

Anticipatory skill and structural biases of a major global risk assessment

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Abstract (232 words)

Calls to navigate the global polycrisis have multiplied, yet one of the most visible systemic risk assessments—the World Economic Forum’s Global Risks Reports (GRRs)—has not been comprehensively evaluated. We analyse all GRRs from 2006–2024 by reconstructing and comparing survey-based risk likelihoods with a multi-decadal database of national shocks, and by tracing how surveys are translated into the reports’ narratives. Despite increasing concerns for environmental risks, we find that GRRs show limited and uneven prospective alignment with observed shock frequency across categories, and that only geopolitical conflicts demonstrate clear anticipatory skill. Alignment is also consistently stronger for high-income than for lower-income regions, suggesting a potential regional bias. In parallel, we document a transcription bias, as the reports selectively and significantly downplay themes linked to poverty, inequality, biodiversity, and conflict, while foregrounding economic growth, simplification, and weaker understandings of sustainability relative to the surveys they rest on. We also note a framing bias in the way GRRs increasingly portray risks as negative, complex and regulatory challenges, hinting at a shift in the target audience over the years towards a technical policy and business one. Our findings suggest that GRRs are informative as a barometer of elite concerns, but cast doubt on their use as early-warning tools. We conclude by proposing that global risk governance uses assessments that are system-based, grounded in empirical data, transparent regarding uncertainties, and developed through pluralistic and accountable processes.

Significance (109 words)

The World Economic Forum’s Global Risks Reports are widely used by governments, businesses, and media as a map of global threats, but their empirical reliability and representativeness are rarely evaluated. We show that, over nearly two decades, the reports show limited prospective alignment with observed shocks, with clear anticipatory skill only for conflict-related risks, and stronger alignment for shocks recorded in high-income countries than elsewhere. We also find that the reports significantly skew attention toward economic risks while downplaying social and environmental concerns. We outline how global risk assessments could be redesigned in times of multiple and compounding crises, and call for establishing an independent systemic risks assessment process.

Keywords

Global risks; World Economic Forum; polycrisis; time series analysis; thematic analysis; linguistic analysis.

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Introduction

Global crises are colliding. Climate extremes, disease outbreaks, geopolitical tensions, and economic turmoils, among other disruptions, interact with one another, heightening impacts and governance challenges in what has been termed a global ‘polycrisis’ (Søgaard Jørgensen et al., 2023; Lawrence et al., 2024; Delannoy et al., 2025a, 2025b; Liu & Renn, 2025; Mark et al., 2025; Rakowski et al., 2025). In such a context, decision makers in politics, business, and civil society alike seek information on global systemic risks, to anticipate where the next destabilising turn might emerge, and prepare for it.

The World Economic Forum’s Global Risks Reports (GRRs) have become one of the most prominent accounts on global systemic risks. Since 2006, the GRRs have been built around the Global Risks Perception Survey (GRPS), an annual survey with now over 1,300 respondents from academia, business, and government, who rate the likelihood, impact, and interconnection of an evolving list of global risks over short-, medium-, and long-term horizons (Aven, 2025; WEF, 2025; 2026). Surveys are refined through stakeholder consultations, and analyzed with risk matrices (plotting risks by likelihood and severity) and interconnection maps (linking risks according to respondents’ perceived connections). The GRRs exert considerable influence over how global risks are framed in public debate and practice, being cited in government white papers, used by risk professionals, and featured in thousands of news articles (Fig. S1). They also inform parallel initiatives, including the AXA Future Risks Report (AXA, 2025), the Protiviti/NC State survey (Beasley et al., 2023) or the UN Global Risk Report (United Nations, 2025), and inspire regional risk assessments (Asgary & Ozdemir, 2019; Asgary et al., 2020; AURG, 2025; Calixte et al., 2026).

GRRs have come under scrutiny on three main grounds, related to *how* risks are conceptualized, *who* is asked to evaluate them, and *which* vision of risk is foregrounded in the reports. First, the GRRs have been criticised for vague or missing definitions of likelihood, severity, interconnection, or the risks themselves; the way risks are classified; limited attention to feedback dynamics; weak handling of uncertainty or knowledge confidence; and low consideration to the drivers of risks (Cutter et al., 2015; Erisman et al., 2015; Aven & Cox, 2016; Aven, 2017a; 2017b; Evans et al., 2017; Yanitsky, 2018; Aven, 2020; 2025). Second, the surveys on which the GRRs rest rely disproportionately on 40–60 years old males from the private sector and from Europe and North America (Aven, 2025). This sample composition is problematic as it may give undue weight to a particular worldview and thus narrow the scope of the analysis. For example, surveying sustainability scholars instead led to several environmental and societal risks being rated significantly higher in terms of likelihood and severity (Garschagen et al., 2020; Wynes et al., 2022). Third, the GRRs are said to adopt a business-centred view of the world, primarily framing risks as threats to growth or investment, with corporations positioned as key problem-solvers and public policy steered toward protecting markets (Sharma & Soederberg, 2020; Taylor, 2021; Pasula, 2024). Migration is, for example, recast as a global risk to be monitored and managed, while migrants are simultaneously portrayed as a flexible resource for competitiveness (Domingo, 2015).

Despite the above critiques, comparative empirical evaluation of the GRRs remains absent. Several studies mined GRRs data to explore patterns of risk interdependence (Szymanski et al., 2015; Lin et al., 2017; Zuo & Wei, 2017; Niu et al., 2018; 2019; Brende, 2019; Brissette et al., 2021; Costola et al., 2022; Kryvovyazyuk et al., 2025; Qazi, 2025; Yazo-Cabuya et al., 2025), assessed specific thematic framings (Domingo, 2015; Pasula, 2024; Gössling & Scott, 2024), or examined individual GRRs in detail, for the 2014, 2017, 2019, 2021, 2024, and 2026 editions (Evans et al., 2017; Silva de Amorim et al., 2018; Taylor, 2021; Qazi & Al-Mhdawi, 2022; Aven, 2025; Ganson, 2026). However, there is no systematic investigation of how the GRRs align with historical events across years and regions, or how surveys are prioritized in the report narratives.

In this paper we aim to fill the gap in comparative empirical evaluation of the GRRs by performing three analyses across all reports from 2006–2024 (see *Materials and Methods*). First, we extract short-term risk likelihoods from GRRs and compare them with a multi-decadal database of national shocks in eight categories (geophysical, climate, disease outbreaks, food, economic, conflict, terrorism, and technology) to quantify how well the reports track past events and anticipate future

ones. Second, we compare the GRRs and the GRPS across social, environmental, and economic dimensions, to detect potential differences in how risks are (de-)emphasised as they move from survey to report narrative. Third, we analyse the language of the GRRs and benchmark it against reports from other major international organisations, in order to characterise how risks are framed and for whom GRRs appear to be written. Our overarching question is to what extent do the GRRs provide a reliable, representative, and anticipatory picture of global systemic risks.

Results

Predictive analysis

We compare the 2006–2021 short-term annual risk likelihoods from the GRRs with the frequency of global shocks from the Delannoy et al. (2025b) database, using backward-looking and forward-looking windows of up to five years. For eight categories of shocks, we estimate ordinary least squares regressions linking the risk score in year y to the average shock occurrences in years $y-\ell$ or $y+\ell$ ($1 \leq |\ell| \leq 5$), and contrast the resulting coefficients with those obtained from 1500 Monte Carlo–randomised shock simulations.

We find that regression coefficients between risk likelihood and shock frequency vary considerably across categories (Fig. 1). Diseases, conflicts, and terrorism show clear positive associations with future shock windows, whereas geophysical, climate, food, economic, and technological categories show negative, weak, or near-zero future coefficients. In seven of eight categories, the strongest association is with past rather than future shocks. Conflicts are the only category for which at least one forward-looking coefficient exceeds all coefficients in the preceding five-year windows. Disease risks, and to a lesser extent economic risks, show the clearest pattern of adjustment to recent events, as illustrated by the low likelihood assigned to infectious diseases in the 2019 and 2020 GRRs before the risk was reassessed upward after the COVID-19 pandemic (Fig S2).

To assess forward-looking performance relative to retrospective association, we define predictive capacity as the maximum regression coefficient across positive horizons (+1 to +5 years). We define anticipatory skill as this predictive capacity minus the coefficient from the corresponding retrospective horizon (Fig. 2, bottom). Globally, predictive capacity is highest for conflicts (0.98), terrorism (0.90), and diseases (0.78), with all other categories showing near-zero or negative capacities. Once compared with the equivalent retrospective association, however, conflicts are the only category with clearly positive global anticipatory skill (1.25; Fig. 2, top left). Other categories show lower or more ambiguous skill: food (0.41) and climate (0.31) are positive despite weak or negative predictive capacity, diseases have positive predictive capacity but modest skill, terrorism has high predictive capacity but near-zero skill, and economic shocks show negative skill (−0.36). Thus, GRR risk scores often align as much with recent events as with subsequent shocks.

Individual GRR editions contribute unevenly to aggregate alignment, with large positive and negative annual components across categories (Fig. S7). This temporal heterogeneity is also reflected in the uncertainty analyses: coefficient-draw and Monte Carlo intervals indicate that predictive capacity is generally more stable than anticipatory skill, which is more sensitive to the corresponding retrospective association (Figs. S10 and S11). Global predictive capacity rises after 2011, peaks in 2015, and remains positive through the late 2010s and early 2020s, whereas anticipatory skill shows no comparable sustained improvement and reaches its highest value in the first edition (Fig. S9). Improvements are concentrated in specific categories, most clearly climate shocks (Fig. S8). Food shocks show strong but coverage-limited positive alignment before the shock series ends, while economic and technological shocks show late increases in predictive capacity without comparable anticipatory skill. Later GRRs therefore do not perform uniformly better.

Among the four shock categories with positive global predictive capacity—climate, disease outbreaks, geopolitical conflicts, and terrorism—high-income countries (HICs) rank highest in both predictive capacity and anticipatory skill (Fig. S12). Income-group differences are significant for both metrics when shock category is treated as the paired block, with predictive capacity differing across HICs, UMCs, LMCs, and LICs (Friedman $\chi^2 = 8.4$, $df = 3$, $P = 0.038$) and anticipatory skill showing the

same pattern ($\chi^2 = 8.1$, $df = 3$, $P = 0.044$; Fig. S13). Food shocks remain the main exception, with the highest anticipatory skill in LICs, but lack positive global predictive capacity (Fig. 2, top left).

The time horizons at which anticipatory skill peaks also cluster more strongly by shock category than by region. Disease outbreaks are most strongly aligned with shocks five years ahead across income groups, conflicts at four years, and climate shocks at two years. By contrast, the few positive anticipatory-skill estimates for other categories are scattered across horizons: 1–2 years for terrorism, 1–3 years for geophysical shocks, 1–4 years for technological shocks, and 1–5 years for food and economic shocks.

