from mines that, at the beginning of the sample period, are insured exclusively by insurers that never adopted a coal policy. We then estimate the following OLS regression:

$$\textit{Coal mine outcome}_{s,m,t} = \sum_{t=-6}^{t=6} \beta_t \times \textit{Coal policy exposed}_{s,m} \times \textit{Event quarter}_{s,t} + \alpha_{s,m} + \alpha_{s,t} + \epsilon_{s,m,t}, \tag{5}$$

where s indexes a stack, m a mine, and t a quarter. *Coal mine outcome* is one of the three mine outcomes used above (*Abandoned*, *Production*, *# Employees*). *Coal policy exposed* equals one if a mine is insured by a policy-adopting insurer between 2014 and 2016, and zero otherwise. *Event quarter* are dummies for quarters relative to the earliest quarter in which the insurer adopts a coal underwriting policy. $\alpha_{s,m}$ are stack-mine fixed effects, and $\alpha_{s,t}$ are stack-time fixed effects, ensuring that we study within-mine variation and compare changes in mine outcomes with non-exposed mines at the same point in time.[25] Standard errors are clustered at the mine-stack level. If coal policies constrain operations, the β_t coefficients should be zero prior to adoption and positive (for abandonment) or negative (for production and employment) thereafter.

Figure 5 plots the dynamic estimates of Eq. 5, relative to the omitted quarter before policy adoption. Panel A documents the absence of pre-trends for mine abandonment, alongside a notable increase in abandonment beginning in the second post-policy quarter. Panel B reveals no consistent pattern for coal production. Panel C shows modest upward pre-trends in employment and a significant decline after policy adoption. While the timing of the employment response suggests some anticipatory behavior, the overall patterns are consistent with coal underwriting policies constraining mine operations.

To complement this dynamic specification, we run a static DiD regression in which we

[25] The fixed effects absorb the standalone effect of *Coal policy* and the *Event quarter* dummies.

replace the event-time indicators with a single post-treatment indicator (*Post*):

$$Coal\ mine\ outcome_{s,m,t} = \beta \times Coal\ policy\ exposed_{s,m} \times Post_{s,t} + \alpha_{s,m,i} + \alpha_{s,m} + \epsilon_{s,t}. \quad (6)$$

Table 9 reports the results of Eq. 6. Column 1 shows that mines exposed to coal policies are 3.6pp more likely to be abandoned (about 33% relative to the sample mean). Columns 2 and 3 examine the intensive margin, restricting the sample to continuously active mines. The estimates point to post-adoption declines in production by about 8% (or about 0.024 MMst) and in employment by 15% (or 10 employees). The production estimates are not statistically significant, whereas the abandonment and employment effects are. Overall, these results provide suggestive evidence that coal policy adoptions are linked to reductions in mine viability.[26]

So far, we have studied the first time a mine is exposed to the adoption of a coal underwriting policy. We now allow for a given mine to be treated repeatedly as its insurers adopt policies in a staggered manner, thereby capturing variation in treatment intensity. To this end, we implement a shift-share (Bartik) design, following Goldsmith-Pinkham et al. (2020) or Green and Vallee (2025). We define the Bartik instrument of mine m in quarter t, *Share coal policy exposed*, as $\sum_i w_{m,i} \times Post\ coal\ policy_{i,t}$, thereby capturing the share of insurers ($w_{m,i}$) that provided coverage to mine m during 2014 and 2016 and have a coal policy in place in quarter t ($Post\ coal\ policy_{i,t} = 1$). A mine's exposure thus increases with each additional policy-adopting insurer, generating shift-share variation in treatment intensity across mines and over time. This analysis relies on two additional assumptions. First, due to the lack of information on the relative importance of insurers for a given mine, we assume that all insurers contribute equally to exposure (i.e., we assign equal weights to each insurer). Second, we limit the set of mines and insurers to those insurer-mine relationships

[26]Figure IA.7 reports estimates from the staggered event-study estimator of de Chaisemartin and D'Haultfœuille (2025), which is robust to treatment-effect heterogeneity and represents another way to mitigate biases in staggered-adoption settings. The effects are similar in magnitude to our baseline and the pre-treatments are weaker for Abandonment (Panel A) and Employment (Panel C), but effects are estimated with lower statistical precision.

lasting at least eight quarters during the 2014-2016 period, ensuring that exposure reflects economically meaningful ties.[27] We implement this identification strategy by regressing each of the three quarterly mine outcomes on the shift-share instrument as well as time and mine fixed effects, using the mine-quarter panel described in Panel C of Table 4. The estimates, presented in Table IA.8, continue to show economically meaningful increases in the likelihood of mine abandonment (Column 1) and, conditional on being operational throughout the sample period, declines in employment (Column 2) and production (Column 3). However, the coefficient for abandoned mines is not statistically significant at conventional levels. These results—based on the intensity of exposure to coal policy-adopting insurers—reinforce the robustness of the association between insurer policies on mine operations.

The finding that the loss of insurance coverage induced by insurers' climate concerns can constrain mine operations is consistent with anecdotal evidence. Several documented cases support the interpretation that insurance-related regulatory constraints can affect mine operations, independently of coal mine operators' financial distress. For example, coal mine operators required to file with the Securities and Exchange Commission (SEC) regularly mention challenging insurance markets for coal mines because of ESG considerations, cite inability to obtain insurance as a risk factor, or warn that resulting non-renewal of insurance policies could adversely affect coal mine production activities and operating results (e.g., CONSOL Energy Inc., 2020; Arch Resources Inc., 2021; NACCO Industries, Inc, 2022; Alliance Resource Partners, 2023). Such frictions may manifest in employment reductions and precautionary abandonment before output is scaled back, especially when contractual obligations or stored inventories allow mines to sustain production temporarily.

[27] Pre-trends are attenuated, and the dynamic post-treatment effects become cleaner when using the refined eight-quarter relationship definition (see Figure IA.8), supporting the notion that longer-lasting insurer ties capture more meaningful exposure.

3.4.3 Cross-sectional variation in mine outcomes

We examine cross-sectional heterogeneity in mine outcomes to assess whether the effects of coal policy adoptions are concentrated among specific subgroups. To do so, we augment Eq. 6 with triple interaction terms. This analysis focuses on mine abandonment, which not only provides the largest sample size relative to alternative outcomes such as production or employment but also constitutes the most drastic operational response.

We consider two dimensions of heterogeneity. First, we test whether mines that are more dependent on specific insurers or have fewer alternative providers are more affected. We proxy dependency using a dummy for whether a mine has a relationship insurer, defined as having at least one insurer that provided coverage for at least eight quarters during the 2014-2016 period. Access to alternatives is measured by having an above-median number of distinct insurers covering a mine during the same period. Results in Columns 1 and 2 of Table 10 show that the effect of coal underwriting policies on mine abandonment is stronger for mines that are more reliant on specific insurers, either by having a relationship insurer or by lacking alternative providers. This indicates that insurer dependency amplifies, while insurer substitutability mitigates, the effects of coal policy adoptions.

Second, we test whether opportunity cost considerations drive abandonment decisions. While we do not observe mine-level profitability, we classify higher-opportunity-cost mines as those with above-median productivity, proxied by average output per working hour, or above-median size, measured by total production, during the 2014-2016 baseline period. The results in Column 1 indicate that more productive mines are generally less likely to be closed post-policy adoption, but this effect does not vary by exposure to coal policies. The results in Column 2 show no significant difference in abandonment probabilities between large and small mines, although the coefficient on the triple interaction term suggests a potentially higher likelihood of abandonment among larger mines. Overall, mine characteristics such as

productivity and size do not materially influence abandonment decisions following coal policy adoptions, whereas dependency on insurers and availability of alternative coverage do.

Overall, the results in this section suggest that coal underwriting policies can have meaningful effects on mine operations. Non-renewal of insurance contracts, regardless of cause, is linked to a higher likelihood of mine abandonment and with reductions in output and employment. Adoptions of coal policies yield similar effects, strengthening the interpretation that coal policies result in operational changes. Because abandonment is rarely reversed in our sample, these declines are unlikely to reflect temporary shutdowns and instead suggest lasting or permanent closures. The magnitude of these effects increases with exposure to policy-adopting insurers, pointing to a potential role for insurers in shaping coal mine activity through underwriting decisions. While abandonment decisions do not vary systematically with mine characteristics such as productivity or size, they are sensitive to the structure of insurer relationships: mines that are more dependent on specific insurers are more likely to be abandoned, whereas those with greater access to alternative insurance providers are less likely to be abandoned. These patterns suggest that the effectiveness of coal underwriting policies is shaped by the degree of insurer dependency and substitutability, with fragmented markets providing opportunities for substitution that weaken the impact of individual insurers' actions.

3.5 Do coal underwriting policies affect overall insurer outcomes?

The previous results suggest that insurers adjust their underwriting behavior following the adoption of coal underwriting policies. This raises the question of whether such policies also meaningfully affect outcomes at the insurer level. For insurers, adopting coal policies may entail important trade-offs. On the one hand, reduced underwriting activity may lead to lower income in the short term. On the other hand, such policies may decrease risk exposure and generate reputational benefits that may enhance franchise value. Assessing these trade-

offs comprehensively is challenging. Coal-related activities account for only a small share of insurers' overall business, our sample of adopting insurers is limited, and financial and non-financial effects may take time to materialize. With these caveats in mind, we examine insurer-level outcomes including (the log of) gross written premiums as a measure of operating income (*GWP (log)*), return on assets as a measure of profitability (*ROA (%)*), abnormal stock returns around the announcement of coal policy adoptions as a forward-looking measure of shareholder wealth (*CAR[0,1]*), an insurer's solvency ratio as a measure of riskiness (*Solvency ratio*), and the number of environmental incidents to capture reputational standing (*# RepRisk incidents*).

Results are reported in Table 11. Gross written premiums, presented in Column 1, remain unchanged around the adoption of coal policies. Return on assets, reported in Column 2, declines by about 0.5 percentage points, though the effect is imprecisely estimated and not statistically significant. Similarly, abnormal announcement returns around adoptions are negative, around -0.5 percentage points, but also not statistically significant. Solvency ratios, shown in Column 4, exhibit no systematic change. Interestingly, however, the number of yearly environmental incidents, reported in Column 5, decreases slightly, potentially because the media reports more favorably once coal policies are in place. This result indicates the presence of some reputational benefits associated with coal policies. Overall, given the small samples, limited time period, and the fact that insurer-level outcomes reflect a wide range of activities beyond coal underwriting, we can provide only limited evidence of insurer-level consequences. Nevertheless, our analysis highlights that coal policies have discernible effects within insurers' coal business and their relationships with coal mines.

4 Conclusion

Insurance companies can facilitate the net-zero transition by restricting insurance coverage of carbon-intensive projects. We study the determinants, structure, implementation, and effects

of insurers' carbon underwriting policies, focusing on their role in shaping U.S. coal mining. While such policies have become increasingly common among the world's major insurance groups, their design, stringency, and enforcement remain highly heterogeneous. Using novel mine-level insurance data, we show that coal underwriting policies reduce insurance coverage of coal mines, lower insured coal volumes, and make it less likely that existing mine-insurer relationships continue. Mines affected by changes in insurance coverage are more likely to be abandoned and reduce scale, particularly employment, suggesting that underwriting decisions provide a viable channel through which financial institutions can influence decarbonization. Our findings provide the first systematic evidence on insurers' carbon underwriting policies and underscore that their effectiveness depends critically on policy design and implementation. They also highlight the role of coordination: in fragmented markets, substitution opportunities limit the reach of individual insurers' actions, whereas dependency on single insurers magnifies policy effects. Greater transparency—particularly public disclosure of underwriting commitments and insured exposures—is essential to assess insurers' contributions to climate goals, especially since effects are difficult to detect at the aggregate insurer level.

Table A.1: Variable definitions

Variable	Definition	Source
	Panel A: Insurer characteristics	
Coal policy	Equals one for insurers with a coal underwriting policy in place, and zero for insurers without a coal underwriting policy	IOF scorecards
Coal policy score	Score ranging from 0 to 10 to reflect the stringency of coal underwriting policies. Higher values indicate stricter policies	IOF scorecards
First coal policy score	An insurer's *Coal policy score* at adoption of the policy. For insurers that adopted a policy in 2017, we use the 2018 stringency scores.	IOF scorecards
Max coal policy score	Maximum of *Coal policy score* for a given insurer	IOF scorecards
Oil & gas policy	Equals one for insurers with an oil & gas underwriting policy, and zero for insurers without an oil & gas underwriting policy	IOF scorecards
Oil & gas policy score	Score ranging from 0 to 10 to reflect the stringency of oil & gas underwriting policies. Higher values indicate stricter policies	IOF scorecards
Coal investment policy	Equals one for insurers with a coal investment policy in place, and zero for insurers without a coal underwriting policy	IOF scorecards
Coal investment score	Score ranging from 0 to 10 to reflect the stringency of coal investment policies. Higher values indicate stricter policies	IOF scorecards
Oil & gas investment policy	Equals one for insurers with an oil & gas investment policy, and zero for insurers without an oil & gas underwriting policy	IOF scorecards
Oil & gas investment score	Score ranging from 0 to 10 to reflect the stringency of oil & gas investment policies. Higher values indicate stricter policies	IOF scorecards
Europe	Equals one if an insurer (parent company of an insurance group) is headquartered in Europe, and zero otherwise	IOF scorecards
US	Equals one if an insurer (parent company of an insurance group) is headquartered in the U.S., and zero otherwise	IOF scorecards
Asia	Equals one if an insurer (parent company of an insurance group) is headquartered in Asia, and zero otherwise	IOF scorecards
RoW	Equals one if an insurer (parent company of an insurance group) is headquartered outside Europe, the U.S, or Asia, and zero otherwise	IOF scorecards
Unlisted insurer	Equals one if the parent company of an insurance group is listed, zero otherwise	Orbis
Specialty insurer	Equals one if an insurer (parent company of an insurance group) is a specialty insurer, and zero otherwise	Online searches
NZIA	Equals one if an insurer (parent company of an insurance group) is a member of the Net Zero Insurance Alliance (NZIA), and zero otherwise	NZIA website

Total assets	Consolidated total assets of the insurer	Orbis
ROA (%)	Consolidated pre-tax return on assets of the insurer	Orbis
GWP (log)	Gross written premiums of the insurer	Orbis
CAR[0,1]	Sum of daily abnormal returns on the day of the announcement of the adoption of a carbon underwriting policy and the following trading day, where daily abnormal returns equal an insurer's stock return minus the market return	Compustat Global and Kenneth French Data Library
Solvency ratio	Solvency capital, computed as the sum of capital and surplus, claims equalization reserve, and unrealized gains on investments, over total assets	Orbis
# RepRisk incidents	Number of environmental incidents in a year	RepRisk
# Coal mines insured	Number of unique coal mines insured in a given quarter	Certificates of Liability Insurance
Coal volume insured	Million short tons (MMst) of coal produced by the mines insured in a given quarter	Certificates of Liability Insurance
	Panel B: Policy characteristics	
Commercial general liability	Equals one if a policy covers commercial general liability, and zero otherwise	Certificates of Liability Insurance
Automobile	Equals one if a policy covers automobile liability, and zero otherwise	Certificates of Liability Insurance
Umbrella & excess	Equals one if a policy covers Umbrella or excess liability, and zero otherwise	Certificates of Liability Insurance
Workers compensation	Equals one if a policy covers workers compensation and employers' liability, and zero otherwise	Certificates of Liability Insurance
	Panel C: Insurer-mine relationship characteristics	
Coal policy	Equals one for quarters in which the insurer has a coal underwriting policy in place, and zero otherwise	Certificates of Liability Insurance
Inactive insurance	Equals one for quarters in which the insurer does not insure the mine, zero if it does	Certificates of Liability Insurance
Length active insurance	Time in quarters since which the insurer insures the mine	Certificates of Liability Insurance
	Panel D: Mine characteristics	
Coal policy exposed	Equals one if, between 2014 and 2016, a mine is insured by an insurer that will eventually adopt a coal underwriting policy, and zero otherwise	Certificates of Liability Insurance
Share coal policy exposed	Equals $\sum_i w_{m,i} \times Post\ coal\ policy_{i,t}$ for a mine-quarter, where i indexes an insurer, m a mine and t a quarter. w are equal weights allocated to each insurer with at least eight quarters of active insurance relationship with a mine between 2014 and 2016, and *Post coal policy* equals one for insurer-quarters after a coal underwriting policy is introduced, and zero otherwise.	Certificates of Liability Insurance
Non-renewed insurance	Equals one if, in a given quarter, the insurance coverage of a given mine by a given insurer is not renewed, and zero as long as the same coverage exists and continues over the following year.	Certificates of Liability Insurance

Abandoned	Equals one if mine status in a quarter is either abandoned or abandoned and sealed, and zero otherwise	MSHA
Production	Million short tons (MMst) of coal produced by a mine in a quarter	MSHA
# Employees	Average number of employees of a mine in a quarter	MSHA
# Insurers per quarter	Number of different insurers of a mine in a quarter	Certificates of Liability Insurance
Relationship insurer	Equals one if a mine has a relationship of eight quarters or more with at least one insurer between 2014 and 2016, and zero otherwise	Certificates of Liability Insurance
Many insurers	Equals one if a mine has an above-median average number of insurers between 2014 and 2016, and zero otherwise	Certificates of Liability Insurance
Productive mine	Equals one if a mine has an above-median average output per working hour between 2014 and 2016, and zero otherwise	MSHA
Large mine	Equals one if a mine has an above-median total coal production between 2014 and 2016, and zero otherwise	MSHA

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Figure 1: Prevalence and structure of coal underwriting policies over time

The figure shows the number of insurers whose coal underwriting policies incorporate specific policy features. The sample is based on annual scorecards compiled by Insure Our Future (IOF) and includes up to 25 insurers with coal underwriting policies in place.

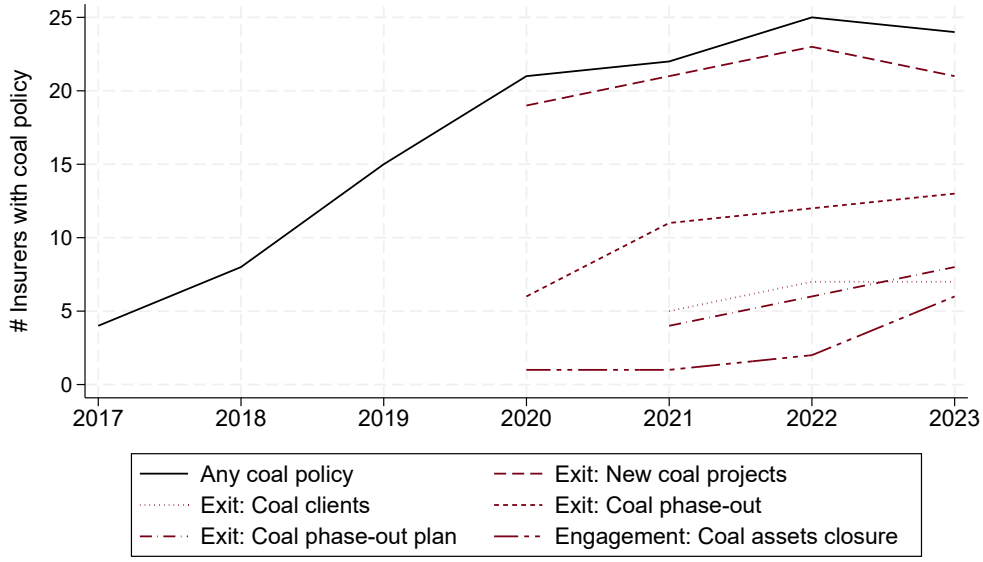


Figure 2: Stringency of coal underwriting policies over time

The figure displays scores capturing the stringency of coal underwriting policies over time. Scores range from 0 to 10, with higher values indicating more restrictive policies. Each dot represents an individual insurer in a given year. The solid line connects average scores by year. The two insurers with the highest and lowest overall carbon policy scores in the final sample year (2023) are highlighted with colored dots. The sample is based on annual scorecards compiled by Insure Our Future (IOF) and includes 25 insurers with coal underwriting policies in place.

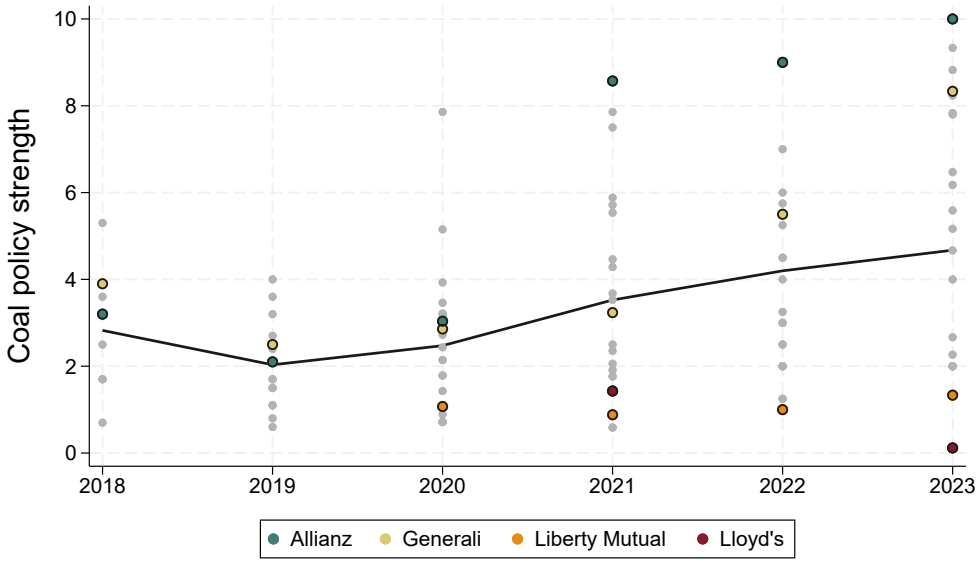
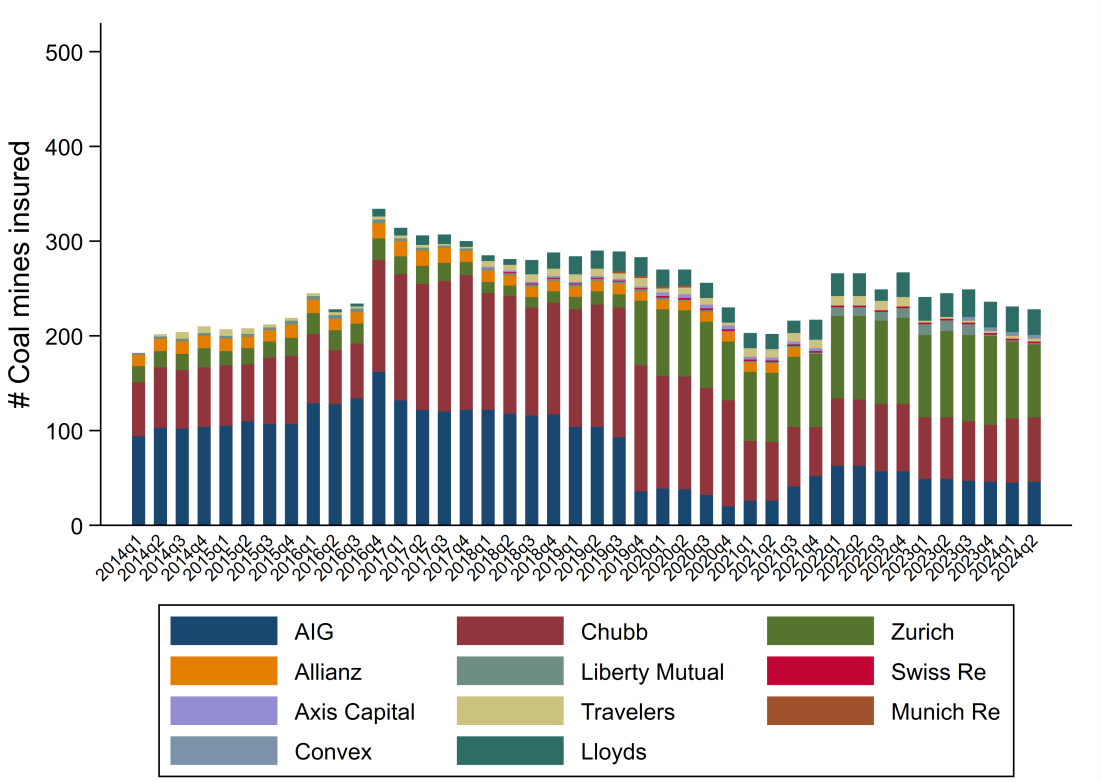


Figure 3: Number of insured coal mines over time

The figure displays the number of insured coal mines over time. For each quarter, we count the number of unique mines insured by each insurer. Panel A presents this information for insurers that adopted a coal underwriting policy at any point during the sample period, while Panel B presents this information for those that never did. The sample includes all coal mines listed in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, provided they report at least one quarter of non-zero coal production, and for which we successfully obtained Certificates of Liability Insurance of ACORD 25 forms from state-level agencies. Table A.1 provides descriptions of all variables.