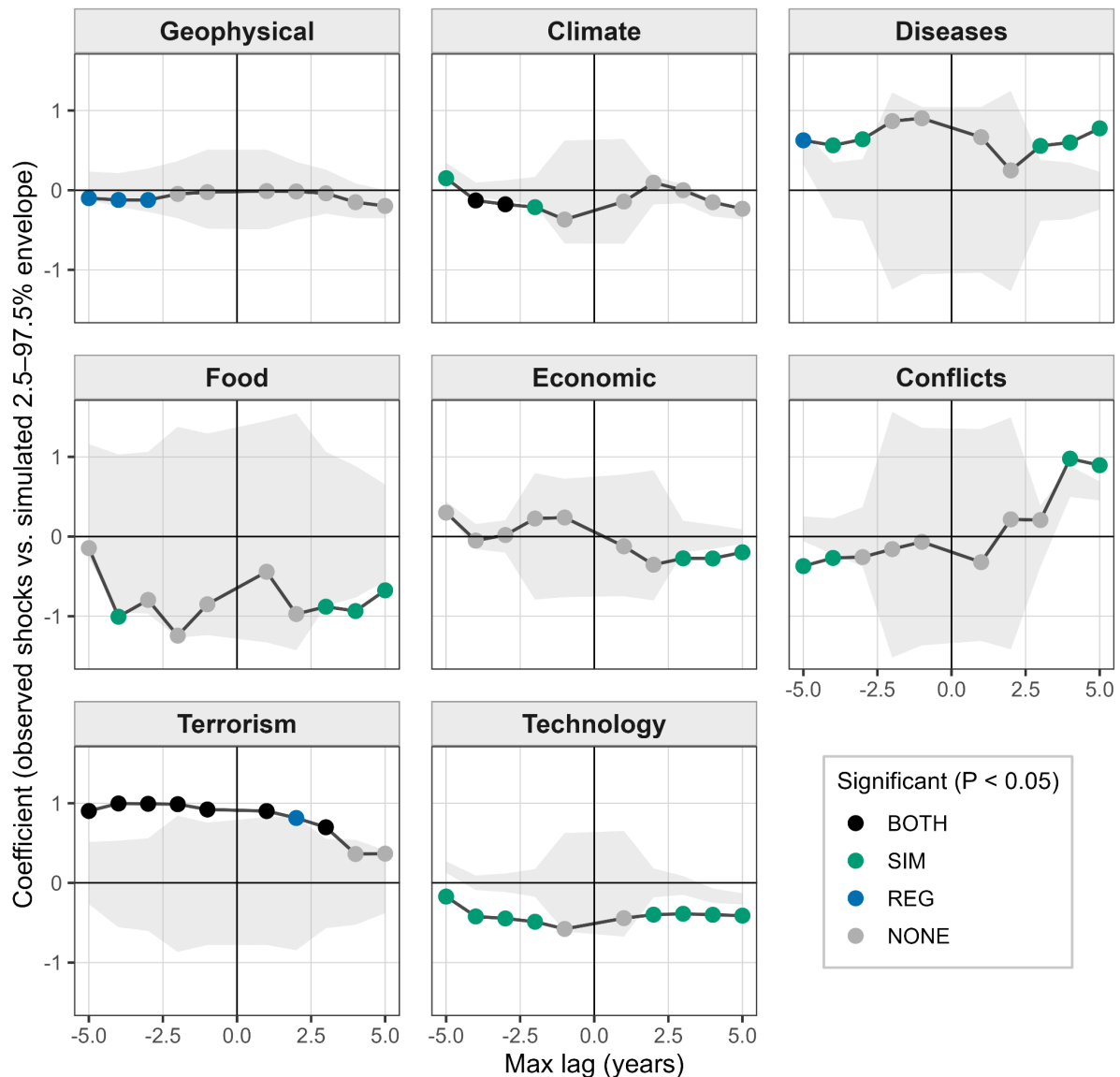


Figure 1 | Retrospective and prospective alignment between GRR risk scores and observed shocks. Regression coefficients relate GRPS-derived risk scores to observed shock frequency across windows extending up to five years before or after each GRR year. Negative lags indicate retrospective windows; positive lags indicate prospective windows. Grey bands show the 2.5–97.5% range from 1500 Monte Carlo-randomised shock simulations. Point colours indicate significance against the parametric baseline, simulation baseline, both, or neither. Regression coefficients are not bounded between -1 and 1 .

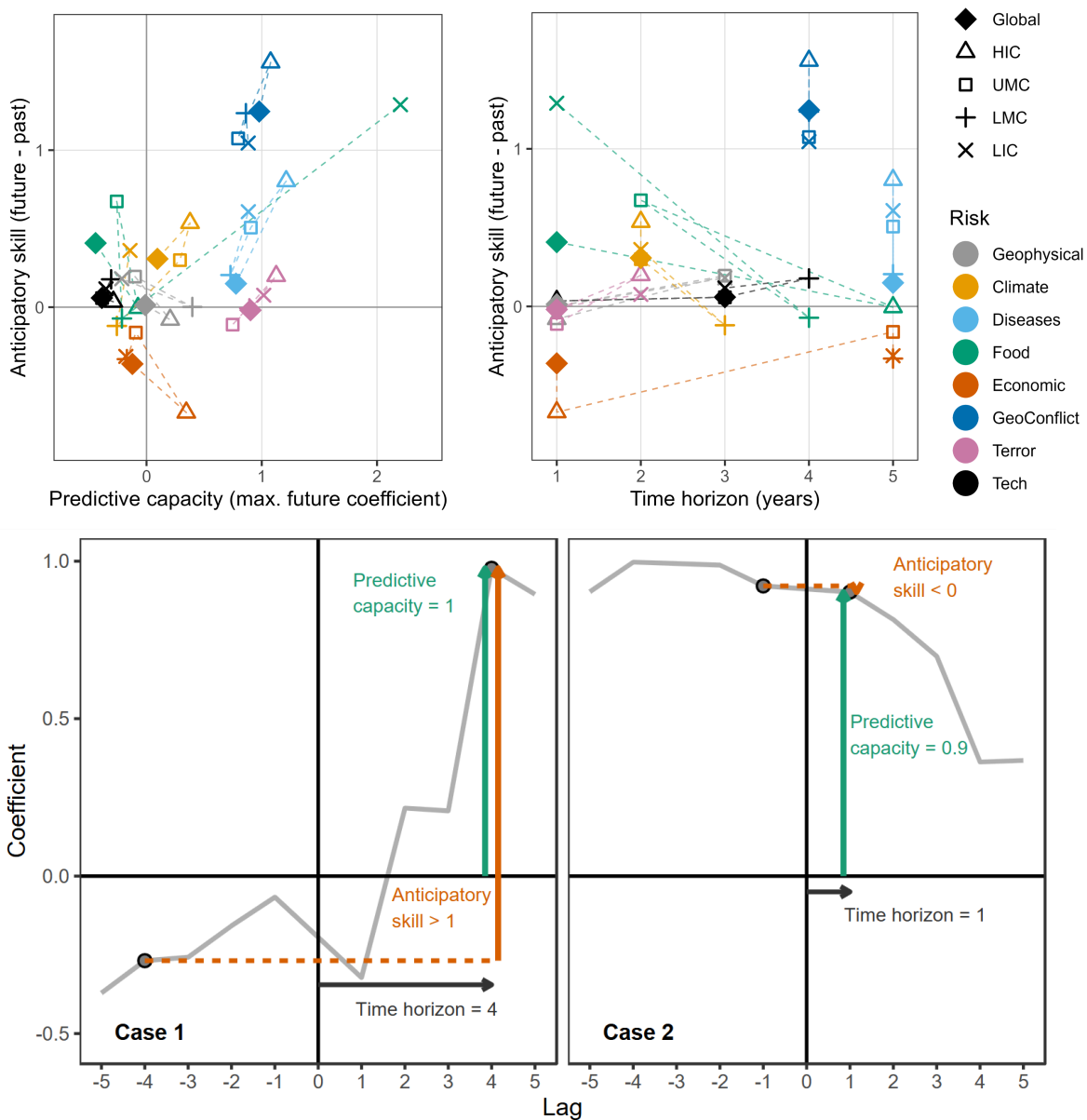


Figure 2 | Top left: scatterplot of anticipatory skill (future–past regression coefficient) against predictive capacity (maximum forward-looking coefficient) for each combination of shock categories and income group. Top right: anticipatory skill as a function of the time horizon (years ahead) at which predictive capacity is maximised. Point shapes denote income groups (Global, high-income countries, upper-middle-income, lower-middle-income, and low-income countries), and colours denote shock categories. Below: exemplification of the predictive capacity, anticipatory skill, and time horizon definitions.

Thematic analysis of GRRs

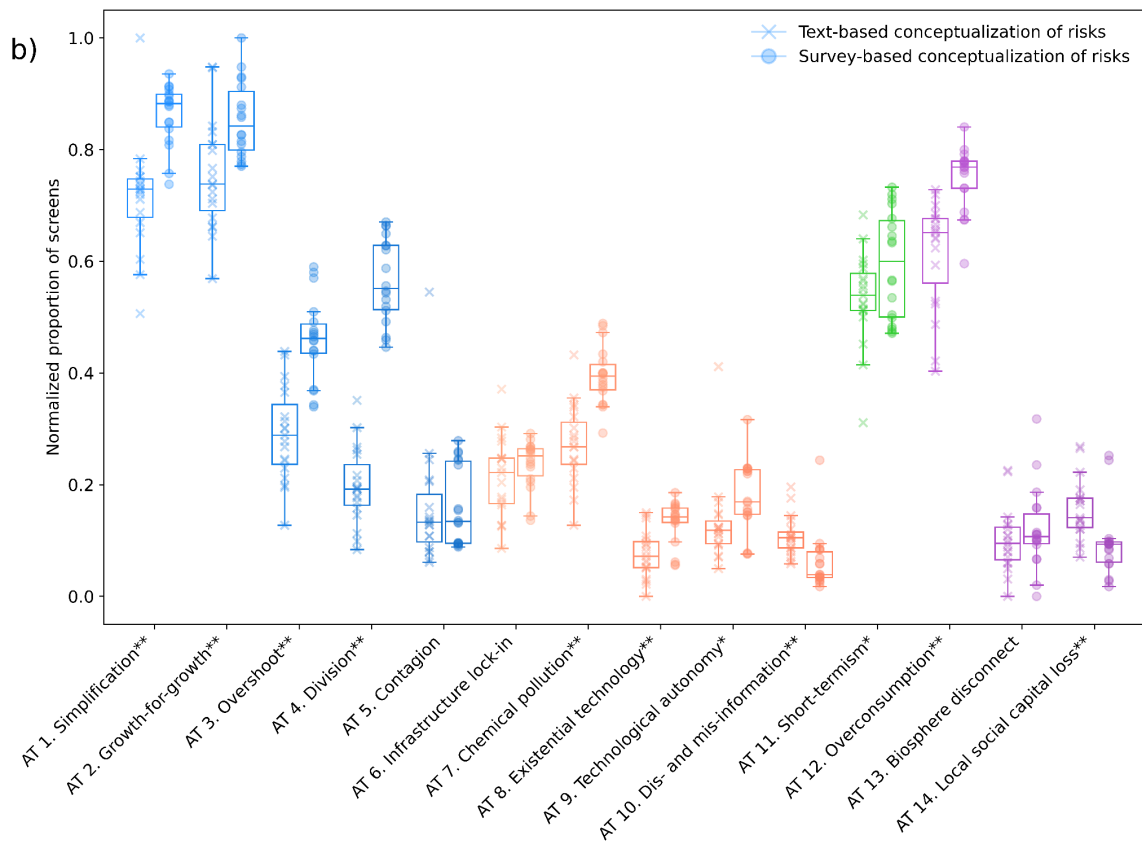
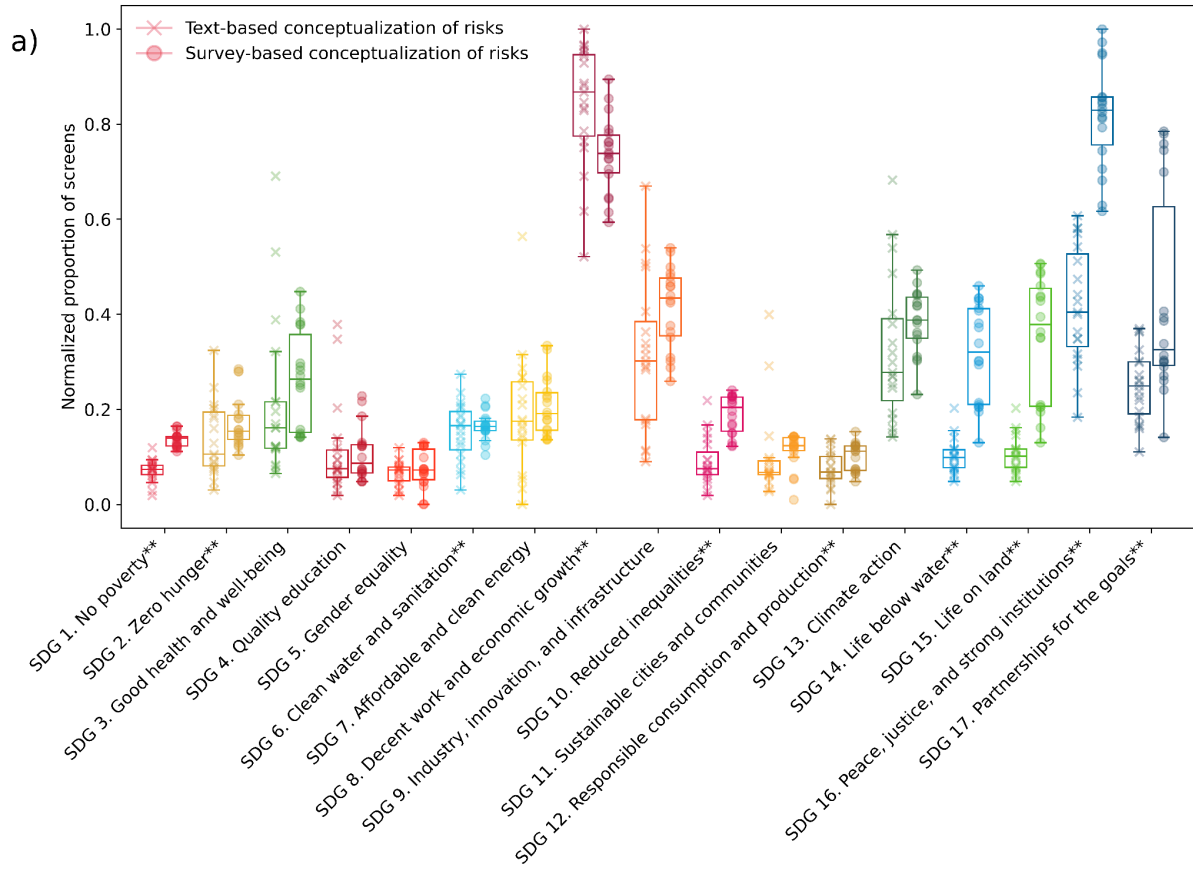
To capture what is emphasised in the reports relative to the surveys, we systematically screen both the GRRs and surveys texts (see *Materials and Methods*) through three frameworks: the Sustainable Development Goals (SDGs), the Anthropocene Traps (ATs; Søgaard Jørgensen et al., 2023, 2026), and the Corporate Sustainability Spectrums (CSSs; Landrum & Ohsowski (2017).