Panel A: Insurer with a coal underwriting policy



Panel B: Insurers without a coal underwriting policy

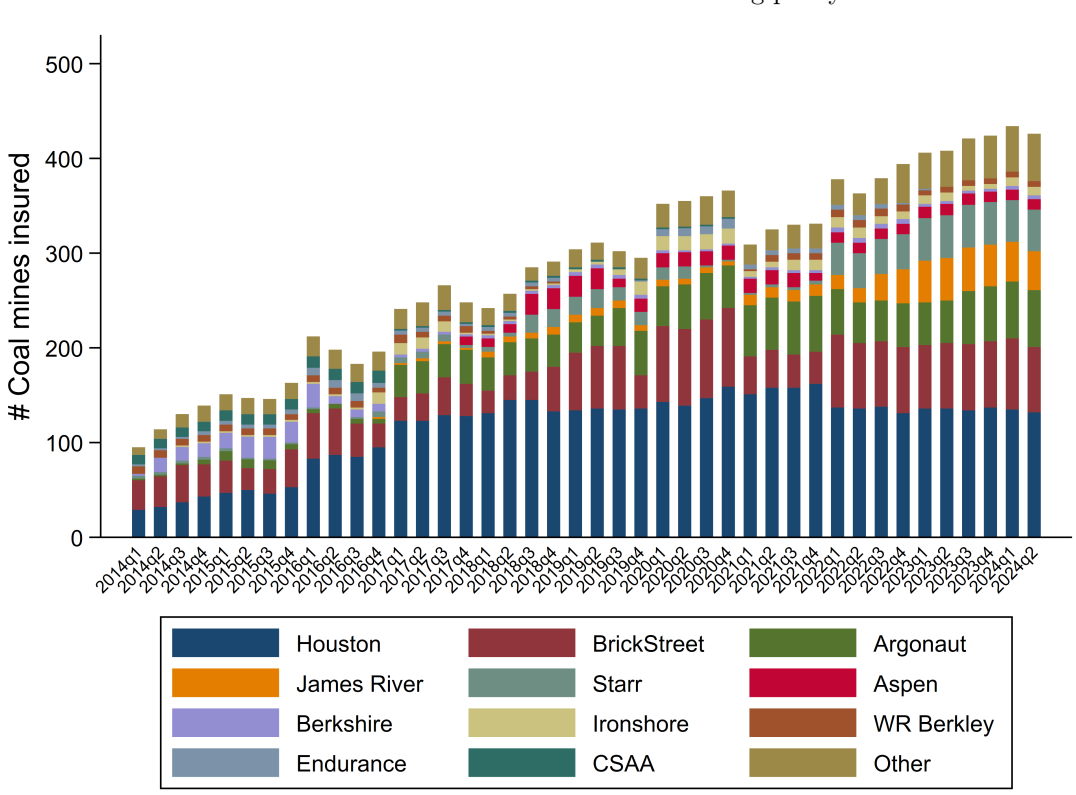


Figure 4: Coal mines' insurance status and underwriting policies

This figure displays coefficient estimates and 90% confidence intervals from the following OLS regression:

$$Inactive\ insurance_{s,m,i,t} = \sum_{t=-6}^{t=6} \beta_t \times Coal\ policy_i \times Event\ quarter_{s,t} + \alpha_{s,m,i} + \alpha_{s,m,t} + \epsilon_{s,m,i,t},$$

where s indexes a stack, m indexes a mine, i an insurer, and t a quarter. The dependent variable, *Inactive insurance*, equals one if an insurer does not insure a mine in a given quarter, and zero if it does. *Coal policy* equals one for insurer-mine pairs involving a policy-adopting insurer, and zero otherwise. *Event quarter* are dummy variables indicating quarters relative to the policy adoption quarter. $\alpha_{s,m,i}$ are stack-mine-insurer fixed effects, while $\alpha_{s,m,t}$ are stack-mine-time fixed effects. The initial sample includes all coal mines that appear in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, report at least one quarter of non-zero production, and have insurance certificate data available for those quarters. For each insurer that adopts a coal underwriting policy, we identify all mines it insures and construct a balanced sample of 13 quarterly observations per mine-insurance pair, six quarters before and six quarters after the policy adoption quarter, whenever information on the liability insurance certificates of a given mine is available. These mine-insurer pairs form the treated relationships in the stack. As a control group, we include all other relationships that the same mines have with insurers that never adopt a coal underwriting policy. Standard errors are clustered at the insurer-stack level. Table A.1 provides descriptions of all variables.

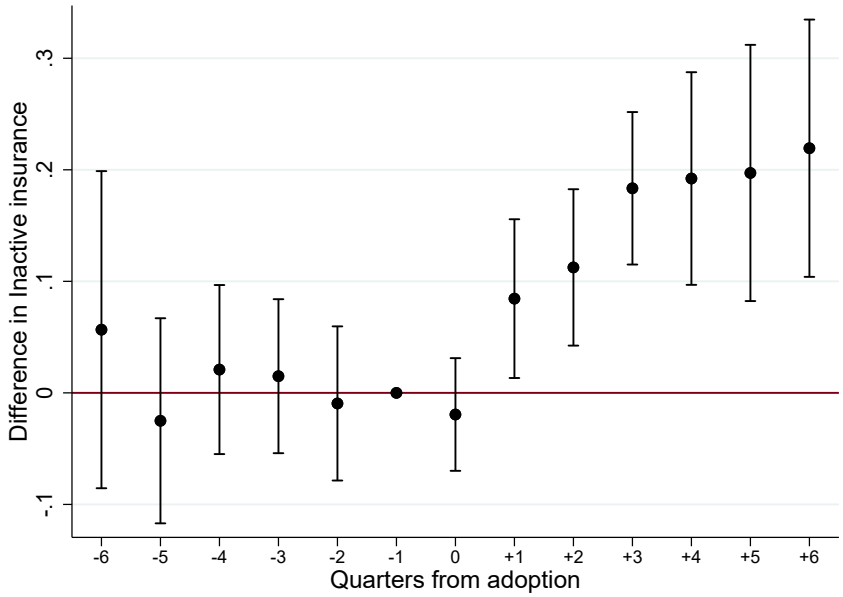


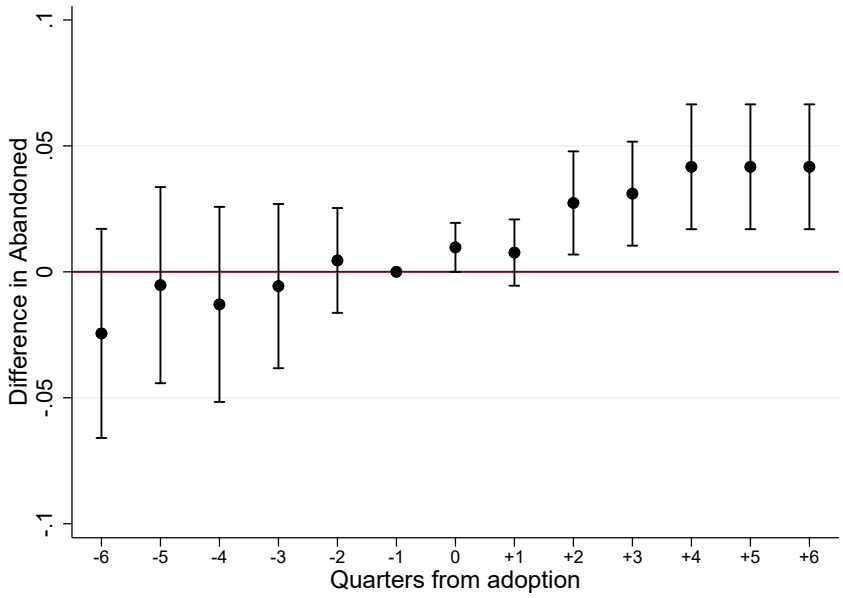
Figure 5: Coal mine outcomes and underwriting policies

This figure displays coefficient estimates and 90% confidence intervals from the following OLS regression:

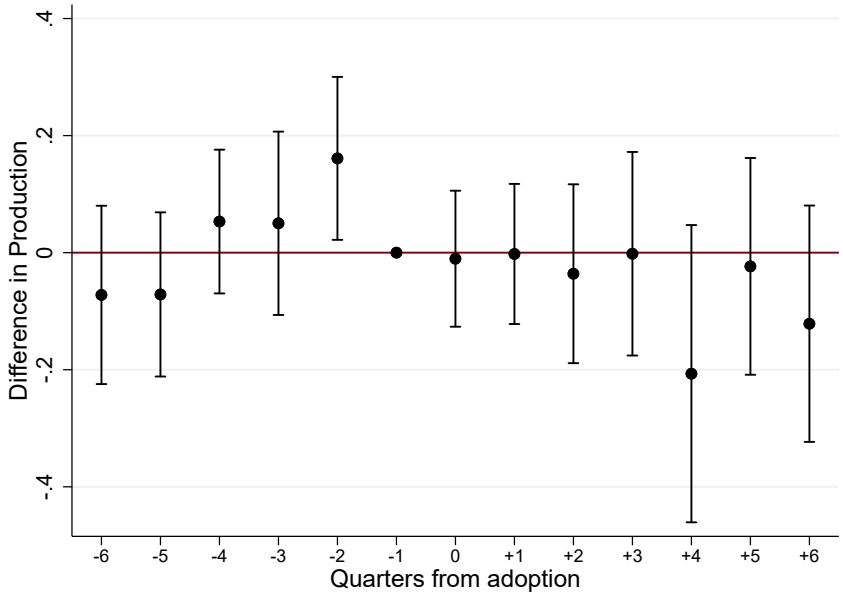
$$Coal\ mine\ outcome_{s,m,t} = \sum_{t=-6}^{t=6} \beta_t \times Coal\ policy\ exposed_{s,m} \times Event\ quarter_{s,t} + \alpha_{s,m} + \alpha_{s,t} + \epsilon_{s,m,t},$$

where s indexes a stack, m a mine, and t a quarter. The dependent variable, *Coal mine outcome*, is a dummy variable indicating whether a mine is abandoned (Panel A), the volume of coal produced (Panel B), or the average number of employees (Panel C). *Coal policy exposed* equals one for mines that, between 2014 and 2016, have at least one insurer with a coal underwriting policy. *Event quarter* are dummy variables indicating quarters relative to the policy adoption quarter. If a mine is exposed to multiple such adoptions, only the first instance is used to define treatment. The sample includes all mines from Table 6, provided that we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies between 2014 and 2016. In Panels B and C, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the mine-stack level. Table A.1 provides descriptions of all variables.

Panel A: Abandoned



Panel B: Production



Panel C: # Employees

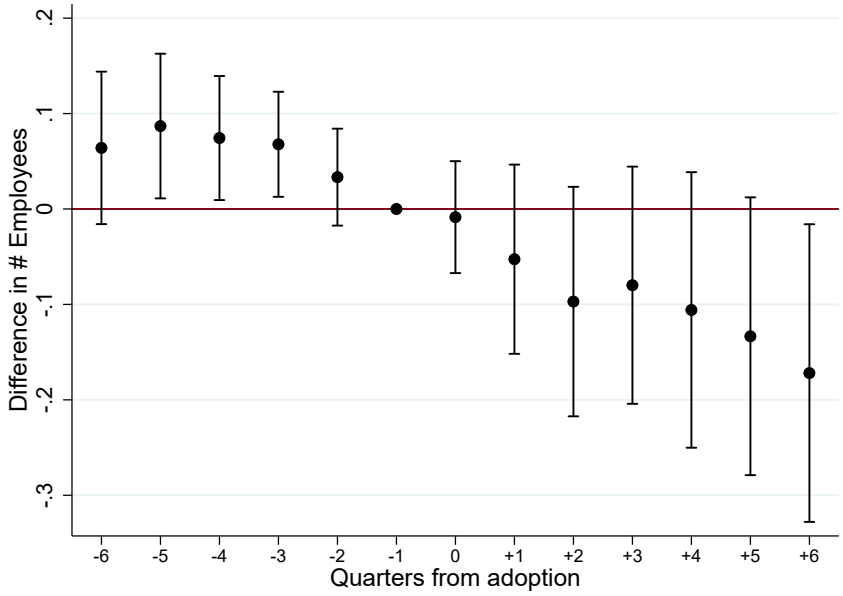


Table 1: Prevalence of coal underwriting policies by insurer

This table lists coal underwriting policies over time for the insurers in the sample. A value of one indicates that an insurer has a coal underwriting policy in place in a year, and a value of zero indicates that an insurer has no coal underwriting policy. Missing values reflect that an insurer was not included in the IOF scorecards or that its policies were not assessed by IOF in a year (e.g., for Legal & General, the coal investment—not the coal underwriting—policies are assessed; therefor the insurer is included in the sample but with missing values). The sample is based on annual scorecards compiled by Insure Our Future (IOF).

Name	2017	2018	2019	2020	2021	2022	2023	% Years w/ policy
AIG	0	0	0	0	0	1	1	29
AXA	1	1	1	1	1	1	1	100
Allianz	0	1	1	1	1	1	1	86
Aviva			1	1	1	1	1	100
Axis Capital	0	0	1	1	1	1	1	71
Berkshire Hathaway	0	0	0	0	0	0	0	0
Chubb	0	0	1	1	1	1	1	71
Convex					0	1		50
Everest Re					0	0	0	0
FM Global			0					0
Generali	0	1	1	1	1	1	1	86
HDI			1	1	1	1	1	100
Hannover Re	0	0	1	1	1	1	1	71
Legal & General								
Liberty Mutual	0	0	0	1	1	1	1	57
Lloyd's		0	0	0	1	1	1	50
MS&AD			0	1	1	1	1	80
Mapfre	0	1	1	1	1	1	1	86
MetLife								
Munich Re	0	1	1	1	1	1	1	86
PICC					0	0	0	0
Ping An			1	1	1	1	1	100
Prudential								
QBE	0	0	1	1	1	1	1	71
SCOR	1	1	1	1	1	1	1	100
Samsung FM			0	1	1	1	1	80
Sinosure			0	0	0	0	0	0
Sompo	0	0	0	1	1	1	1	57
Starr						0	0	0
Swiss Re	1	1	1	1	1	1	1	100
TIAA								
The Hartford				1	1	1	1	100
Tokio Marine	0	0	0	1	1	1	1	57
Travelers				0	0	1	1	50
WR Berkley	0	0	0	0	0		0	0
XL Catlin	0							0
Zurich	1	1	1	1	1	1	1	100
% Insurance groups w/ policy	21	42	58	78	73	80	80	
# Insurance groups	25	24	30	30	30	30	30	

Table 2: Stringency of coal underwriting policies by insurer

This table reports scores reflecting the stringency of coal underwriting policies over time of the insurers in the sample. The scores range from 0 to 10, with higher values reflecting stricter coal underwriting policies. Insurers are ranked based on 2023 score values, from high to low. The sample period starts in 2018 because policy strength was not assessed before. The sample is based on annual scorecards compiled by Insure Our Future (IOF).

Name	2017	2018	2019	2020	2021	2022	2023	Average score
Allianz		3.20	2.10	1.33	8.57	9.00	10.00	5.70
AXA		2.50	3.20	4.38	7.86	9.00	9.33	6.05
Swiss Re		5.30	4.00	4.29	5.54	6.00	8.82	5.66
Generali		3.90	2.50	2.34	3.24	5.50	8.33	4.30
Axis Capital		0.00	2.70	2.17	7.50	9.00	8.24	4.93
Aviva			1.10	1.09	3.68	5.75	7.83	3.89
Zurich		3.60	3.60	2.66	5.88	7.00	7.80	5.09
SCOR		1.70	1.70	1.67	4.29	4.50	6.47	3.39
Hannover Re		0.00	1.50	2.86	5.71	5.25	6.18	3.58
Munich Re		1.70	1.10	2.62	2.50	4.50	5.59	3.00
Mapfre		0.70	0.80	0.63	4.46	5.50	5.17	2.88
HDI			1.50	1.48	1.91	3.25	4.67	2.56
QBE		0.00	2.40	1.41	3.53	4.00	4.00	2.56
AIG		0.00	0.00	0.00	0.00	3.00	2.67	0.94
Samsung FM			0.00	0.78	1.76	2.50	2.27	1.46
Travelers				0.00	0.00	2.00	2.00	1.00
The Hartford				1.25	2.06	2.00	2.00	1.83
Sompo		0.00	0.00	0.31	0.59	2.00	2.00	0.82
Tokio Marine		0.00	0.00	0.31	2.35	2.00	2.00	1.11
MS&AD			0.00	0.31	1.76	3.00	2.00	1.41
Chubb		0.00	1.70	0.39	1.47	1.25	2.00	1.14
Liberty Mutual		0.00	0.00	0.47	0.88	1.00	1.33	0.61
Ping An			0.60	0.31	0.59	1.25	1.33	0.82
Lloyd's		0.00	0.00	0.00	1.43	0.00	0.12	0.26
Starr						0.00	0.00	0.00
PICC					0.00	0.00	0.00	0.00
WR Berkley		0.00	0.00	0.00	0.00		0.00	0.00
Sinosure			0.00	0.00	0.00	0.00	0.00	0.00
Berkshire Hathaway		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Everest Re					0.00	0.00	0.00	0.00
Legal & General								
TIAA								
MetLife								
XL Catlin								
Prudential								
Convex					0.00	2.50		1.25
FM Global			0.00					0.00
Average score		1.19	1.17	1.22	2.59	3.36	3.74	
# Insurance groups	25	24	30	30	30	30	30	
# Missing scores	25	5	4	3	0	0	0	

Table 3: Determinants of coal underwriting policies

This table presents results from the following OLS regression:

$$Y_{i,t} = \beta \times X_{i,t-1} + \epsilon_{i,t},$$

where i indexes an insurer and t a year. In Columns 1 to 3, Y is *Coal policy*, which equals one if the insurer has a coal underwriting policy, and zero otherwise. In Columns 4–6, Y is *Coal policy score*, which is a score ranging from 0 to 10, with higher scores indicating stricter coal underwriting policies. X is a vector of insurer-level characteristics. The sample is based on annual scorecards compiled by Insure Our Future (IOF). Standard errors are clustered at the insurer level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Coal policy			*Coal policy score*		
	(1)	(2)	(3)	(4)	(5)	(6)
2018	0.211**	0.211*	0.158			
	(0.099)	(0.105)	(0.112)			
2019	0.366***	0.388***	0.380***	-0.792**	-0.352	-0.129
	(0.116)	(0.119)	(0.124)	(0.377)	(0.440)	(0.446)
2020	0.567***	0.599***	0.598***	-0.351	0.898	1.222*
	(0.115)	(0.117)	(0.113)	(0.553)	(0.584)	(0.610)
2021	0.523***	0.565***	0.544***	0.701	1.892**	2.187***
	(0.117)	(0.109)	(0.114)	(0.684)	(0.686)	(0.639)
2022	0.623***	0.665***	0.754***	1.205*	2.515***	2.752***
	(0.115)	(0.104)	(0.104)	(0.697)	(0.714)	(0.673)
2023	0.589***	0.638***	0.715***	1.848**	3.211***	3.056***
	(0.115)	(0.107)	(0.133)	(0.720)	(0.688)	(0.655)
US		-0.516***	-0.482***		-3.247***	-2.332***
		(0.119)	(0.136)		(0.601)	(0.597)
Asia		-0.378***	-0.468***		-3.281***	-3.408***
		(0.128)	(0.108)		(0.563)	(0.506)
RoW		-0.327**	-0.350*		-0.037	0.402
		(0.159)	(0.174)		(1.055)	(1.230)
NZIA			-0.164*			0.853
			(0.088)			(0.531)
Specialty insurer			-0.243**			-0.357
			(0.101)			(0.830)
Unlisted insurer			-0.316**			-2.498**
			(0.149)			(1.091)
Total assets (log)			-0.020			0.179
			(0.048)			(0.284)
ROA			-0.044**			-0.218
			(0.020)			(0.173)
Obs.	181	181	180	115	115	115
Adj. R^2	0.146	0.359	0.441	0.103	0.471	0.606
# Insurers in sample	33	33	32	25	25	25

Table 4: Descriptive statistics on coal mines and underwriting policies

This table presents descriptive statistics on coal mines and underwriting policies. The sample includes all coal mines listed in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, provided they report at least one quarter of non-zero coal production, and for which we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies. In Panel A, the sample is at the mine-quarter-insurer level. In Panel B, the sample is collapsed at the insurer-quarter level. In Panel C, the sample is collapsed at the mine-quarter level. Table A.1 provides descriptions of all variables.

	Obs.	Mean	Std.	25th	Median	75th
Panel A: Insurer-mine-quarter sample						
Coal policy	51,710	0.47				
Inactive insurance	51,710	0.57				
Length active insurance (quarters)	51,710	14.20	8.91	8.00	12.00	19.00
Panel B: Insurer-quarter sample						
Coal policy	1,145	0.28				
# Coal mines insured	1,145	19.61	33.65	2.00	4.00	16.00
Coal volume insured (MMst)	1,145	5.94	10.85	0.04	1.13	4.91
Panel C: Mine-quarter sample						
Coal policy exposed	10,883	0.80				
Non-renewed insurance	12,812	0.07				
Share coal policy exposed	7,342	0.25	0.40	0.00	0.00	0.50
Abandoned mine	12,812	0.11				
Production (MMst)	12,812	0.35	1.68	0.00	0.00	0.12
# Employees	12,812	71.40	147.91	0.00	9.00	78.00
# Insurers per quarter	12,812	4.15	1.84	3.00	4.00	5.00
Relationship insurer	12,932	0.57				
Many insurers	11,254	0.45				
Productive mine	10,129	0.50				
Large mine	11,254	0.50				

Table 5: Insurers' coal underwriting activity and underwriting policies

This table presents results from the following OLS regression:

$$Coal\ insurance_{i,t} = \beta \times Post\ coal\ policy_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t},$$

where i indexes an insurer and t a quarter. In Columns 1 and 3, the dependent variable, *Coal insurance*, is *# Coal mines insured*, which is the number of mines insured by an insurer in a given quarter. In Columns 2 and 4, *Coal insurance* is *Coal volume insured*, which is the volume of insured coal that is produced. *Post coal policy* equals one for insurer-quarters after a coal underwriting policy is introduced, and zero otherwise. The sample includes all coal mines listed in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, provided they report at least one quarter of non-zero coal production, and for which we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies. In Columns 3 and 4, the sample includes only mines that are active throughout the entire sample period. Robust standard errors are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	# Coal mines insured (log)	*Coal volume insured* (log)	*# Coal mines insured* (log)	*Coal volume insured* (log)
	All coal mines		Active coal mines	
	(1)	(2)	(3)	(4)
Post coal policy	-0.172**	-0.824***	-0.582***	-0.651***
	(0.080)	(0.145)	(0.085)	(0.152)
Insurance group FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Obs.	1,145	951	680	671
Adj. R^2	0.828	0.767	0.750	0.754
# Insurance groups	46	40	29	28

Table 6: Coal mines' insurance status and underwriting policies

This table presents results from the following OLS regression:

$$Inactive\ insurance_{s,m,i,t} = \beta \times Coal\ policy_i \times Post_{s,t} + \alpha_{s,m,i} + \alpha_{s,m,t} + \epsilon_{s,m,i,t},$$

where s indexes a stack, m a mine, i an insurer, and t a quarter. The dependent variable, *Inactive insurance*, equals one if an insurer does not insure a mine in a given quarter, and zero if it does. *Coal policy* equals one for insurer-mine pairs involving a policy-adopting insurer, and zero otherwise. *Post* equals one for the quarter of the adoption of coal policy and all quarters thereafter, and zero otherwise. The initial sample includes all coal mines that appear in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, report at least one quarter of non-zero production, and have insurance certificate data available for those quarters. For each insurer that adopts a coal underwriting policy, we identify all mines it insures and construct a balanced sample of 13 quarterly observations per mine-insurance pair, six quarters before and six quarters after the policy adoption quarter, whenever information on the liability insurance certificates of a given mine is available. These mine-insurer pairs form the treated observations in the stack. As control observations, we include all other mine-insurer pairs that include the same mines but insurers that never adopt a coal underwriting policy. In Column 2, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the insurer-stack level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Inactive insurance	
	All coal mines	Active coal mines
	(1)	(2)
Coal policy × *Post*	0.128**	0.137**
	(0.055)	(0.066)
Stack × Insurance group × Coal mine FE	Yes	Yes
Stack × Coal mine × Time FE	Yes	Yes
Obs.	24,907	4,330
Adj. R^2	0.587	0.604
# Insurance groups	46	26

Table 7: Cross-sectional variation in changes in underwriting activity

In Columns 1 and 2, this table presents variants of the following OLS regression:

$$Inactive\ insurance_{s,m,i,t} = \beta \times Coal\ policy\ score_i \times Post_{s,t} + \alpha_{s,m,i} + \alpha_{s,m,t} + \epsilon_{s,m,i,t},$$

while Columns 3 and 4 present variants of the following OLS regression:

$$Inactive\ insurance_{s,m,p,i,t} = \beta \times Coal\ policy_i \times Post_{s,t} \times Insurance\ type + \alpha_{s,m,p,i} + \alpha_{s,m,t} + \epsilon_{s,m,p,i,t},$$

where s indexes a stack, m a mine, p a policy type, i an insurer, and t a quarter. The dependent variable, *Inactive insurance*, equals one if an insurer does not insure a mine in a given quarter, and zero if it does. *Coal policy* equals one for mines insured by an insurer adopting a carbon underwriting policy, and zero otherwise. *Post* equals one for the quarter of the adoption of coal policy and all quarters thereafter, and zero otherwise. The initial sample of mines includes all coal mines listed in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, provided they report at least one quarter of non-zero coal production, and for which we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies. For Columns 1 and 2, we define the unit of observation as a mine-insurer pair. For each insurer that adopts a coal underwriting policy, we identify all mines it insures and construct a balanced sample of 13 quarterly observations per pair—six quarters before and six quarters after the policy adoption quarter—whenever liability insurance certificate data are available. These mine-insurer pairs form the treated observations in the stack. As controls, we include all other mine-insurer pairs involving the same mines but insurers that never adopt a coal underwriting policy. Standard errors are clustered at the insurer-stack level. For Columns 3 and 4, we repeat this procedure at the finer level of mine-policy type-insurer triplets. That is, we construct balanced panels of 13 quarterly observations per triplet and stack them analogously. Standard errors are clustered at the insurer-policy type-stack level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Inactive insurance			
	(1)	(2)	(3)	(4)
First coal policy score × Post	0.042*			
	(0.023)			
Max coal policy score × Post		0.026***		
		(0.010)		
Coal policy × Post			0.087*	0.125**
			(0.047)	(0.059)
Coal policy × Post × Automobile				-0.040
				(0.084)
Coal policy × Post × Umbrella & excess				-0.072
				(0.100)
Coal policy × Post × Workers compensation				-0.135*
				(0.079)
Post × Automobile				0.011
				(0.081)
Post × Umbrella & excess				0.029
				(0.065)
Post × Workers compensation				-0.042
				(0.063)
Stack × Insurance group × Coal mine FE	Yes	Yes		
Stack × Coal mine × Time FE	Yes	Yes		
Stack × Insurance group × Coal mine × Insurance type FE			Yes	Yes
Stack × Coal mine × Time FE			Yes	Yes
Obs.	24,907	24,907	41,615	41,615
Adj. R^2	0.585	0.585	0.623	0.625
# Insurance groups	46	46	46	46

Table 8: Coal mine outcomes and insurance non-renewal

This table presents results from the following OLS regression estimated at the mine-quarter level:

$$Coal\ mine\ outcome_{m,t} = \sum_{k=1}^{k=4} \beta_k \times Non\text{-}renewed\ insurance_{m,t-k} + \alpha_m + \alpha_t + \epsilon_{m,t}$$

where m indexes a mine and t a quarter. The dependent variable, *Coal mine outcome*, is a dummy variable indicating whether a mine is abandoned (Column 1), the volume of coal produced (Column 2), or the average number of employees (Column 3). *Non-renewed insurance* equals one if in quarter $t-k$, with $k \in [1,4]$, at least one insurer of mine m does not renew its coverage, it equals zero as long as insurance coverage for mine m by the set of its insurers exists and is renewed. The sample includes all coal mines that appear in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, report at least one quarter of non-zero production, and have insurance certificate data available for those quarters. In Columns 2 and 3, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the mine level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Abandoned	*Production (log)*	*# Employees (log)*
	(1)	(2)	(3)
$Non\text{-}renewed\ insurance_{t-1}$	0.003	-0.066	-0.048*
	(0.007)	(0.059)	(0.027)
$Non\text{-}renewed\ insurance_{t-2}$	0.002	-0.112**	-0.112***
	(0.007)	(0.054)	(0.040)
$Non\text{-}renewed\ insurance_{t-3}$	0.006	-0.043	-0.082*
	(0.008)	(0.047)	(0.043)
$Non\text{-}renewed\ insurance_{t-4}$	0.014*	-0.088	-0.086*
	(0.008)	(0.064)	(0.046)
Coal mine FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Obs.	12,812	2,173	2,256
Adj. R^2	0.601	0.911	0.911
# Coal mines	456	62	63