Screening against the SDGs reveals an overall focus on economic growth in both text and surveys, but a marked imbalance in how social and environmental goals are represented (Fig. 3a). SDG 8 (economic growth) is the most frequently referenced goal, with mean normalised proportions of 0.84 in text and 0.74 in surveys. SDG 16 (peace, justice and strong institutions) is the second-most common theme (0.42 vs. 0.82), implying that conflict and institutional stability are more prevalent in

survey responses than in the GRRs text. The gaps are even larger for SDGs associated with poverty, inequality and biodiversity: SDG 1, 10, 14 and 15 show absolute differences of 0.07 (63%), 0.10 (71%), 0.22 (104%) and 0.25 (107%), respectively, with these themes far more prominent in the surveys than in the written reports (see statistical significance tests in the supporting information material). By contrast, SDGs 4, 6 and 7 (education, water, and energy) show only small differences (4–8%), indicating more balanced treatment. Over time, gaps widen for several SDGs, notably 9, 14 and 15, while they narrow for others such as SDG 5 and 17 (Table S11).

The Anthropocene Traps screening uncovers a narrowing view of crisis-generating processes (Fig. 3b). The GRRs foreground risks related to simplification of supply chains (AT1), institutional lock-ins (AT2), short-termism (AT11), and overconsumption (AT12), with mean normalised screening values of 0.79, 0.80, 0.56 and 0.68, respectively. They comparatively focus less and systematically underrepresent material overshoot (AT3), division and conflicts (AT4), and pollution (AT7), with gaps in the text compared with the surveys of 0.17, 0.37, and 0.12, respectively. Some of these differences shrink over time, but others grow. For example, AT11 and AT13 (biosphere disconnect) show converging text–survey patterns, whereas AT1, AT3 and AT9 (technological autonomy) display increasing gaps (Table S12).

The Corporate Sustainability Spectrums lens shows that the GRRs shift the implied locus of responsibility, moving away from the survey's more systemic framing toward business-centred and incremental conceptions of sustainability (Fig. 3c). Notably, we find a predominance of weak-to-intermediate conceptions of sustainability in texts, whereas survey responses concentrate on more systemic responsibility. For instance, the GRRs rank first the incremental corporate responsibility (CSS2, 0.85), while surveys place their peak on systemic responsibility (CSS3; 0.86). GRRs also devote non-negligible attention to both very weak/voluntary (CSS1; 0.15) and very strong, justice-oriented conceptions of sustainability (CSS5; 0.14), whereas these extremes are almost absent from the surveys (0.03 and 0.02). Over time, the text shifts further toward CSS2 at the expense of CSS3, and its earlier emphasis on CSS5 declines toward zero (Table S13).



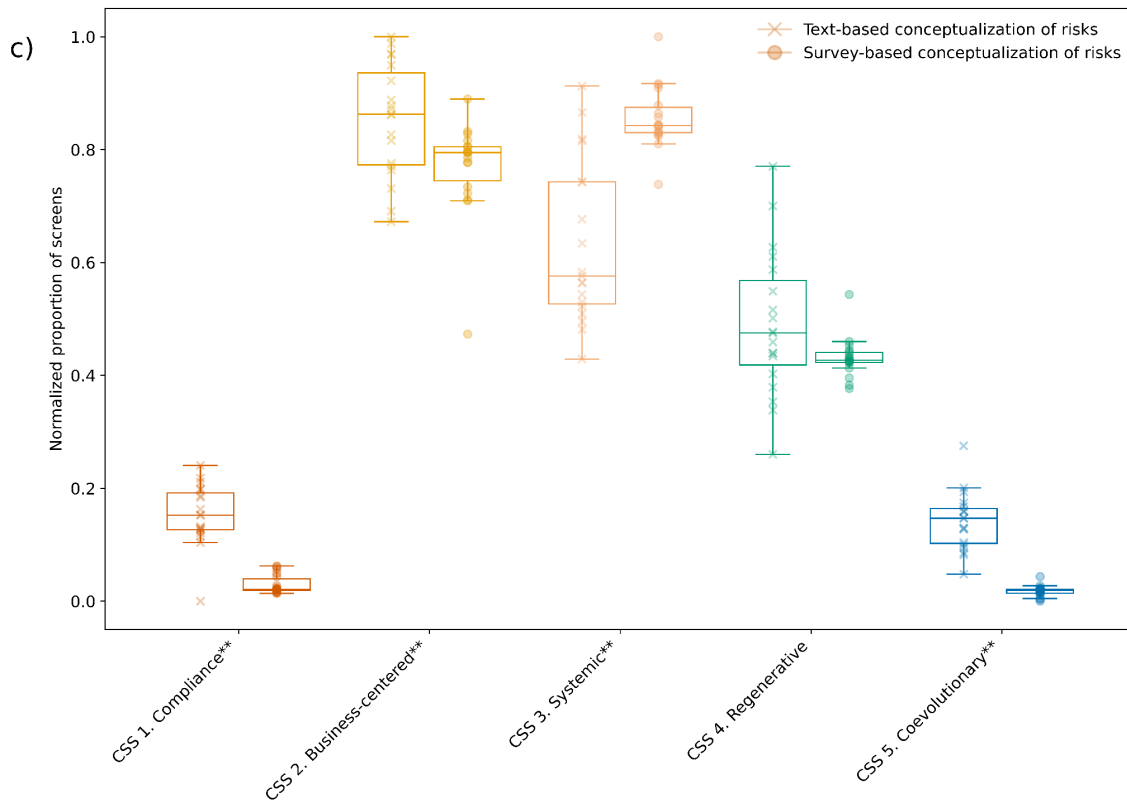


Figure 3 | Text and survey-based conceptualizations of global risks in relation to (a) Sustainable Development Goals, (b) Anthropocene Traps, and (c) Corporate Sustainability Spectrums. Proportions of screens are normalized (See *Materials and Methods*). ** indicates a difference statistically significant at $p < 0.05$ in both t-test and Wilcoxon; * indicates a difference statistically significant in one of the tests; no symbol indicates no significant difference.

Linguistic analysis of GRRs

Our analysis of GRRs across six linguistic dimensions shows that the reports have become increasingly negative, regulatory, and difficult to read over time (Fig. 4). On a 0–1 scale, they rely heavily on negative (mean = 0.71) and uncertainty-related terms (0.64). Negative wording increases while uncertainty-related wording declines, suggesting that GRRs increasingly frame global risks in more negative but more explicitly certain terms. Constraining vocabulary (e.g., “required”, “comply”; mean = 0.50) and litigious language (e.g., “legislation”, “regulation”; mean = 0.46) are used at moderate but rising levels, indicating a growing emphasis on rule-setting, compliance, and institutional response. At the same time, readability drops, suggesting that the GRRs increasingly address a technical policy and business audience rather than a broad public.

Relative to international-organisation reports that address different facets of global risk (Table S3), the GRRs occupy a distinct niche. They show the largest mean Euclidean distance of any report set analysed (0.84; Fig. S14), indicating the strongest overall divergence in linguistic profile. Notably, the GRRs sit closest not to climate, humanitarian, food, water, or technology reports, but to the Bank for International Settlements (BIS) annual reports (0.66). This further suggests that the GRRs place an emphasis on economic aspects, and might speak first and foremost to a macro-financial audience.

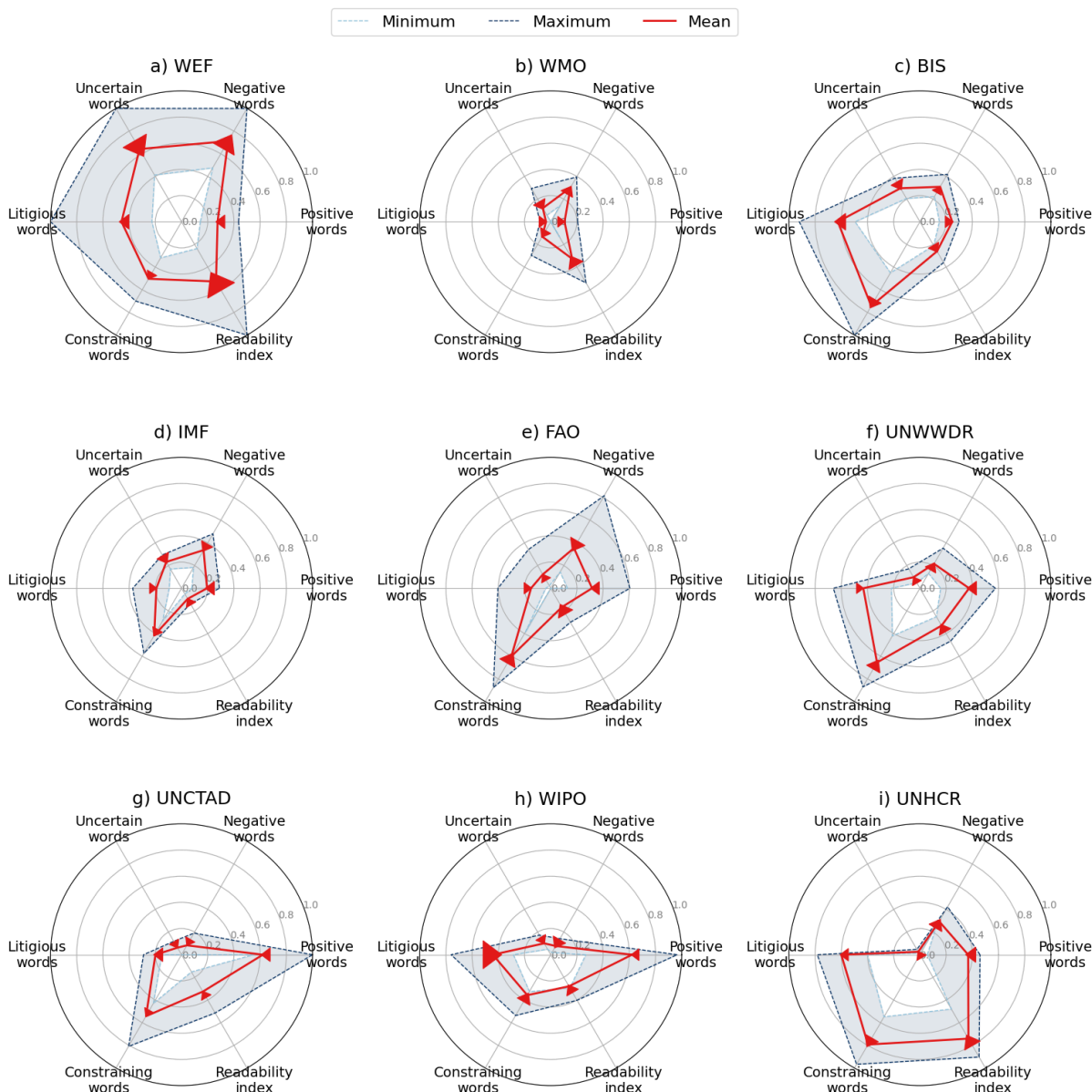


Figure 4 | Linguistic profile of GRRs relative to international-organisation reports. Radar plots show normalised scores for positive, negative, uncertainty-related, litigious, and constraining language, and Gunning Fog readability. Points show minima, means, and maxima across each report series. Red arrows indicate change from early to recent reports. Report abbreviations are defined in Table S3.

Discussion

Analysing 19 years of Global Risks Reports using three lenses (predictive analysis, linguistic analysis, thematic analysis) shows that GRRs display biases (i.e., a systematic emphasis or inclination towards a certain perspective over others) in what they anticipate and emphasize. We here identify four biases. First, we find a temporal bias as GRRs likelihoods generally show weak alignment with future shock frequency, with conflict-related shocks as the main exception. Second, we uncover a potential regional bias: when GRR scores show positive global future alignment, this alignment is consistently strongest for high-income countries, suggesting that the reports better anticipate shocks as recorded in wealthier regions than those recorded elsewhere. Third, the GRRs involve an apparent transcription bias, as texts selectively and significantly downplay themes linked to poverty, inequality, biodiversity, and conflict, while foregrounding economic growth, simplification, and short-term stability relative to the surveys they rest on. Finally, we observe a comparative framing bias to other reports in the way GRRs

increasingly portray risks as complex, regulatory, and compliance challenges for a technical policy and business audience.