Table 9: Coal mine outcomes and underwriting policies

This table presents results from the following OLS regression estimated at the mine-quarter level:

$$Coal\ mine\ outcome_{s,m,t} = \beta \times Coal\ policy\ exposed_m \times Post_{s,t} + \alpha_{s,m} + \alpha_{s,t} + \epsilon_{s,m,t}$$

where s indexes a stack, m a mine, and t a quarter. The dependent variable, *Coal mine outcome*, is a dummy variable indicating whether a mine is abandoned (Column 1), the volume of coal produced (Column 2), or the average number of employees (Column 3). *Coal policy exposed* equals one for mines that, between 2014 and 2016, have at least one insurer with a coal underwriting policy, and zero otherwise. *Post* equals one for the first and all subsequent quarters following the earliest quarter in which the insurer of the mine adopted a coal underwriting policy. If a mine is exposed to multiple such adoptions, only the first instance is used to define treatment. The sample includes all mines from Table 6. In Columns 2 and 3, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the mine-stack level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Abandoned	*Production (log)*	*# Employees (log)*
	(1)	(2)	(3)
Coal policy exposed × *Post*	0.036*	-0.078	-0.147**
	(0.018)	(0.082)	(0.069)
Stack × Coal mine FE	Yes	Yes	Yes
Stack × Time FE	Yes	Yes	Yes
Obs.	5,525	932	936
Adj. R^2	0.835	0.912	0.947
# Coal mines	270	57	57

Table 10: Cross-sectional variation in changes in coal mine outcomes

This table presents results from the following OLS regression estimated at the mine-quarter level:

$$\textit{Coal mine outcome}_{s,m,t} = \beta_1 \times \textit{Coal policy exposed}_m \times \textit{Post}_{s,t} + \beta_2 \times \textit{Coal policy exposed}_m \times \textit{Post}_{s,t} \times X_m + \beta_3 \times \textit{Post}_{s,t} \times X_m + \alpha_{s,m} + \alpha_{s,t} + \epsilon_{s,m,t}$$

where s indexes a stack, m a mine, and t a quarter. The dependent variable, *Coal mine outcome* is a dummy variable indicating whether a mine is abandoned. *Coal policy exposed* equals one for mines that, between 2014 and 2016, have at least one insurer with a coal underwriting policy, and zero otherwise. *Post* equals one for the first and all subsequent quarters following the earliest quarter in which the insurer of the mine adopted a coal underwriting policy. If a mine is exposed to multiple such adoptions, only the first instance is used to define treatment. X is a dummy indicating whether a mine has a relationship of eight quarters or more with at least one insurer between 2014 and 2016 (Column 1), a dummy indicating above-median average number of insurers between 2014 and 2016 (Column 2), a dummy indicating above-median average productivity between 2014 and 2016 (Column 3), a dummy indicating above-median total production between 2014 and 2016 (Column 4). The sample includes all mines from Table 6. Standard errors are clustered at the mine-stack level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Abandoned			
	(1)	(2)	(3)	(4)
Coal policy exposed × *Post*	-0.016	0.051***	0.033	0.011
	(0.030)	(0.019)	(0.024)	(0.030)
Coal policy exposed × *Post* × *Relationship insurer*	0.076**			
	(0.032)			
Post × *Relationship insurer*	-0.034*			
	(0.018)			
Coal policy exposed × *Post* × *Many insurers*		-0.057*		
		(0.033)		
Post × *Many insurers*		0.006		
		(0.011)		
Coal policy exposed × *Post* × *Productive mine*			0.001	
			(0.032)	
Post × *Productive mine*			-0.030*	
			(0.016)	
Coal policy exposed × *Post* × *Large mine*				0.036
				(0.030)
Post × *Large mine*				0.007
				(0.011)
Stack × Coal mine FE	Yes	Yes	Yes	Yes
Stack × Time FE	Yes	Yes	Yes	Yes
Obs.	5,525	5,525	4,836	5,525
Adj. R^2	0.836	0.836	0.845	0.836
# Coal mines	425	425	372	425

Table 11: Insurer-level outcomes and coal underwriting policies

This table presents results from the following OLS regression:

$$Y_{i,t} = \beta_1 \times Coal\,policy_{i,t-1} + \alpha_i + \alpha_t + \epsilon_{i,t},$$

where i indexes an insurer and t time. The dependent variable, Y, is gross written premiums (Column 1), return on assets (Column 2), two-day cumulative abnormal returns around the announcement of policy adoptions (Column 3), solvency ratio (Column 4), or the number of RepRisk environmental incidents (Column 5). α_i are insurer fixed effects and α_t are time fixed effects. The sample in Columns 1, 2, 3, and 5 is a firm-year panel based on annual scorecards compiled by Insure Our Future (IOF), while the sample in Column 4 includes all 18 listed insurers that adopt a coal underwriting policy. Standard errors in Columns 1, 2, 4, and 5 are clustered at the insurer level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	GWP (log)	*ROA*	*CAR[0,1]*	*Solvency ratio*	*# RepRisk incidents*
	(1)	(2)	(3)	(4)	(5)
Coal policy	-0.002	-0.471		-0.156	-0.963**
	(0.030)	(0.395)		(0.476)	(0.427)
Constant			-0.526		
			(0.450)		
Time FE	Yes	Yes	No	Yes	Yes
Insurance group FE	Yes	Yes	No	Yes	Yes
Obs.	130	133	18	133	146
Adj. R^2	0.993	0.363	0.000	0.983	0.749
# Insurers in sample	28	29	18	29	29

Internet Appendix

for

Insurers' Carbon Underwriting Policies

Figure IA.1: Prevalence and structure of oil & gas underwriting policies over time

The figure shows the number of insurers whose oil & gas underwriting policies incorporate specific policy features. The sample is based on annual scorecards compiled by Insure Our Future (IOF) and includes up to 22 insurers with oil & gas underwriting policies in place.

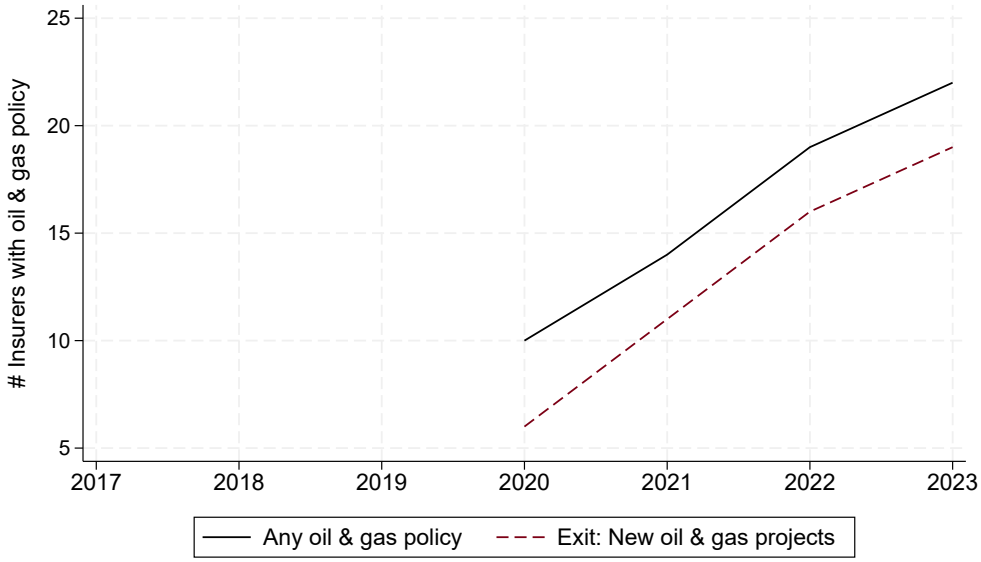


Figure IA.2: Stringency of oil & gas underwriting policies over time

The figure displays scores capturing the stringency of oil & gas underwriting policies over time. Scores range from 0 to 10, with higher values indicating more restrictive policies. Each dot represents an individual insurer in a given year. The solid line connects average scores by year. The two insurers with the highest and lowest overall carbon policy scores in the final sample year (2023) are highlighted with colored dots. The sample is based on annual scorecards compiled by Insure Our Future (IOF) and includes 22 insurers with oil & gas underwriting policies in place.

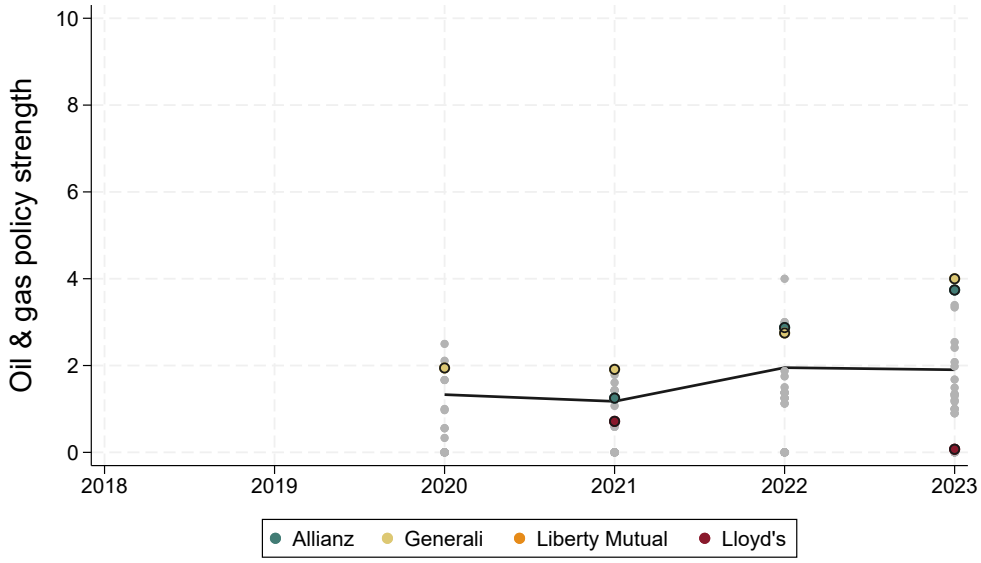
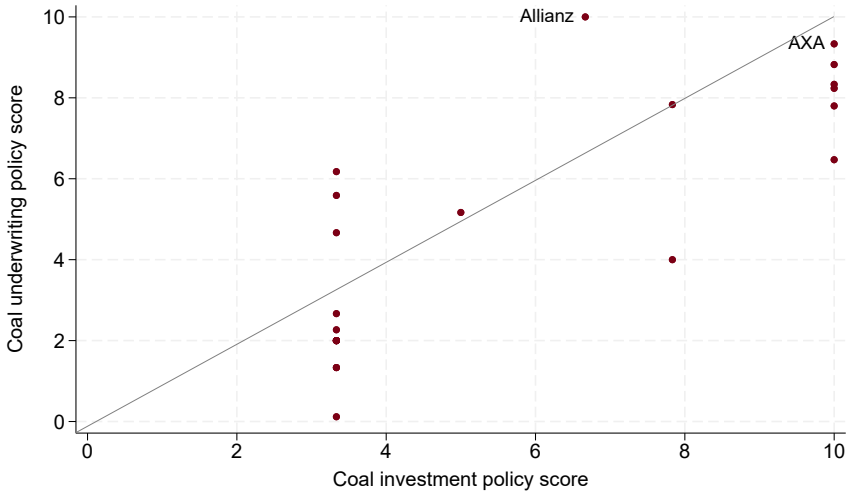


Figure IA.3: Alignment of carbon underwriting and investment policy stringency

The figure shows the relationship between the stringency of carbon underwriting and carbon investment policies for the year sample 2023. Each dot represents the combination of underwriting and investment policies of an insurer. Panel A shows the relationship for coal policies, while Panel B shows the relationship for oil & gas policies. The sample is based on annual scorecards compiled by Insure Our Future (IOF) and comprises 25 insurers with carbon policies in place.

Panel A: Coal underwriting policies



Panel B: Oil & gas underwriting policies

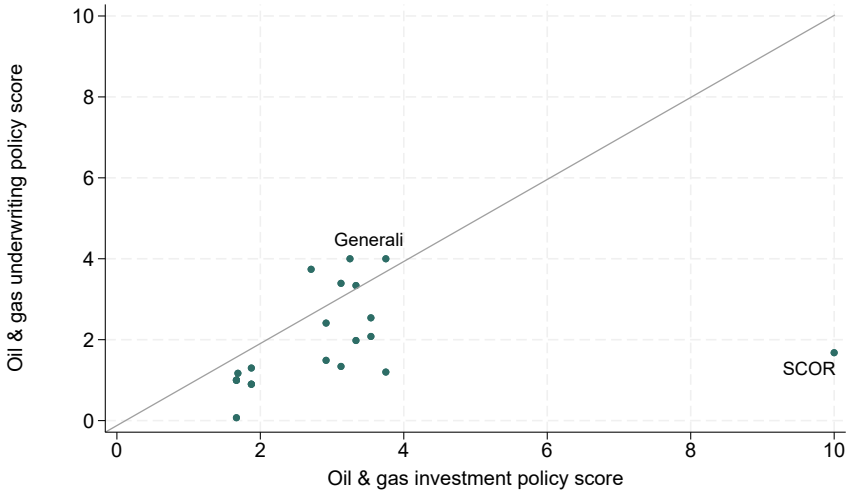
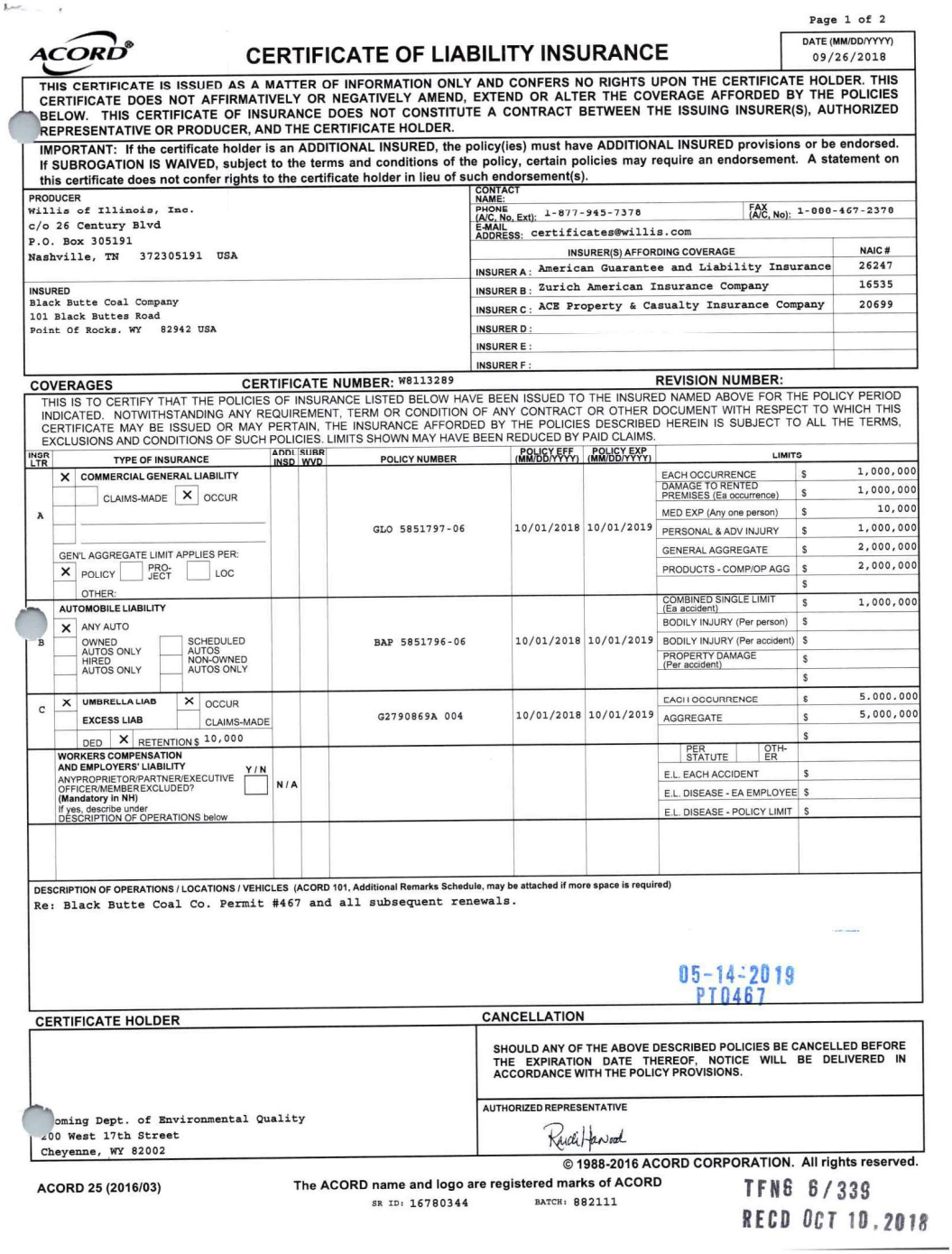


Figure IA.4: Certificate of Liability Insurance of Black Butte Coal Mine

The figure shows the Certificate of Liability Insurance of Black Butte Coal Mine dated September 26, 2018, on a standardized ACORD 25 form filed with the Wyoming Department of Environmental Quality.



Page 1 of 2

ACORD

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 09/26/2018

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Willis of Illinois, Inc.
c/o 26 Century Blvd
P.O. Box 305191
Nashville, TN 372305191 USA

CONTACT NAME:
PHONE (A/C, No, Ext): 1-877-945-7378 FAX (A/C, No): 1-800-467-2378
E-MAIL ADDRESS: certificates@willis.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A: American Guarantee and Liability Insurance	26247
INSURER B: Zurich American Insurance Company	16535
INSURER C: ACE Property & Casualty Insurance Company	20699
INSURER D:	
INSURER E:	
INSURER F:	

INSURED
Black Butte Coal Company
101 Black Buttes Road
Point Of Rocks, WY 82942 USA

COVERAGES **CERTIFICATE NUMBER:** W8113289 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: X POLICY PRO-JECT LOC OTHER:			GLO 5851797-06	10/01/2018	10/01/2019	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ 1,000,000 $ 10,000 $ 1,000,000 $ 2,000,000 $ 2,000,000
B	AUTOMOBILE LIABILITY X ANY AUTO OWNED AUTOS ONLY HIRED AUTOS ONLY SCHEDULED AUTOS NON-OWNED AUTOS ONLY			BAP 5851796-06	10/01/2018	10/01/2019	COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ 1,000,000 $ $ $
C	X UMBRELLA LIAB X OCCUR EXCESS LIAB CLAIMS-MADE DED X RETENTION $ 10,000			G2790869A 004	10/01/2018	10/01/2019	EACH OCCURRENCE AGGREGATE	$ 5,000,000 $ 5,000,000 $
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N If yes, describe under DESCRIPTION OF OPERATIONS below		N/A				PER STATUTE OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	$ $ $

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)
Re: Black Butte Coal Co. Permit #467 and all subsequent renewals.

05-14-2019
PT0467

CERTIFICATE HOLDER

oming Dept. of Environmental Quality
200 West 17th Street
Cheyenne, WY 82002

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE
Randi Harwood

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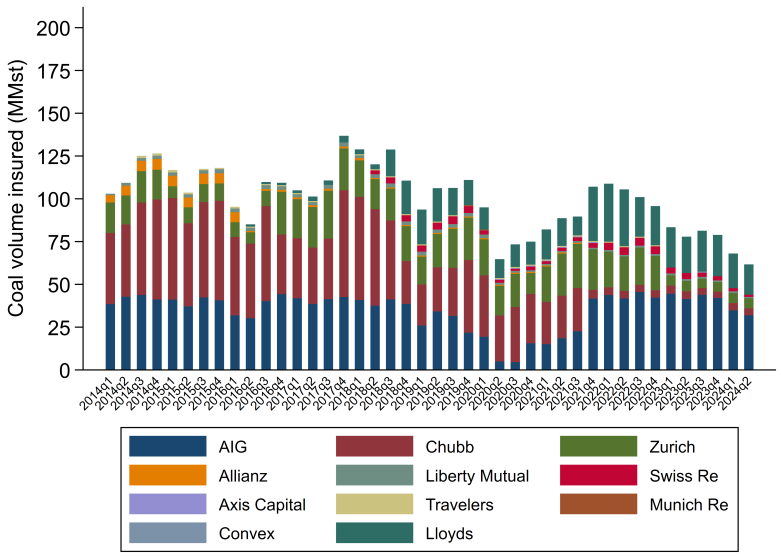
SR ID: 16780344 BATCH: 882111

TFNG 6/339
RECD OCT 10, 2018

Figure IA.5: Volume of coal insured by insurers

The figure displays the volume of coal insured by insurance group. For each quarter, we aggregate the volume of coal produced by the mines that are insured by each insurer. Panel A presents insurers that adopted a coal underwriting policy at any point during the sample period, while Panel B presents those that never did. The sample includes all coal mines listed in MSHA's Mine Data Retrieval System between the first quarter of 2014 and the second quarter of 2024, provided they reported at least one quarter of non-zero coal production, and for which we successfully obtained ACORD 25 certificates of liability insurance from state-level agencies.

Panel A: Insurer with a coal policy



Panel B: Insurers without a coal policy

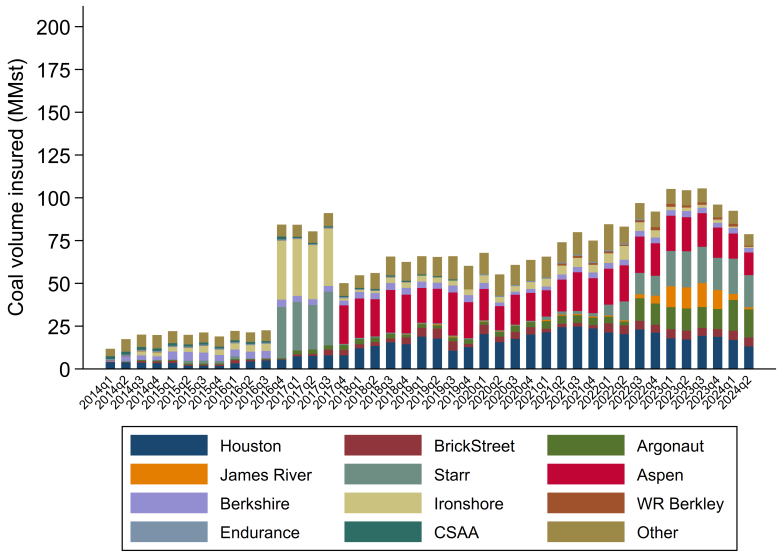


Figure IA.6: Coal mines' insurance status and underwriting policies by policy type

This figure displays 90% confidence intervals and coefficient estimates from the following OLS regression:

$$Inactive\ insurance_{s,m,p,i,t} = \sum_{t=-6}^{t=6} \beta_t \times Coal\ policy_i \times Event\ quarter_{s,t} + \alpha_{s,m,p,i} + \alpha_{s,m,t} + \epsilon_{s,m,p,i,t},$$

where s indexes a stack, m a mine, p a policy type, i an insurer, and t a quarter. The dependent variable, *Inactive insurance*, equals one if an insurer does not insure a mine in a given quarter, and zero if it does. *Coal policy* equals one for mines insured by an insurer adopting a coal underwriting policy, and zero otherwise. $\alpha_{s,m,p,i}$ are stack-mine-policy type-insurer fixed effects, while $\alpha_{s,m,t}$ are stack-mine-time fixed effects. The initial sample of mines includes all coal mines listed in MSHA's Mine Data Retrieval System between 2014Q1 and 2024Q2, provided they report at least one quarter of non-zero coal production, and for which we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies. For each insurer that adopts a coal underwriting policy, we identify all mines it insures and construct a balanced sample of 13 quarterly observations per mine-policy type-insurance triplet, six quarters before and six quarters after the policy adoption quarter, whenever information on the liability insurance certificates of a given mine is available. These mine-policy type-insurance triplets form the treated observations in the stack. As control observations, we include all other mine-policy type-insurance triplets that include the same mines but insurers that never adopt a coal underwriting policy. Standard errors are clustered at the insurance group-policy type-stack level. Table A.1 provides descriptions of all variables.