Our study has several methodological limitations that should be borne in mind when interpreting the results. Although we estimate these limitations likely to be relevant only to a subset of risks or to certain aspects of the trends highlighted above, they highlight the challenges involved in evaluating risk assessments. The predictive analysis is for instance subject to reporting, geographical, hazard, and threshold effects. Reporting effect is defined as the increased number of recorded shocks over time, often resulting from changes and improvements in data collection (Wyatt et al., 2023). It is unlikely to be significant here given that the timeline is limited to 25 recent years. The geographical effect stems from the preferential reporting of events occurring in different locations, and the geographical scale at which impacts are reported. If events from low- and middle-income regions are underreported in the shocks database, but correctly anticipated by the GRRs, this could lead to a seemingly low anticipatory skill. This is accentuated by national-level data, which could lead regional events to be recorded as multiple entries. While this issue prevails for higher income countries in comparison to lower income ones, as the former tend to have more reporting capacity, it does less for the two middle-income groups. The hazard effect appears from a partial match between risks and events. This partial match can be caused by risk labels evolving over time in the GRRs, and is accentuated by unavailable disaggregated survey data, reducing detail and possibly weakening associations. To mitigate this effect, we adopted a structured matching process (see Fig. S5). The threshold effect results from the selective inclusion of events of greater severity and the inconsistent criteria for including records across different agencies and organizations (Wyatt et al., 2023). Its potential consequences are most clearly illustrated in the analysis of technology risks. Here, the shocks include among others industrial fires, train accidents and oil spills, but these hazards may only partly surpass the thresholds of risks aimed for in the definition by the GRRs of “breakdown of critical infrastructure and networks”, “lack & failure of public infrastructure”, and “human made environmental damage and pollution”. This could help explain the overall low regression coefficients for technological shocks, although the low likelihood of these risks attenuates the limitation. We mitigated this effect by focusing on shock occurrence rather than severity, which is more dependent on impact thresholds and damage estimates (Delannoy et al., 2025b).

Several other underlying processes can be involved in generating the biases identified above. GRRs likelihoods may capture judgments about whether major events seem plausible, important, and potentially disruptive. They may therefore reflect assessments of notable events rather than expectations about how often shocks will occur in a given year. As Wynes et al. (2022) suggest, this points to a possible mismatch between what the GRPS elicits and how risk likelihoods are often interpreted in the GRRs or by external audiences. Moreover, risk perceptions are influenced by recent events. Respondents may assign higher likelihoods to several risks because recent disruptions make them more cognitively available and salient (Tversky and Kahneman, 1974; Di Baldassarre et al., 2021). This effect is especially relevant for the aspects outside respondents’ own domain of expertise, and could be key in the GRRs given the large spectrum of risks surveyed (Won et al., 2025).

The biases also point to the importance of the institutional context in which the GRRs are produced. The reports are prepared by the WEF, a Swiss foundation sustained through corporate membership and partnerships, and influential through its convening of business leaders and decision-makers at Davos (Pigman, 2002; Graz, 2003; Pigman, 2007; Fougner, 2008; McNeill, 2023). Two features of this organization are relevant for interpreting our results. First, the WEF exercises a discretionary governance, in which access, roles, and agendas are shaped through curated participation. Access to the Forum communities is thus mediated by invitation and fees, stabilising a transnational elite club whose horizons extend beyond national politics and blend corporate, financial, philanthropic, and policy interests—often summarised as “Davos Man” (Nauta, 2015; Navidi, 2017; Stefán, 2023; Kaplan, 2024). Second, the WEF operates with a “liquid mandate”, moving across policy domains without a fixed remit (Garsten & Sörbom, 2014; 2018; 2021). While curated participation may give greater weight to business and policy views than others (Garsten & Sörbom, 2019b; Wynes et al., 2022), the Forum’s liquid mandate may make different issues comparable by recasting them as

problems of coordination, resilience, innovation, and public–private partnership (Garsten & Sörbom, 2017; Soederberg, 2016; Sharma & Soederberg, 2020). Risks rooted in poverty, inequality, biodiversity loss, or ecological overshoot are harder to emerge, as they imply more redistributive and ecological interventions (Giridharadas, 2018; Garsten & Sörbom, 2019a; Calmettes & Pfister, 2025). Interestingly, similar patterns appear within WEF initiatives on gender, competitiveness, Artificial Intelligence, COVID-19, climate, so-called inclusive growth, and the Fourth Industrial Revolution (Elias, 2013; Nam & Nam, 2021; Moll, 2022; Francisco & Linnér, 2023; Pal, 2023; Saqer, 2023; Woodworth, 2023; Pasula, 2024; Bergsteiner & Avery, 2026).

For the GRRs to improve, their production would need to be broadened and made auditable. Notably, the process should be plural enough for different biases, assumptions, and risk priorities to be made visible and contestable. This requires balancing business and policy perspectives with other forms of expertise and experience, including institutions in highly exposed regions, humanitarian agencies, sustainability scholars, public-health experts, heterodox economists, labour organisations, grassroots and Indigenous communities, and critical-infrastructure practitioners. Such plurality should be a key part of the process in a structured co-production approach (Hochrainer-Stigler et al., 2024). The biases we document also point to clearer procedures for disclosing sampling choices, uncertainty treatment, editorial decisions, and criteria for prioritising risks (Baybutt, 2015; Aven, 2020; 2025). Without such changes, GRRs are best treated not as neutral early-warning systems (Garsten & Sörbom, 2016), but as situated indicators of elite risk perception and narrative prioritisation, to be used with caution.

Yet, the institutional context of the WEF suggests that improving GRRs might not be sufficient to adequately represent global risks. We therefore call for a standing assessment capacity for systemic risks. Such a process should start from critical systems, vulnerabilities, and propagation pathways instead of risk labels, so that risks are connected to observable mechanisms of disruption or drivers (Keys et al., 2019; Wassénus & Crona, 2021; Ahlström et al., 2024; Sjöfjell & Cornell, 2024; Ciullo et al., 2025; Mille et al., 2025). It should also treat catastrophic and existential risks as a distinct class requiring more than rankings that encourage spurious precision, especially on low-probability but high-impact events (Bhowmik et al., 2022; Burgess et al., 2022; Kemp et al., 2022a; Arnscheidt et al., 2025; Aven, 2025; GCF, 2026). Finally, the new assessment should make uncertainty, knowledge gaps, value judgements, and prioritisation criteria explicit, and be plural and accountable enough to reduce regional and thematic blind spots (Visser et al., 2020; Galaz, 2017; 2022; Kreienkamp & Pegram, 2020; Benett et al., 2026; Richardson et al., 2026). In practice, it could build on emerging efforts by the UN Global Risk Report and the Accelerator for Systemic Risk Assessment network (Gambhir et al., 2025; 2026), which paved the way to broader representation in systemic risks assessment, as well as emerging deliberative capacities (Blue, 2016; Ruhl & Craig, 2022; Kemp et al., 2022b; Curato et al., 2023; Kim & Bridgewater, 2025; Daw et al., 2026). Such an assessment would give decision makers a clearer basis for anticipating where crises may emerge, how they may spread, whose lives and livelihoods they are likely to disrupt, and how to respond.

Materials and methods

Predictive analysis

We assessed the extent to which GRPS-derived risk scores in the World Economic Forum Global Risks Reports are statistically associated with the empirical occurrence of shocks across multiple categories. The predictive analysis uses the comparable annual risk-score series for 2006–2021. Later reports are analysed in the thematic and linguistic parts of the study, but are excluded from the predictive analysis because the GRPS methodology changed substantially after 2021.

First, we retrieved from the GRRs the short-term (1–5 years) likelihood (Fig. S2) and severity (Fig. S3) of each risk. Due to data availability constraints, values were manually extracted from risk matrices using WebPlotDigitizer when tabulated values were unavailable. To assess the robustness of this extraction method, values obtained via the software were compared against available data for 2024 (Table S1). We then associated risks with shocks from the database of Delannoy et al. (2025b) through an interactive and structured process (Fig. S5, Table S2). This database documents the frequency, impact, and co-occurrence of shocks across 170 countries from 1970 to 2019 in six categories: climatic, geophysical, ecological, economic, technological, and conflict-related shocks. In the working files used here, harmonised extensions were available for some categories, while other categories ended earlier because of source-data limitations. We therefore imposed category-specific end years before aggregation: food-related ecological shocks, 2013; disease outbreaks, 2022; climate, geophysical, and technological shocks, 2024; terrorism, 2020; geopolitical conflicts, 2023; and economic shocks, 2019. Years outside category-specific coverage were not treated as observed zero-shock years. When several GRR risks mapped to the same empirical shock category in a given year, we aggregated their normalised scores into a single category-level score using mean values.

Second, shock counts were aggregated regionally or globally and standardised using a category-first approach. Region grouping follows the 2024 World Bank classification, distinguishing low-, lower-middle-, upper-middle-, and high-income countries. For each region j , shock category r , and year t , raw annual shock counts were scaled by the temporal variability specific to that region–category series:

$$S_{jrt} = \frac{C_{jrt}}{sd(C_{jr})} \quad (1)$$

where C_{jrt} is the raw shock count and $sd(C_{jr})$ is the standard deviation of annual counts for region j and shock category r . Global standardisation was performed analogously using global shock counts. This procedure makes shock occurrence comparable across categories that differ substantially in frequency and reporting intensity.

Third, for each shock category r , region j , GRR year y , and lag $\ell \in \{-5, \dots, -1, 0, 1, \dots, 5\}$, we computed average standardised shock occurrence in the corresponding retrospective, contemporaneous, or prospective window. In the current specification, windows are inclusive of the GRR assessment year. For $\ell > 0$, the prospective window covers years y to $y + \ell$; for $\ell < 0$, the retrospective window covers years $y + \ell$ to y ; and for $\ell = 0$, the window corresponds to year y . We then estimated ordinary least squares regressions of the form:

$$\bar{S}_{jry}(\ell) = \alpha_{jr\ell} + \beta_{jr\ell} \times R_{ry} + \varepsilon_{jry\ell} \quad (2)$$

where R_{ry} is the GRPS-derived risk score for shock category r in GRR year y , and $\beta_{jr\ell}$ measures the association between risk scores and shock occurrence at lag ℓ . Negative lags estimate retrospective association; positive lags estimate prospective alignment. Lag zero was estimated and shown for comparison, but was not used to define predictive capacity or anticipatory skill. Regressions with fewer than five paired observations were not estimated.

To test robustness, we generated 1500 Monte Carlo randomisations by expanding the shock data to a complete country \times shock-category \times year grid within valid category coverage, filling observed absences with zeros, and permuting annual shock counts within each country–shock-category series. The permuted counts were then reaggregated to regional and global totals, restandardized, and

analysed using the same lag-regression procedure. This preserves each country–category marginal distribution while breaking temporal alignment between shocks and GRPS-derived risk scores. The simulation envelope used for lag-level classification is the 2.5–97.5% range of simulated coefficients. Separately, uncertainty in predictive-capacity and anticipatory-skill metrics was assessed using 10,000 coefficient draws from normal distributions centred on the estimated lag-regression coefficients and scaled by their standard errors.

From this analysis, we defined predictive capacity PC as the maximum prospective regression coefficient across horizons $h = 1, \dots, 5$:

$$PC_{jr} = \max \beta_{jr\ell}; \ell \in \{1, \dots, 5\} \quad (3)$$

The predictive time horizon is:

$$\ell^*_{jr} = \arg \max \beta_{jr\ell}; \ell \in \{1, \dots, 5\} \quad (4)$$

Anticipatory skill AS is defined as predictive capacity minus the coefficient from the corresponding retrospective window:

$$AS_{jr} = PC_{jr} - \beta_{jr, -\ell^*_{jr}}; \ell \in \{1, \dots, 5\} \quad (5)$$

To test income-group differences, we used Friedman omnibus tests with risk category as the paired block and income group as the repeated factor. The main test was restricted to the four risk categories with positive global predictive capacity—climate shocks, disease outbreaks, geopolitical conflicts, and terrorism—because anticipatory skill is mostly substantively interpretable when there is at least some positive global future alignment. Pairwise income-group contrasts were not used as the main inferential target because the targeted test contains only four category-level blocks, giving very low power and coarse exact P-value resolution.

Thematic analysis

We collected PDF files of the Global Risks Report from 2006 to 2024 from the WEF website and converted them to .txt format. Once textual and survey data were collected, we performed a systematic thematic analysis of both data against (i) the Sustainable Development Goals (SDGs), (ii) Anthropocene Traps (ATs), and (iii) Corporate Sustainability Spectrums (CSSs) (Fig. S15). We selected these three typologies as they represent different and complementary aspects of the conceptualization of risks, with the ATs, SDGs, and CSSs respectively answering (i) *what* type of risks are assessed, (ii) *how* are the risks believed to impact human societies (i.e., transgressing what SDG?), (iii) *who* is framed as shaping global risks, and specifically to what extent corporate actors are implicated? A thematic analysis is an effective way of assessing the various relevant dimensions of a concept. For example, it has been used to study how interpretations of the ‘green economy’ vary according to the sets of indicators proposed to monitor its progress (Merino-Saum et al., 2018).

For each report, we extracted a frequency-weighted vocabulary after applying a stop-word list and removing non-informative terms and closely co-occurring terms that would otherwise double-count the same concept. Survey material was screened separately from the report text; because survey entries mainly consist of risk labels and short definitions, this screening captures the conceptual content of the surveyed risks more directly, but with less contextual information than the full reports. Each word or survey response was categorized according to the most related of the 17 SDGs, 14 ATs, and 5 CSSs, considering all potential categories. The screening process consistency was ensured through an individual screening, a collective screening, an internal consistency check across all screens, and a screening against a fourth framework (the environmental, social, and governance (ESG) factors) using the dictionary from Baier et al. (2020). As a rule, we determined the most pertinent category for each indicator and each typology, but for the typologies made of non-exclusive categories (SDGs and ATs), the same indicator could be classified by referring to more than one category. For instance, the 2013 risk “Diffusion of weapons of mass destruction” was screened against SDG 16 (Peace, Justice and Strong Institutions) but against AT 4 (Division) and AT 8 (Existential Technology).

We then normalized screens to ensure comparability and consistency across the three dimensions and the 19 years of reports. To do so, we employed "z-score" normalization:

$$z = \frac{x - \mu}{\sigma} \quad (7)$$

where z is the standardized value, x is the original value, μ is the mean of the considered year, and σ is the standard deviation of the considered year. The normalization process involves subtracting the mean of each year from its respective data points and then dividing by the standard deviation of the same year. This transformation produces a distribution with a mean of zero and a standard deviation of one, standardizing the data for meaningful comparisons. Following normalization using the z-score method, the resulting values were rescaled to a range of 0 to 1 to enhance the readability and interpretability.

Linguistic analysis

First, we collected annual reports from various international organizations that were selected for their coverage of global issues discussed in the GRRs, yearly availability, and institutional reputation (Table S3). We then assessed the linguistic patterns from the GRRs through Python coding six different linguistic criteria throughout the text of each report: the percentage of words classified as positive, negative, constraining, litigious, and uncertain, as well as the overall readability of the text. The identification of words classified as positive, negative, constraining (*required*, *comply*, etc.), litigious (*legislation*, *regulation*, etc.), and uncertainty-related (*indefinite*, *fluctuate*, etc.) is conducted using the February 2024 version of the dictionary of words of Loughran & McDonald (2011; 2023). The readability is computed through the Gunning Fog Index (GFI), which is commonly used to evaluate how easily text can be read by its intended audience:

$$GFI = 0.4 \left(\frac{\text{number of words}}{\text{number of sentences}} + 100 \left(\frac{\text{number of complex words}}{\text{number of words}} \right) \right) \quad (8)$$

Complex words are words with 3 syllables or more that are not compound words, and compound words are a combination of 2 or more smaller words (for example, "multinational", which is made up of the words "multi" and "national"). The compilation of the Gunning Fog Index for all reports is done through a slightly modified version of the open-source code of Anusha (2024). The values reported for the six different linguistic criteria are then normalized between 0 and 1 to ensure comparability (0 being the lowest value of the indicator across all reports from all organizations and 1 the highest).

Future development

Future work could extend our analysis in several directions. The predictive analysis could be extended to severities and mid- and long- term horizons of risks, to assess whether biases appear across the impacts of the shocks. Exploiting higher-resolution geocoded shock data could also strengthen the analysis, but faces issues of data availability. Future work could also evaluate whether perceived interdependencies in the GRRs correspond to empirical patterns of shock co-occurrence, but faces the potential differences in "interconnection" interpretation by the survey respondents. On the textual side, more fine-grained linguistic features (including sentiment analysis at sentence level, rhetorical framing devices, or topic models) could complement the broad indicators used here. Finally, direct collaboration, including semi-structured interviews with GRRs organizers and contributors would allow a more detailed evaluation of survey design and institutional incentives, and thus a more comprehensive understanding of how biases might arise, and potential capacity to address them.

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Author Contributions

Louis Delannoy: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Mélis Busson:** Data Curation, Investigation, Methodology, Visualization. **Peter Søgaard Jørgensen:**

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Conflicts of Interest declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement

Data and code for the analysis, as well as figures, can be accessed from the following repository: <https://github.com/LouisD-KVA/WEF-GRR-analysis>

Declaration of AI use

We have used AI-assisted technologies (Chat-GPT 5.4 and 5.5) for spellchecking, code checking, and as inspiration for rewording individual sentences. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Supporting Information

A. Coverage of the Global Risks Reports

- **Figure S1** | Distribution of news articles referencing ‘Global Risks Report’ in 2023, as documented in InfoMedia.

B. Extracted risks likelihood and severity (normalized) from the Global Risks Reports.

- **Figure S2** | Surveyed likelihood of global risks (normalized from 1 to 5), by category of risks, in GRRs from 2006 to 2021. Note that the 2022 Global Risk Report did not include a risk survey, and the 2023 and 2024 reports only show severity multiplied by likelihood.
- **Figure S3** | Surveyed severity of global risks (normalized from 1 to 5), by category of risks, in GRRs from 2006 to 2021. Note that the 2022 Global Risk Report did not include a risk survey, and the 2023 and 2024 reports only show severity multiplied by likelihood.
- **Figure S4** | Surveyed severity times likelihood of global risks (normalized from 1 to 5), by category of risks, in GRRs from 2006 to 2024. Note that the 2022 Global Risk Report did not include a risk survey, and the 2023 and 2024 reports only show severity times likelihood.
- **Notes S1** | Methodological details for risk likelihood extraction process.
- **Table S1** | Long-term surveyed severity of risks in the 2024 Global Risks Report, as provided by the WEF or extracted from the risk matrices using the WebPlotDigitizer software.

C. Association between risks and shocks.

- **Figure S5** | Association process between risks from the Global Risks Reports and the shocks from the database of Delannoy et al. (2025b).
- **Table S2** | Association of risks from the Global Risks Reports against the shocks from the database of Delannoy et al. (2025b). Year range refers to the years these risks were available for extraction in the GRRs.

D. Predictive analysis.

- **Figure S6** | Regional lag-regression results. Regression coefficients relate GRPS-derived risk scores to observed shock frequency across lags from -5 to $+5$ years, by shock category and income group. Bands show Monte Carlo-randomised simulation envelopes. HIC, high-income countries; UMC, upper-middle-income countries; LMC, lower-middle-income countries; LIC, low-income countries.
- **Figure S7** | Year-level contributions to predictive capacity and anticipatory skill by shock category.
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- **Figure S10** | Observed predictive-capacity and anticipatory-skill metrics with 95% coefficient-draw intervals.
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E. Linguistic analysis.

- **Table S3** | Reports from international organizations that were selected for the linguistic analysis comparison with the GRRs. WMO = World Meteorological Organization: State of the Climate Reports; BIS = Bank for International Settlements: Annual Reports; IMF = International Monetary Fund: World Economic Outlooks; FAO = Food and Agriculture Organization: The State of Food Insecurity in the World Reports; UNWWDR = The United Nations World Water Development Reports; UN Technology = UN Conference on Trade and Development: Technology and Innovation Reports; WIPO = World Intellectual Property Organization Reports; UNHCR = The UN Refugee Agency Global Reports.
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F. Thematic analysis

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- **Table S6** | Anthropocene Traps description. Relying on Søgaard Jørgensen et al. (2023, 2026).
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G. Statistical significance tests.

- **Figure S20** | P-values of t-test and Wilcoxon signed-rank test between survey and text-based screens against Sustainable Development Goals.
- **Table S8** | P-values of t-test and Wilcoxon signed-rank test between survey and text-based screens against Sustainable Development Goals. Differences between survey and text-based screens are considered statistically significant if p-values are below 0.05.
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H. Evolution of the screening proportions per year.

- **Table S11** | Evolution of the difference (absolute values of normalized screenings) between the surveys and the text, for the Sustainable Development Goals.
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- **Table S13** | Evolution of the difference (absolute values of normalized screenings) between the surveys and the text, for the Corporate Sustainability Spectrums.

A - Coverage of the Global Risks Reports

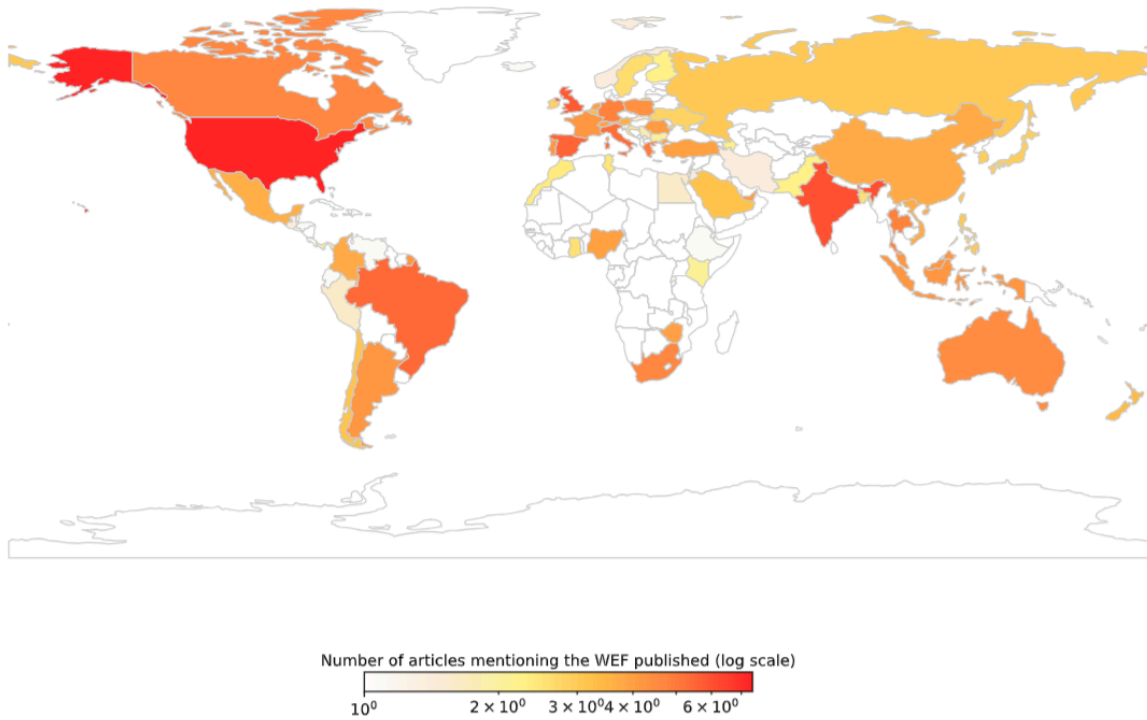


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B - Extracted risks likelihood and severity (normalized) from the Global Risks Reports.

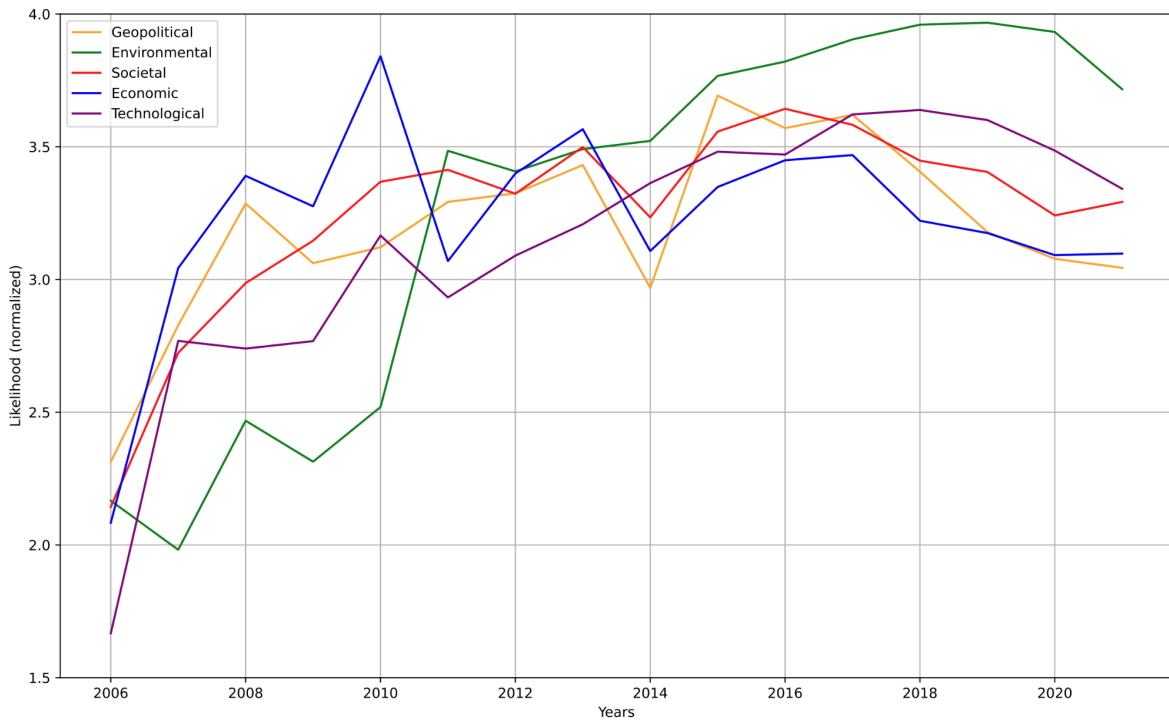


Figure S2 | Surveyed likelihood of global risks (normalized from 1 to 5), by category of risks, in GRRs from 2006 to 2021. Note that the 2022 Global Risk Report did not include a risk survey, and the 2023 and 2024 reports only show severity multiplied by likelihood.