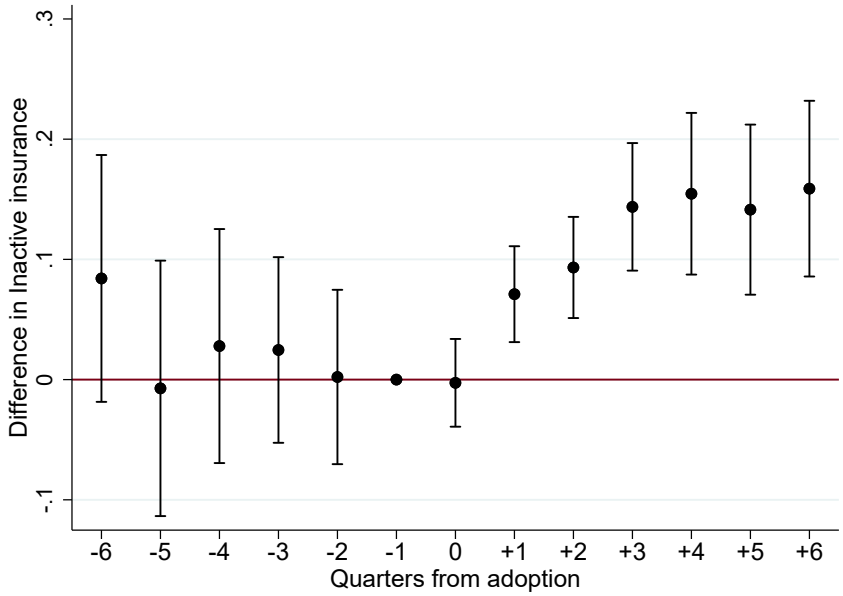
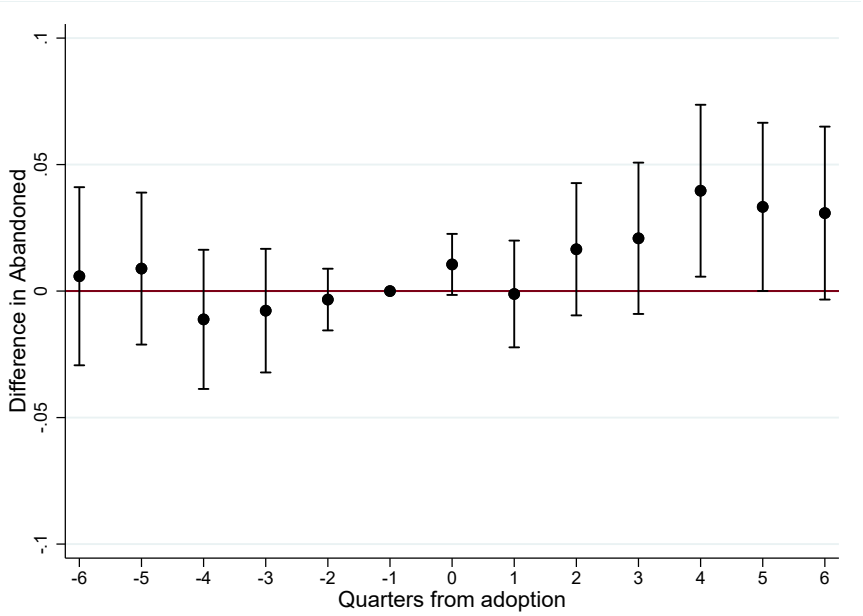


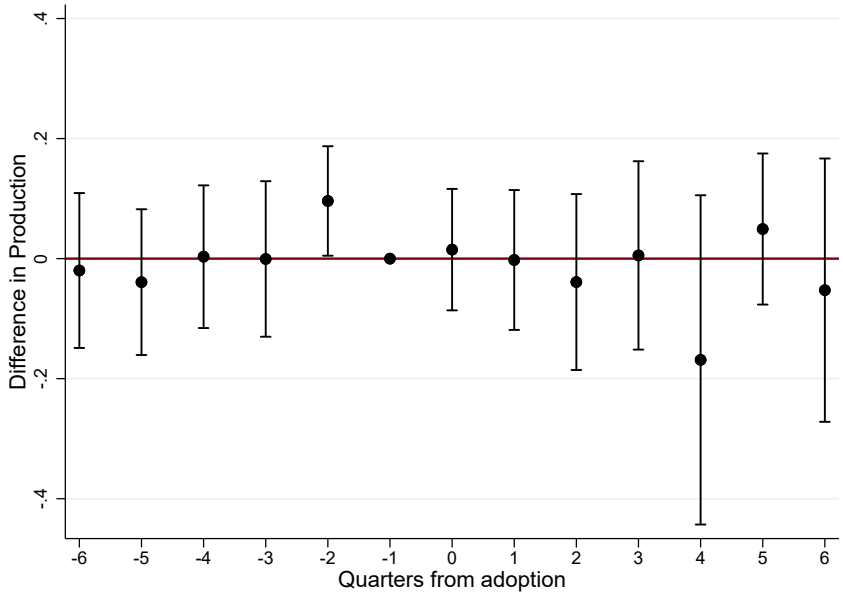
Figure IA.7: Coal mine outcomes and underwriting policies

This figure reports dynamic treatment effect estimates with 90% confidence intervals computed using the cohort-aggregated event-study estimator of de Chaisemartin and D'Haultfœuille (2025), implemented via `did_multiplegt_dyn` as described in de Chaisemartin et al. (2025). We apply the estimator without modification. Event time is measured in quarters relative to the insurer's coal-policy adoption ($t = 0$); if a mine is exposed to multiple adoptions, the first defines treatment. A mine is *coal-policy exposed* if, between 2014 and 2016, it maintained an insurance relationship lasting at least eight quarters with an insurer that subsequently adopted a coal underwriting policy. The dependent variable is a dummy for mine abandonment (Panel A), the volume of coal produced (Panel B), or the average number of employees (Panel C). The sample comprises all mines listed in Table 6 for which ACORD 25 Certificates of Liability Insurance were obtained from state agencies during 2014–2016; Panels B and C further restrict to mines active throughout the full period. Standard errors are clustered at the mine–stack level. See Table A.1 for variable definitions.

Panel A: Abandoned



Panel B: Production



Panel C: # Employees

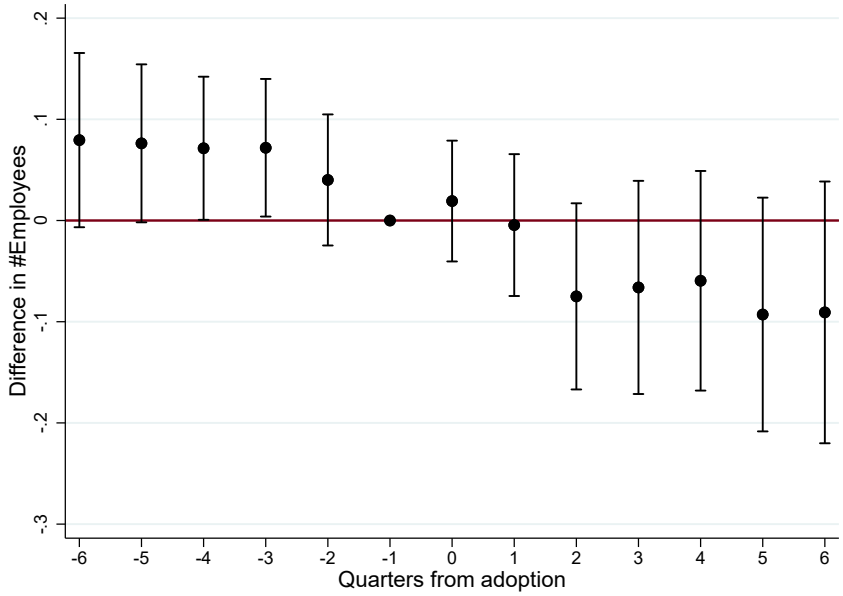


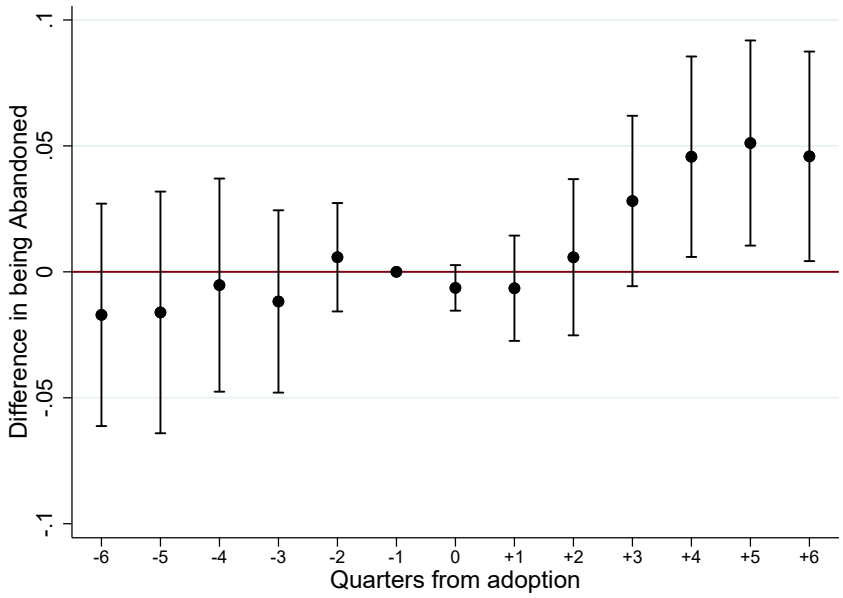
Figure IA.8: Coal mine outcomes and underwriting policies

This figure displays coefficient estimates and 90% confidence intervals from the following OLS regression:

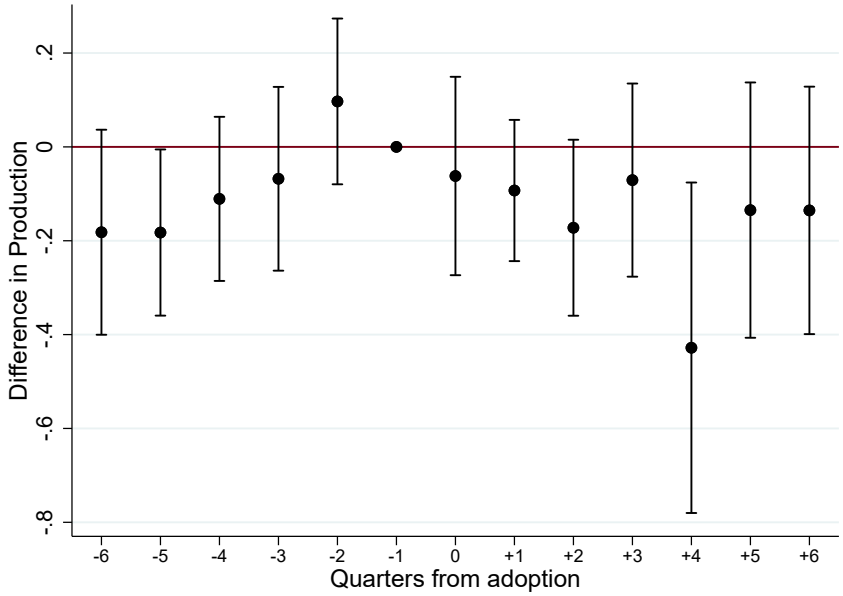
$$Coal\ mine\ outcome_{s,m,t} = \sum_{t=-6}^{t=6} \beta_t \times Coal\ policy\ exposed_{s,m} \times Event\ quarter_{s,t} + \alpha_{s,m} + \alpha_{s,t} + \epsilon_{s,m,t},$$

where s indexes a stack, m a mine, and t a quarter. The dependent variable, *Coal mine outcome*, is a dummy variable indicating whether a mine is abandoned (Panel A), the volume of coal produced (Panel B), or the average number of employees (Panel C). *Coal policy exposed* equals one for mines that, between 2014 and 2016, have a relationship lasting at least eight quarters with at least one insurer with a coal underwriting policy. *Event quarter* are dummy variables indicating quarters relative to policy adoption. If a mine is exposed to multiple such adoptions, only the first instance is used to define treatment. The sample includes all mines from Table 6, provided that we successfully obtained Certificates of Liability Insurance on ACORD 25 forms from state-level agencies between 2014 and 2016. In Panels B and C, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the mine-stack level. Table A.1 provides descriptions of all variables.

Panel A: Abandoned



Panel B: Production



Panel C: # Employees

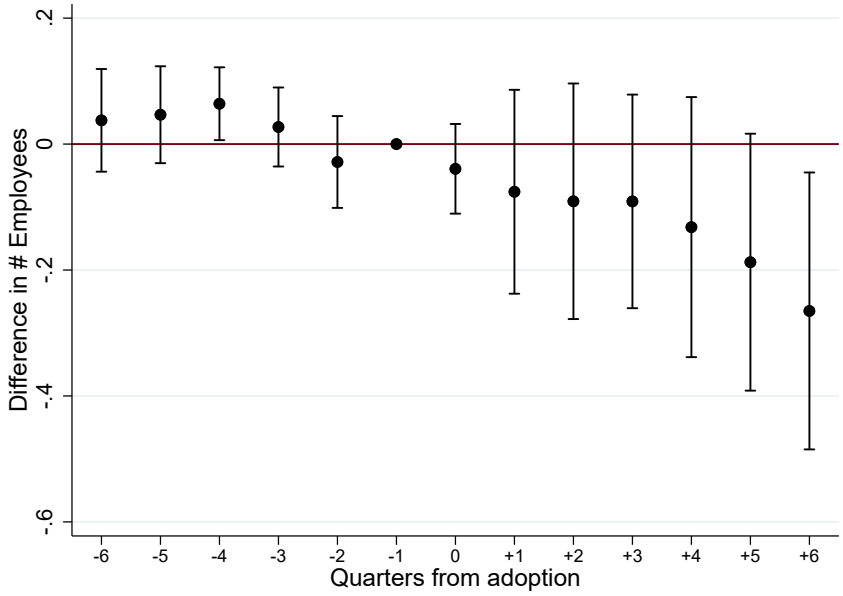


Table IA.1: Assessment of carbon underwriting policies

This table reports the five dimensions over which carbon underwriting policies are assessed by IOF and the respective description.

IOF scoring dimension	Description
Scope	Whether policies rule out insurance for (i) all types of new coal infrastructure (including mines and power plants as well as transport facilities); (ii) extreme fossil fuels such as tar sands, associated pipelines, Arctic and ultra-deepwater drilling; and (iii) any oil and gas expansion projects that drive increased production.
Types of cover	Whether policies apply to all lines of business for new and existing projects and companies, except cover for protecting workers, ringfenced renewable energy projects, and existing mine reclamation surety bonds. Reinsurers' policies should apply to treaty as well as facultative reinsurance.
Fossil fuel companies	Whether policies apply comprehensive criteria to define companies operating in coal, oil and gas, and tighten cover over time in line with the need to phase out these fossil fuels completely. Whether policies immediately exclude new customers from the fossil fuel sector not aligned with a 1.5°C pathway and phase out all insurance services within two years for existing fossil fuel company customers not aligned with such a pathway.
Emissions reduction targets	Whether insurers set emissions reduction targets for new projects as well as ongoing operations which they insure, and define short- and medium-term targets across their entire commercial property & casualty portfolio. The targets must cover the Scope 3 emissions of all carbon-intensive sectors, including energy and power, and aim for a reduction of insured emissions of at least 43% by 2030, in line with IPCC findings.
Human rights	Whether policies include robust due diligence to ensure that clients fully respect all human rights, including a requirement that they obtain and document the Free, Prior, and Informed Consent of impacted Indigenous Peoples.