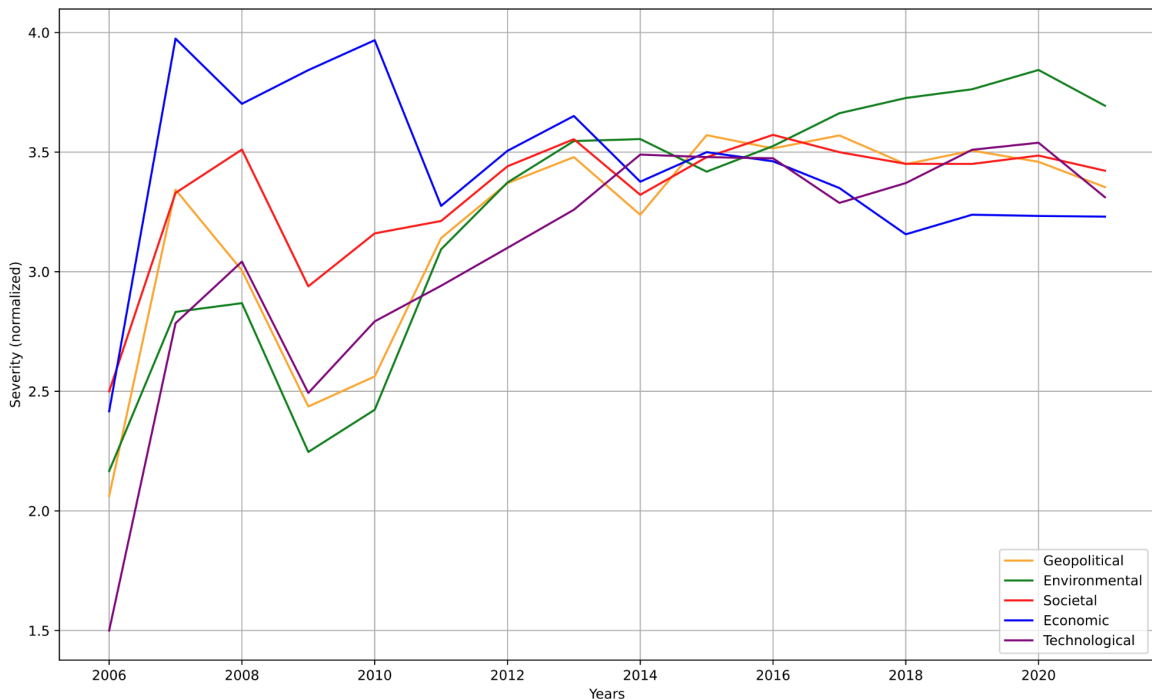


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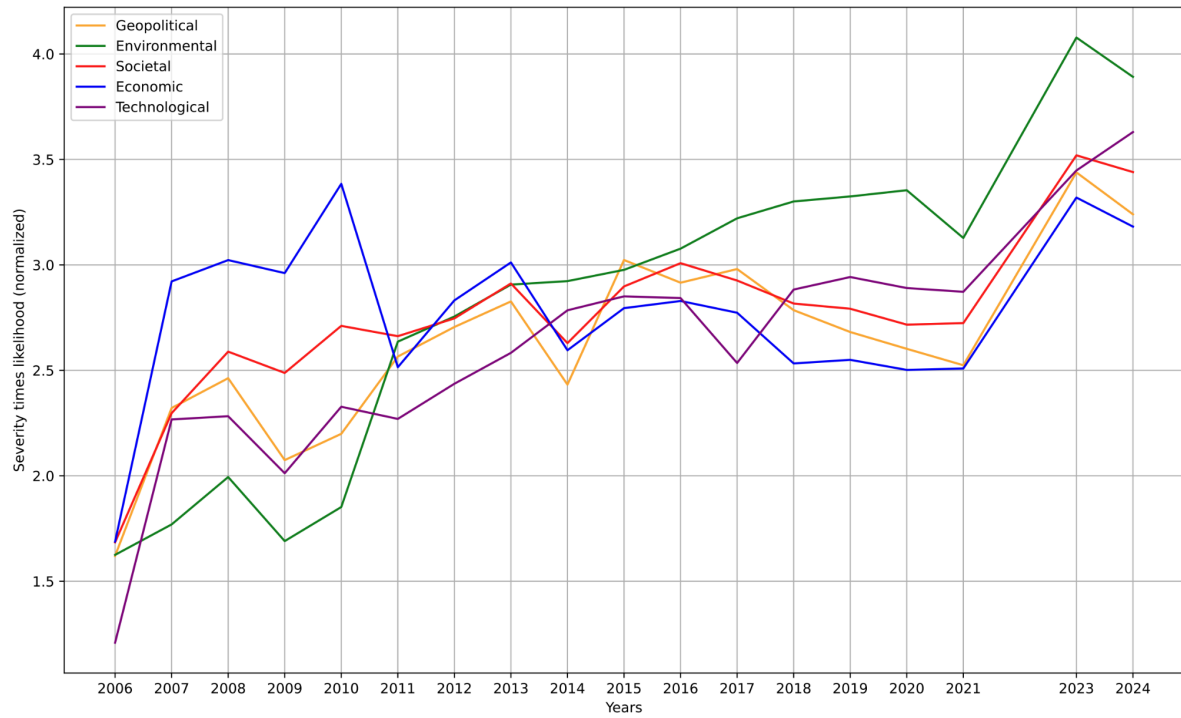


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Notes S1 | Methodological details for risk likelihood extraction process.

To retrieve the primary results from the Global Risks Perception Survey (GRPS), we extract from the risk matrix of each GRR and with the "WebPlotDigitizer" software, the likelihood and short-term (1-5 years) severity for each risk from 2006 to 2021. In 2022, the WEF adopted a distinct methodology for measuring risk likelihood and severity: likelihood was assessed as the percentage of respondents anticipating the risk to occur within a 5-10-year horizon, while severity was quantified using a "number of points" system. Due to the significant methodological deviation from the approach employed in other years (2006–2024), survey data from 2022 were excluded from subsequent analyses to ensure methodological consistency and comparability across the study period. In 2023 and 2024, the WEF introduced a measure termed "long-term severity," which, as confirmed through email correspondence with the WEF in April 2024, represents a composite of both long-term likelihood and severity. Values of likelihood and severity of risks across each year are then normalized on a 1 to 5 scale (1 being the lowest, 5 the highest), with the following caveats:

- 2006: No graphical representation of risks was provided, but the appendix included a list of risks with likelihood and severity values under four scenarios: "Short-term Base," "Short-term Worst," "Long-term Base," and "Long-term Worst." The average of the "Long-term Base" and "Long-term Worst" values was used to maintain consistency with other years referencing long-term projections.
- 2007–2010: Likelihood was expressed as a percentage, and severity was quantified in US dollars. However, the appendices included a correspondence between these metrics and scales ranging from 1 to 5, allowing both axes to be standardized on this scale.
- 2011: A unique approach was needed due to differences in the likelihood (percentage) and severity (US dollars) scales compared to previous years. First, the average likelihood and severity values from 2010 and 2012 were calculated and used as reference averages for 2011. The WebPlotDigitizer software was then employed to extract the coordinates of all points on the 2011 risk matrix using an arbitrary axis calibration. The extracted values were adjusted with a correction factor to align their averages with the reference values.
- 2013: Values for this year were directly available in the report appendix, eliminating the need for software-based extraction.
- 2012–2021: Risk values were represented on scales ranging from 1 to 5 or 1 to 7. These values were extracted using the WebPlotDigitizer software and standardized to a 1–5 scale to facilitate comparisons across years.
- 2022: This year was excluded from the study due to methodological differences, as explained previously.
- 2023–2024: For these years, only a combined measure of likelihood and severity was provided, expressed on a scale of 1 to 5. To enable comparisons with earlier years, the likelihood and severity values for each risk from 2006 to 2021 were multiplied and normalized to the same 1–5 scale. For 2024, data was directly available from the WEF website.

Table S1 | Long-term surveyed severity of risks in the 2024 Global Risks Report, as provided by the WEF or extracted from the risk matrices using the WebPlotDigitizer software.

Risk	Category	WEF (2024)	WebPlotDigitizer
Adverse outcomes of AI technologies	Technological	5.3	5.277799665
Adverse outcomes of frontier technologies	Technological	4.4	4.374618339
Asset bubble bursts	Economic	4.1	4.122426869
Biodiversity loss and ecosystem collapse	Environmental	5.7	5.734216488
Biological, chemical or nuclear hazards	Geopolitical	4.4	4.355953905
Censorship and surveillance	Technological	4.7	4.69206146
Chronic health conditions	Societal	4.5	4.467792771
Concentration of strategic resources	Economic	4.8	4.798187728
Critical change to Earth systems	Environmental	5.9	5.936718211
Cyber insecurity	Technological	5.2	5.138924456
Debt	Economic	4.6	4.57815424
Disruptions to a systemically important supply chain	Economic	4.4	4.339456318
Disruptions to critical infrastructure	Economic	4.4	4.382941003
Economic downturn	Economic	4.2	4.175514626
Erosion of human rights	Societal	4.6	4.550034473
Extreme weather events	Environmental	6	6.002708559
Goeconomic confrontation	Geopolitical	4.6	4.627302275
Illicit economic activity	Economic	4	4.003151778
Inequality or lack of economic opportunity	Societal	4.6	4.900325027
Infectious diseases	Societal	4.5	4.467054073
Inflation	Economic	3.9	3.914508027
Insufficient public infrastructure and services	Societal	4.4	4.423766374
Interstate armed conflict	Geopolitical	4.7	4.660888407
Intrastate violence	Geopolitical	4.4	4.388555107
Involuntary migration	Societal	5.2	5.140057126
Labour shortages	Economic	4.2	4.136018911
Misinformation and disinformation	Technological	5.3	5.291046981
Natural resource shortages	Environmental	5.4	5.42992219
Non-weather related natural disasters	Environmental	3.9	3.92056535
Pollution	Environmental	5	4.999507535
Societal polarization	Societal	5.2	5.138185758
Technological power concentration	Technological	4.9	4.89446469
Terrorist attacks	Geopolitical	3.8	3.76553728
Unemployment	Societal	4.2	4.193538856

C - Association between risks and shocks.

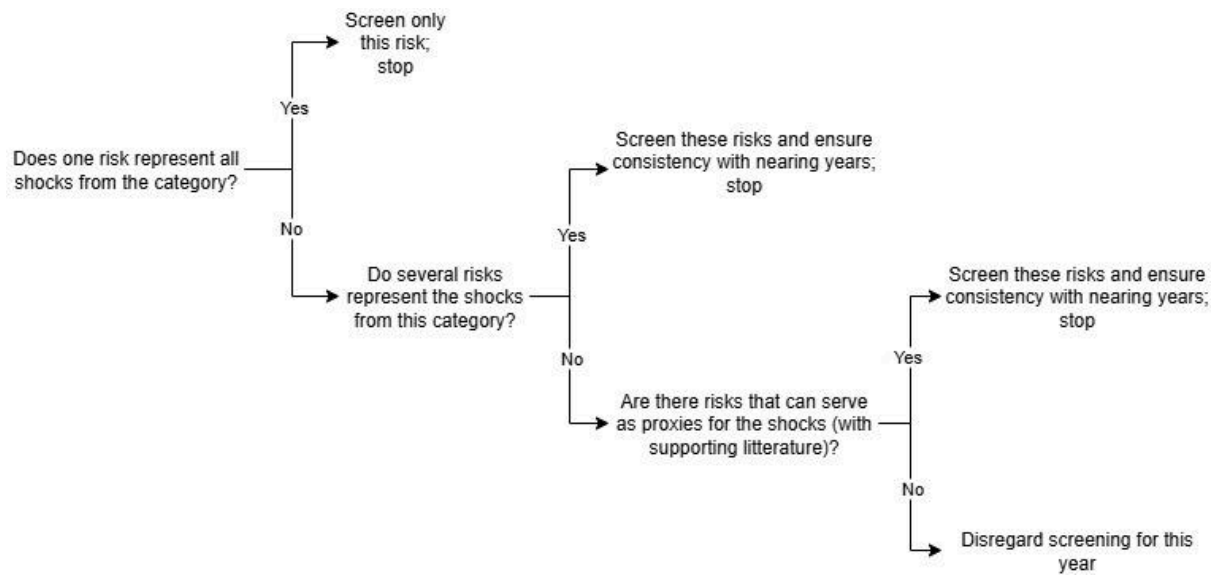


Figure S5 | Association process between risks from the Global Risks Reports and the shocks from the database of Delannoy et al. (2025b).

Table S2 | Association of risks from the Global Risks Reports against the shocks from the database of Delannoy et al. (2025b). Year range refers to the years these risks were available for extraction in the GRRs.

Risk	Shocks category	Year range
Extreme weather events from climate change	Climatic	2006–2021
Earthquake / volcanic eruptions / major geophysical disasters	Geophysical	2007-2021
Biodiversity loss / ecosystem collapse	Ecological - food	2006; 2009-2021
Food insecurity / shortages	Ecological - food	2009-2021
Loss of freshwater services	Ecological - food	2007-2015
Commodity shock (energy or food)	Ecological - food	2006-2021
Infectious disease / pandemics	Ecological - diseases	2006–2021
Asset bubbles / liquidity crises	Economic	2006–2021
Fiscal / debt crises	Economic	2006–2021
Failure / collapse of a major financial institution or currency	Economic	2011-2021
Breakdown of critical infrastructure or networks	Technological	2006-2021
Lack / failure of public infrastructures	Technological	2009-2021
Human-made environmental damage / pollution	Technological	2012-2021
Large-scale terrorist attacks	Geopolitical - terrorist attacks	2006–2021
Critical fragile / failing / collapsing states	Geopolitical - conflicts	2007-2008; 2011–2021
Interstate conflicts and civil wars	Geopolitical - conflicts	2007-2008; 2011–2021

D - Time-series simulation results.

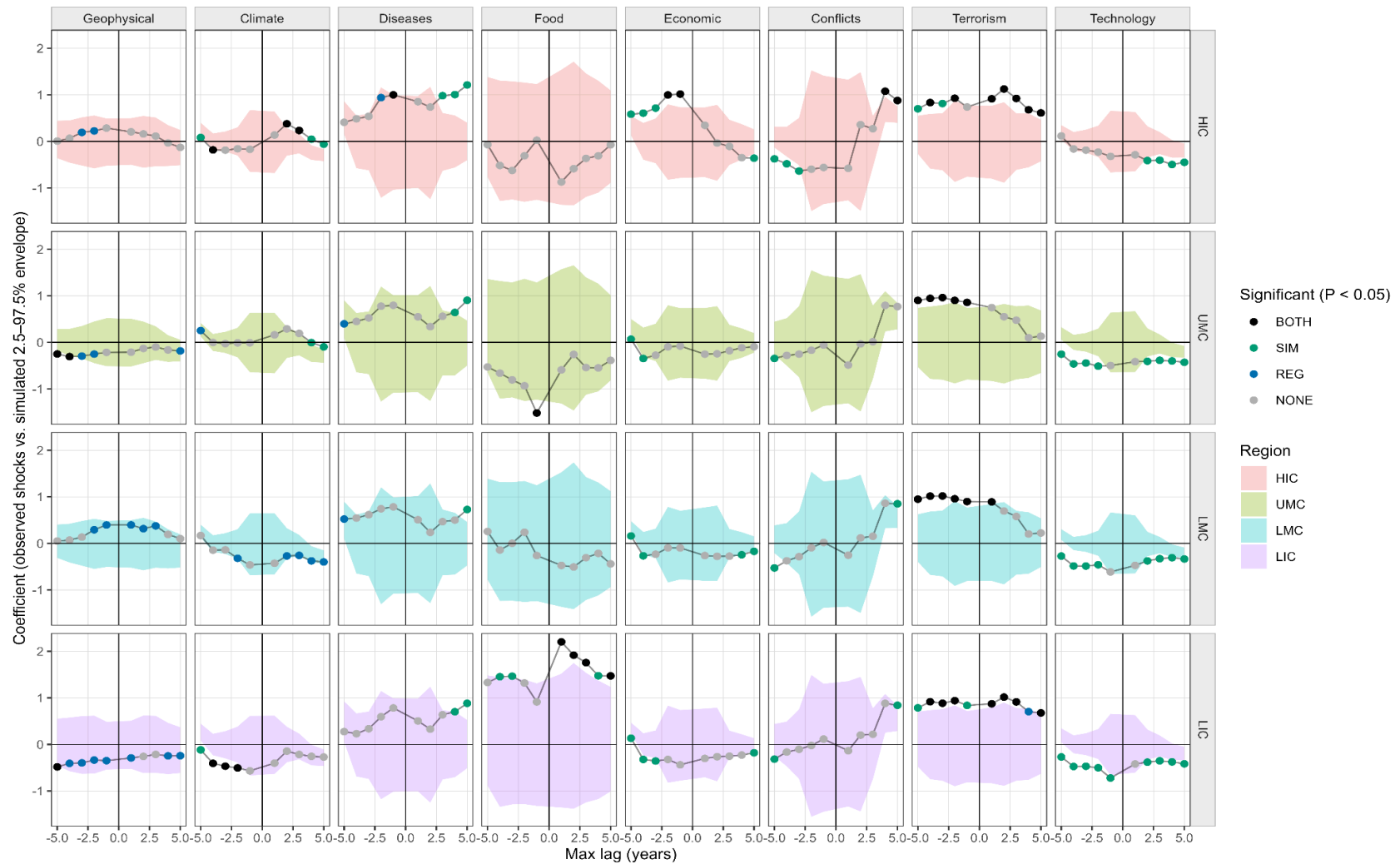


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Figure S7 | Year-level contributions to predictive capacity and anticipatory skill by shock category.

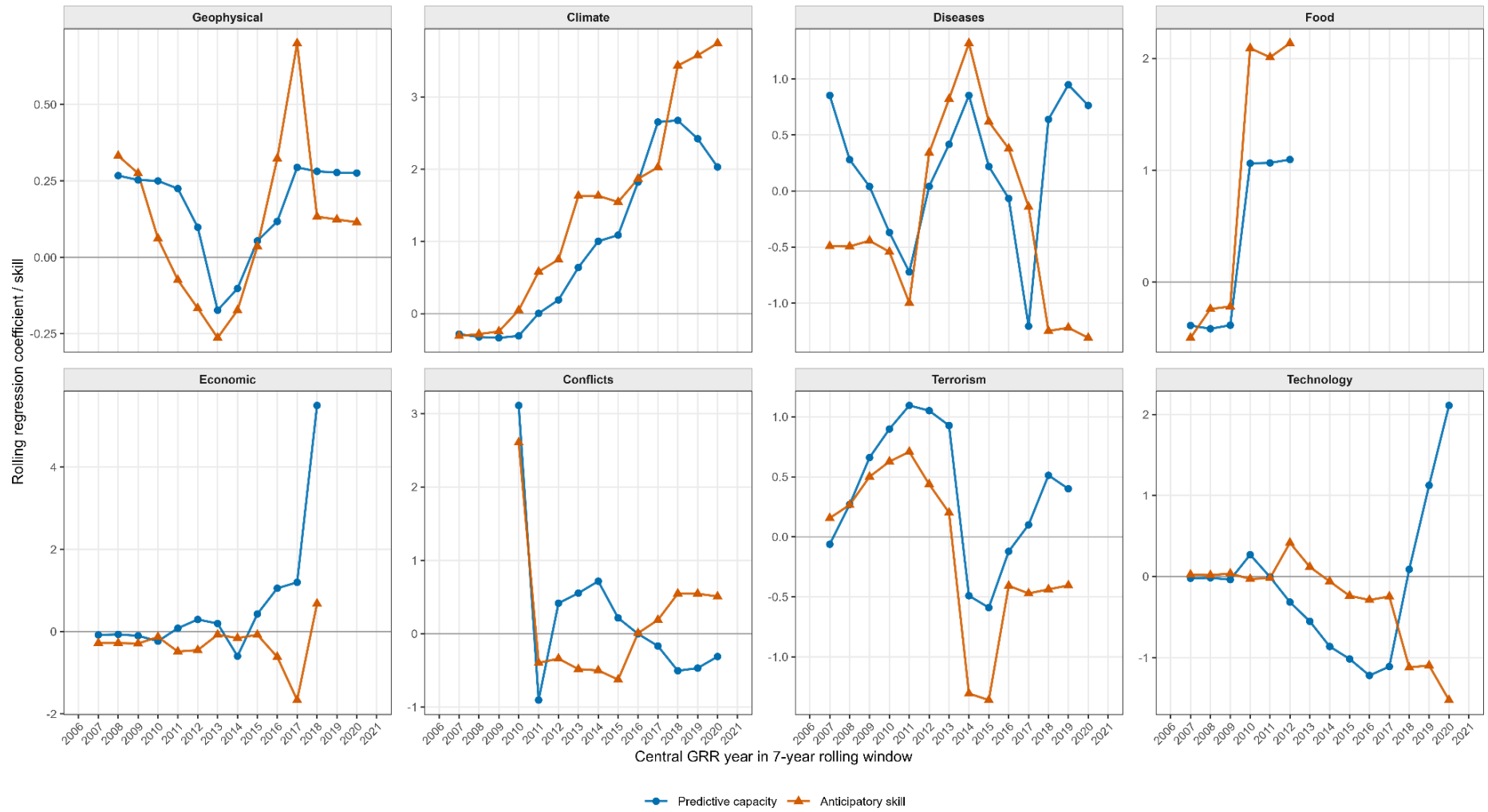


Figure S8 | Seven-year rolling estimates of predictive capacity and anticipatory skill by shock category.