Table IA.2: Insurer characteristics

This table reports insurance characteristics for all insurers in IOF's scorecard. *Unlisted insurer* and *Specialty insurer* are header variables. *NZIA* is time-varying and we report the maximum value per insurer.

Name	Adoption date	Region (Country)	Unlisted insurer	Specialty insurer	NZIA
AIG	01-03-2022	U.S. (United States)	0	0	0
AXA	12-12-2017	Europe (France)	0	0	1
Allianz	04-05-2018	Europe (Germany)	0	0	1
Aviva	n/a (unknown)	Europe (United Kingdom)	0	0	1
Axis Capital	16-10-2019	RoW (Bermuda)	0	1	0
Berkshire Hathaway		U.S. (United States)	0	0	0
Chubb	01-07-2019	U.S. (United States)	0	0	0
Convex	01-02-2022	RoW (Bermuda)	1	1	0
Everest Re		RoW (Bermuda)	0	1	0
FM Global		U.S. (United States)	1	1	0
Generali	21-02-2018	Europe (Italy)	0	0	1
HDI	18-04-2019	Europe (Germany)	1	0	0
Hannover Re	18-04-2019	Europe (Germany)	0	1	1
Legal and General		Europe (United Kingdom)	0	0	0
Liberty Mutual	13-12-2019	U.S. (United States)	1	0	0
Lloyd's	16-12-2020	Europe (United Kingdom)	1	1	1
MS&AD	30-09-2020	Asia (Japan)	0	0	0
Mapfre	11-03-2019	Europe (Spain)	0	0	1
MetLife		US (United States)	0	0	0
Munich Re	06-08-2018	Europe (Germany)	0	0	1
PICC		Asia (China)	0	0	0
Ping An	n/a (unknown)	Asia (China)	0	0	0
Prudential		U.S. (United States)	0	0	0
QBE	01-04-2019	RoW (Australia)	0	0	1
SCOR	06-09-2017	Europe (France)	0	1	1
Samsung FM	12-11-2020	Asia (Korea, Rep.)	0	0	0
Sinosure		Asia (China)	1	0	0
Sompo	23-09-2020	Asia (Japan)	0	0	1
Starr		U.S. (United States)	1	1	0
Swiss Re	02-07-2018	Europe (Switzerland)	0	0	1
TIAA		U.S. (United States)	1	0	0
The Hartford	20-12-2019	U.S. (United States)	0	0	0
Tokio Marine	28-09-2020	Asia (Japan)	0	0	1
Travelers	07-02-2022	U.S. (United States)	0	0	0
WR Berkley		U.S. (United States)	0	1	0
XL Catlin		Europe (Ireland)	0	1	0
Zurich	13-11-2017	Europe (Switzerland)	0	0	1

Table IA.3: Prevalence of oil & gas underwriting policies by insurer

This table lists oil & gas underwriting policies over time for the insurers in the sample. A value of one indicates that an insurer has an oil & gas underwriting policy in place in a year, and a value of zero indicates that an insurer has no underwriting policy. Missing values reflect that an insurer was not included in the IOF scorecards or that its policies were not assessed by IOF in a year. The sample is based on annual scorecards compiled by Insure Our Future (IOF).

Name	2017	2018	2019	2020	2021	2022	2023	% Years w/ policy
AIG				0	0	1	1	50
AXA				1	1	1	1	100
Allianz				0	1	1	1	75
Aviva				1	0	1	1	75
Axis Capital				1	1	1	1	100
Berkshire Hathaway				0	0	0	0	0
Chubb				0	0	0	1	25
Convex					0	0		0
Everest Re					0	0	0	0
FM Global								
Generali				1	1	1	1	100
HDI				1	1	1	1	100
Hannover Re				1	1	1	1	100
Legal & General								
Liberty Mutual				0	0	0	0	0
Lloyd's				0	1	1	1	75
MS&AD				0	0	0	1	25
Mapfre				0	1	1	1	75
MetLife								
Munich Re				1	1	1	1	100
PICC					0	0	0	0
Ping An				0	0	0	0	0
Prudential								
QBE				0	1	1	1	75
SCOR				0	0	1	1	50
Samsung FM				0	0	0	1	25
Sinosure				0	0	0	0	0
Sompo				0	0	1	1	50
Starr						0	0	0
Swiss Re				1	1	1	1	100
TIAA								
The Hartford				1	1	1	1	100
Tokio Marine				0	0	1	1	50
Travelers				0	0	1	1	50
WR Berkley				0	0		0	0
XL Catlin								
Zurich				1	1	1	1	100
% Insurance groups w/ policy				37	43	60	73	
# Insurance groups	25	24	30	30	30	30	30	

Table IA.4: Stringency of oil & gas underwriting policies by insurer

This table reports scores reflecting the stringency of oil & gas underwriting policies over time of the insurers in the sample. The scores range from 0 to 10, with higher values reflecting stricter policies. We rank insurers in all panels based on the 2023 score values (from high to low). The sample period starts in 2020 because policy strength was not assessed before. The sample is based on annual scorecards compiled by Insure Our Future (IOF).

Name	2017	2018	2019	2020	2021	2022	2023	Average score
Generali				1.94	1.91	2.75	4.00	2.65
Aviva				0.56	0.00	4.00	4.00	2.14
Allianz				0.00	1.25	2.88	3.74	1.97
Hannover Re				1.00	1.43	3.00	3.39	2.21
Swiss Re				0.33	1.61	2.88	3.34	2.04
HDI				0.97	0.74	1.75	2.54	1.50
Munich Re				2.50	1.43	3.00	2.41	2.33
Mapfre				0.00	1.43	1.50	2.08	1.25
AXA				1.67	1.79	1.88	1.98	1.83
SCOR				0.00	0.00	1.25	1.68	0.73
Zurich				1.67	0.59	1.38	1.49	1.28
Chubb				0.00	0.00	0.00	1.34	0.34
Axis Capital				2.11	1.07	1.38	1.34	1.47
AIG				0.00	0.00	1.25	1.30	0.64
QBE				0.00	0.74	1.38	1.20	0.83
Sompo				0.00	0.00	1.38	1.17	0.64
Tokio Marine				0.00	0.00	1.25	1.00	0.56
Samsung FM				0.00	0.00	0.00	1.00	0.25
MS&AD				0.00	0.00	0.00	1.00	0.25
The Hartford				0.56	0.59	1.12	0.90	0.79
Travelers				0.00	0.00	1.12	0.90	0.51
Lloyd's				0.00	0.71	0.00	0.07	0.20
Everest Re					0.00	0.00	0.00	0.00
WR Berkley				0.00	0.00		0.00	0.00
Sinosure				0.00	0.00	0.00	0.00	0.00
Liberty Mutual				0.00	0.00	0.00	0.00	0.00
Ping An				0.00	0.00	0.00	0.00	0.00
Berkshire Hathaway				0.00	0.00	0.00	0.00	0.00
PICC					0.00	0.00	0.00	0.00
Starr						0.00	0.00	0.00
MetLife								
Legal & General								
Prudential								
FM Global								
XL Catlin								
Convex						0.00	0.00	0.00
TIAA								
Average score				0.49	0.51	1.17	1.40	
# Insurance groups	25	24	30	30	30	30	30	
# Missing scores	25	24	30	3	0	0	0	

Table IA.5: Correlations between carbon underwriting and investment policies

This table reports correlations between carbon underwriting and investment policies. In Panel A, the table reports the correlations between carbon underwriting policies and carbon investment policies. The sample comprises 32 insurers and spans the period from 2017 to 2023. In Panel B, the table reports the correlations between the scores assigned to carbon underwriting policies and carbon investment policies of insurers. The sample comprises 25 insurers with carbon policies in place and spans the period from 2018 to 2023.

Panel A: Prevalence of policies				
	Coal policy	*Oil & gas policy*	*Coal inv. policy*	*Oil & gas inv. policy*
Coal policy	1.00			
Oil & gas policy	0.62	1.00		
Coal investment policy	0.79	0.65	1.00	
Oil & gas investment policy	0.59	0.87	0.62	1.00
Panel B: Stringency of policies				
	Coal score	*Oil & gas score*	*Coal inv. score*	*Oil & gas inv. score*
Coal score	1.00			
Oil & gas score	0.55	1.00		
Coal investment score	0.81	0.34	1.00	
Oil & gas investment score	0.36	0.33	0.55	1.00

Table IA.6: Descriptive statistics on carbon underwriting policies

This table presents descriptive statistics on carbon underwriting policies. The sample is based on annual scorecards compiled by Insure Our Future (IOF). Table A.1 provides descriptions of all variables.

	Obs.	Mean	Std.	25th	Median	75th
Panel A: Insurer-year sample						
Coal policy	181	0.66				
Coal policy score	162	2.44	2.59	0.00	1.85	3.60
Oil & gas policy	117	0.55				
Oil & gas policy score	117	0.90	1.09	0.00	0.59	1.43
Europe	181	0.44				
US	181	0.25				
Asia	181	0.20				
RoW	181	0.10				
Unlisted insurer	181	0.15				
Reinsurer	181	0.29				
Specialty insurer	181	0.23				
NZIA	181	0.13				
Total assets (billion $)	180	299.98	350.52	61.31	148.14	437.56
ROA (%)	180	1.51	1.83	0.70	1.27	2.23
GWP (billion $)	130	44.98	32.17	20.00	37.48	63.68
Solvency ratio (%)	130	17.04	10.75	8.71	14.48	22.01
# RepRisk incidents	146	2.53	3.31	0.00	1.00	4.00
Panel B: Listed insurer sample						
CAR[0,1]	18	-0.53	1.91	-1.40	-0.42	-0.14

Table IA.7: Determinants of oil & gas underwriting policies

This table presents results from the following OLS regression:

$$Y_{i,t} = \beta \times X_{i,t-1} + \epsilon_{i,t},$$

where i indexes an insurer and t a year. In Columns 1–3, Y is *Oil & gas policy*, which equals one if the insurer has an oil & gas underwriting policy, and zero otherwise. In Columns 4–6, Y is *Oil & gas policy score*, which is a score ranging from 0 to 10, with higher scores indicating stricter oil & gas underwriting policies. X is a vector of insurer-level characteristics. The sample is based on annual scorecards compiled by Insure Our Future (IOF). Standard errors are clustered at the insurer level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Oil & gas policy			*Oil & gas policy score*		
	(1)	(2)	(3)	(4)	(5)	(6)
2021	0.063	0.076	0.073	-0.156	-0.149	-0.161
	(0.083)	(0.081)	(0.079)	(0.243)	(0.262)	(0.311)
2022	0.263**	0.276***	0.308***	0.518	0.710*	0.735*
	(0.101)	(0.095)	(0.097)	(0.345)	(0.398)	(0.398)
2023	0.363***	0.384***	0.390***	0.573	0.873*	0.814*
	(0.106)	(0.100)	(0.122)	(0.366)	(0.428)	(0.435)
US		-0.572***	-0.566***		-1.098***	-1.100***
		(0.140)	(0.132)		(0.253)	(0.388)
Asia		-0.660***	-0.750***		-1.186***	-1.368***
		(0.097)	(0.110)		(0.317)	(0.322)
RoW		-0.349	-0.390		-0.594**	-0.759
		(0.239)	(0.239)		(0.280)	(0.609)
NZIA			-0.002			0.130
			(0.109)			(0.300)
Specialty insurer			-0.275*			-0.333
			(0.154)			(0.399)
Unlisted insurer			-0.324**			-1.149*
			(0.152)			(0.564)
Total assets (log)			-0.069			-0.055
			(0.053)			(0.148)
ROA			-0.021			-0.103
			(0.017)			(0.131)
Obs.	117	117	117	64	64	64
Adj. R^2	0.062	0.395	0.451	0.061	0.275	0.395
# Insurance groups	31	31	31	22	22	22

Table IA.8: Coal mine outcomes and share of underwriters with policies

This table presents results from the following OLS regression estimated at the mine-quarter level:

$$Coal\ mine\ outcome_{m,t} = \beta \times Share\ coal\ policy\ exposed_{m,t} + \alpha_m + \alpha_t + \epsilon_{m,t}$$

where m indexes a mine and t a quarter. The dependent variable, *Coal mine outcome*, is a dummy variable indicating whether a mine is abandoned (Column 1), the volume of coal produced (Column 2), or the average number of employees (Column 3). *Share coal policy exposed* is defined as $\sum_i w_{m,i} Post\ coal\ policy_{i,t}$ where i indexes an insurer, w are equal weights allocated to each insurer with at least eight quarters of active insurance relationship with a given mine between 2014 and 2016, and *Post coal policy* equals one for insurer-quarters after a coal underwriting policy is introduced, and zero otherwise. The sample includes all mines from Table 6, excluding those that do not have an active insurance relationship with the same insurer for at least eight quarters between 2014 and 2016. In Columns 2 and 3, the sample includes only mines that are active throughout the entire sample period. Standard errors are clustered at the mine level and reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. Table A.1 provides descriptions of all variables.

	Abandoned	*Production (log)*	*# Employees (log)*
	(1)	(2)	(3)
Share coal policy exposed	0.047	-0.220**	-0.207**
	(0.037)	(0.094)	(0.100)
Coal mine FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Obs.	7,342	1,559	1,595
Adj. R^2	0.577	0.896	0.894
# Coal mines	175	38	38