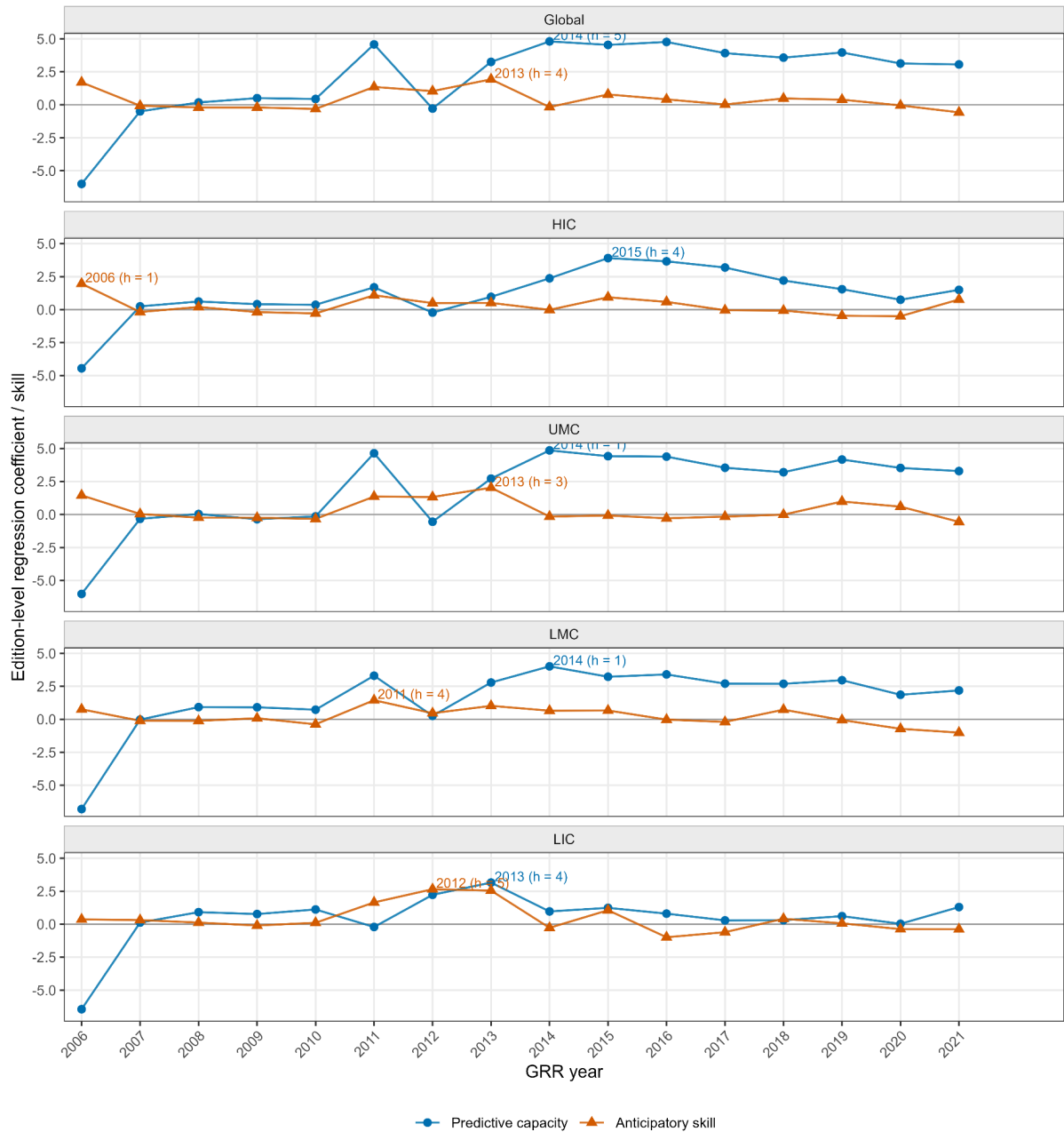


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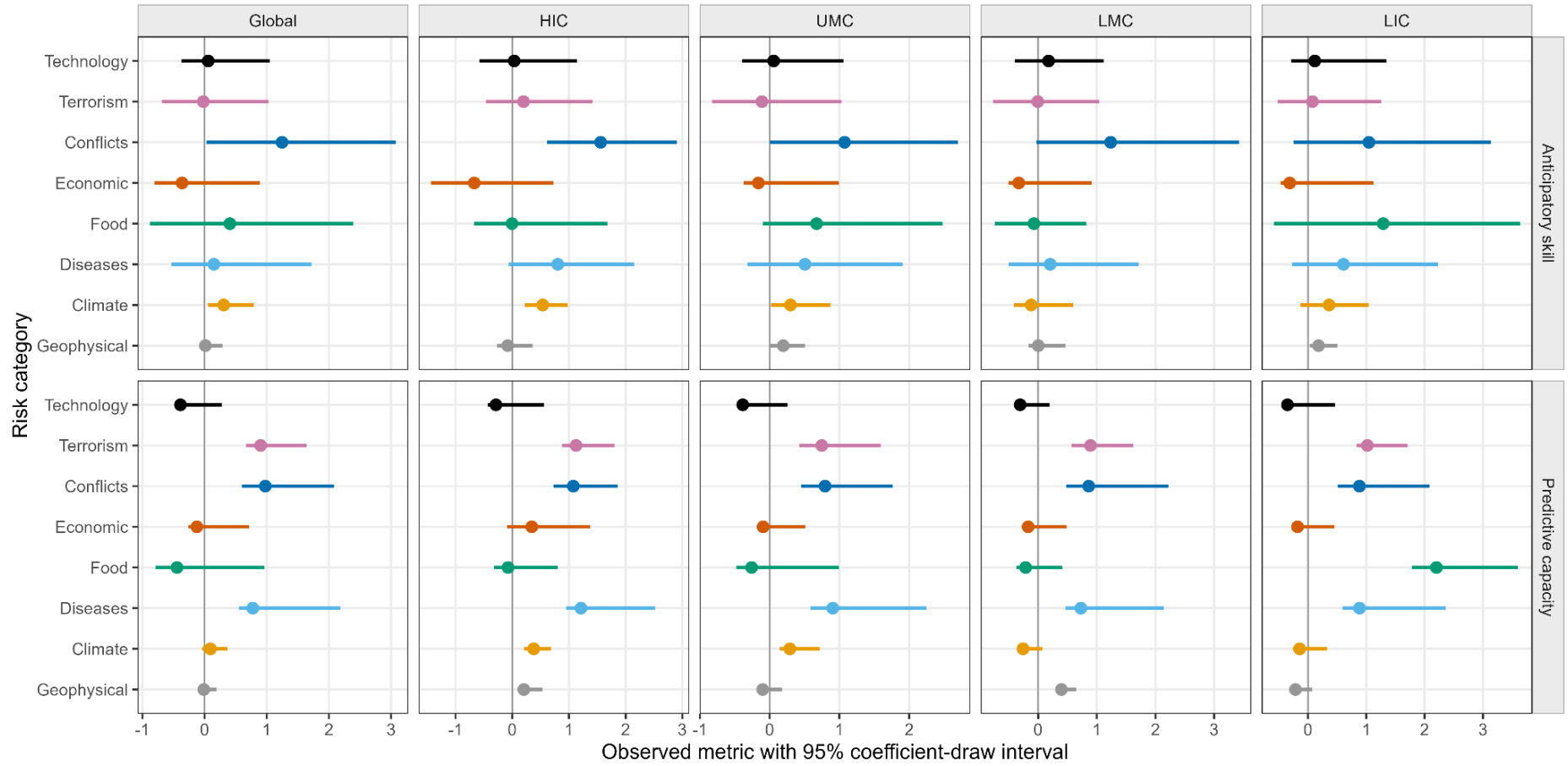


Figure S10 | Observed predictive-capacity and anticipatory-skill metrics with 95% coefficient-draw intervals.

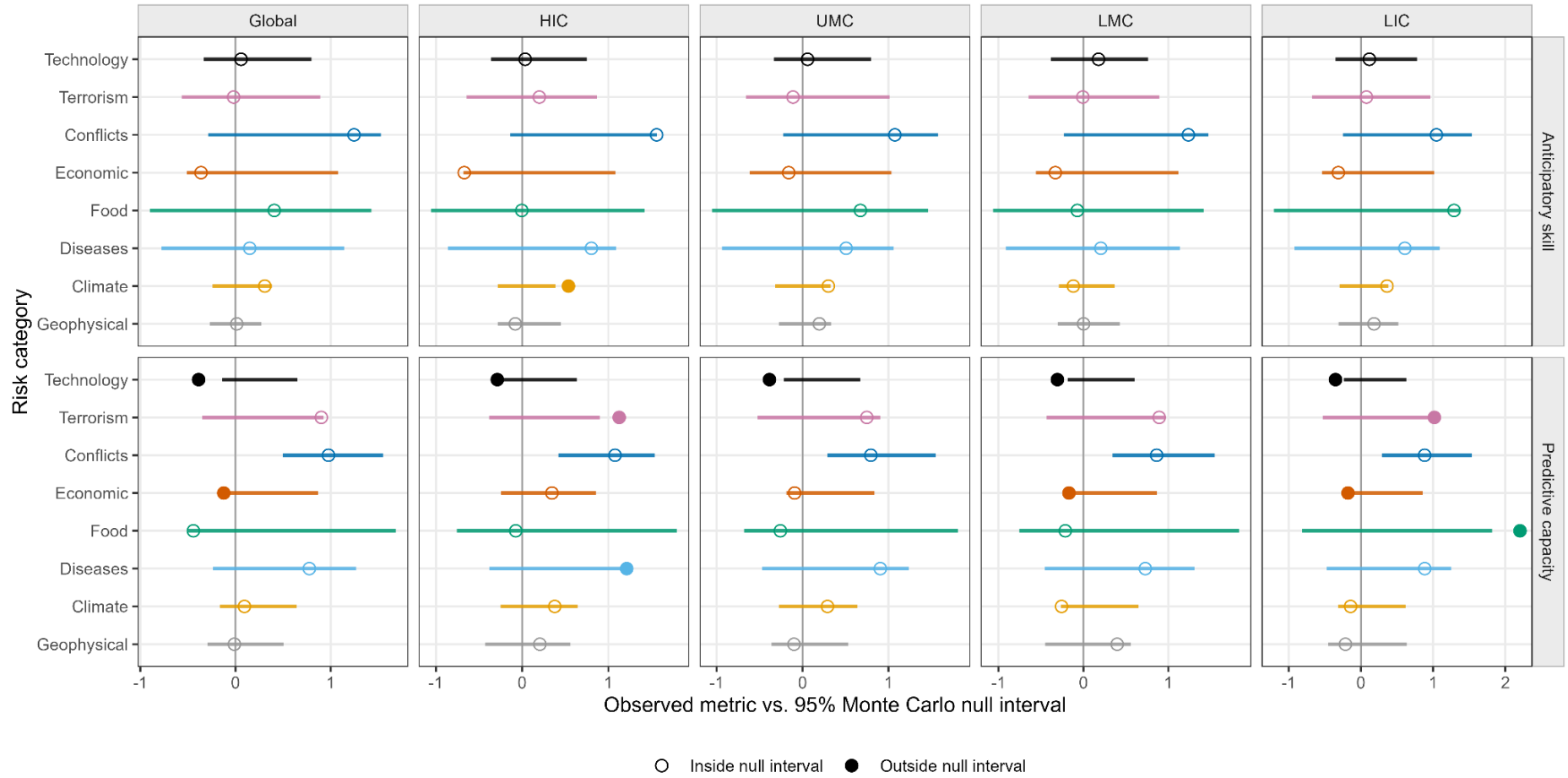


Figure S11 | Observed predictive-capacity and anticipatory-skill metrics against 95% Monte Carlo null intervals.

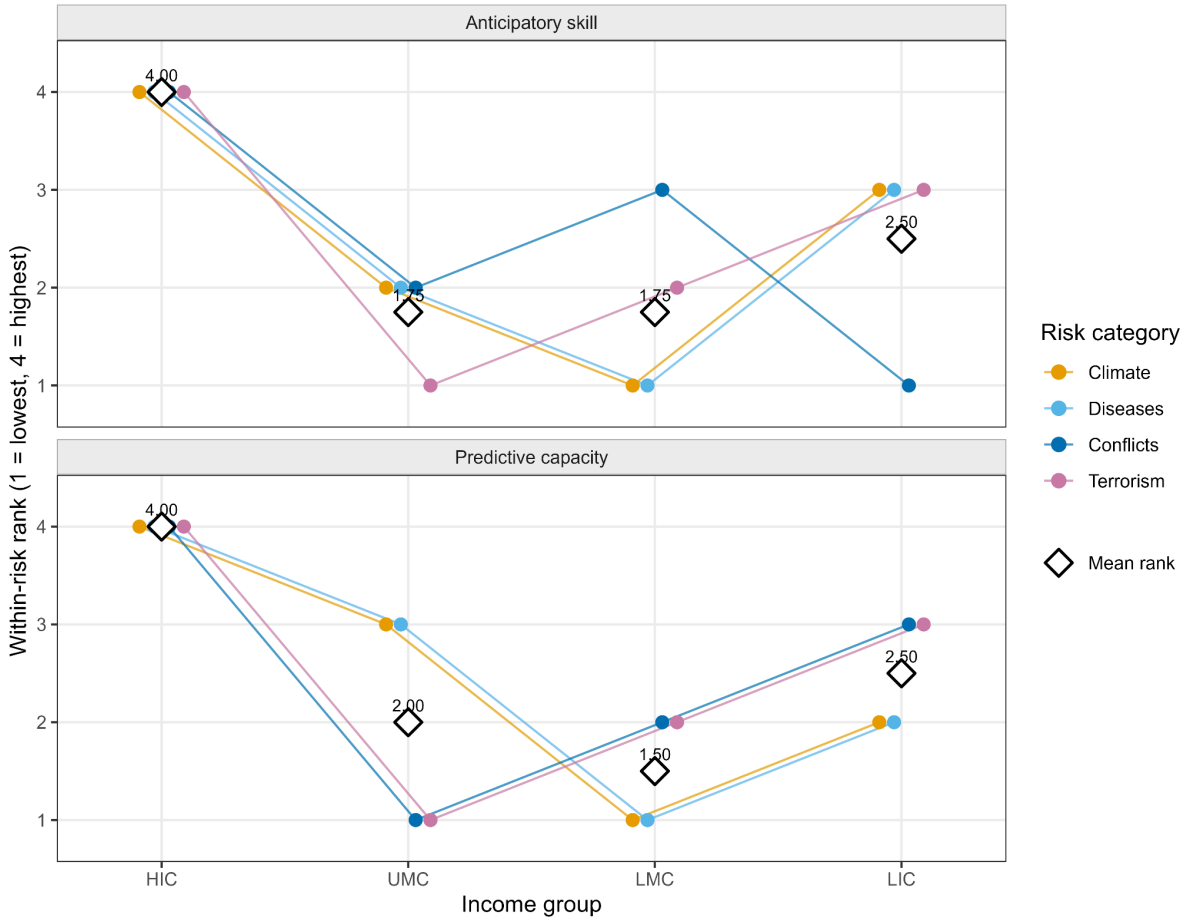


Figure S12 | Income-group ranks for risk categories with positive global predictive capacity.

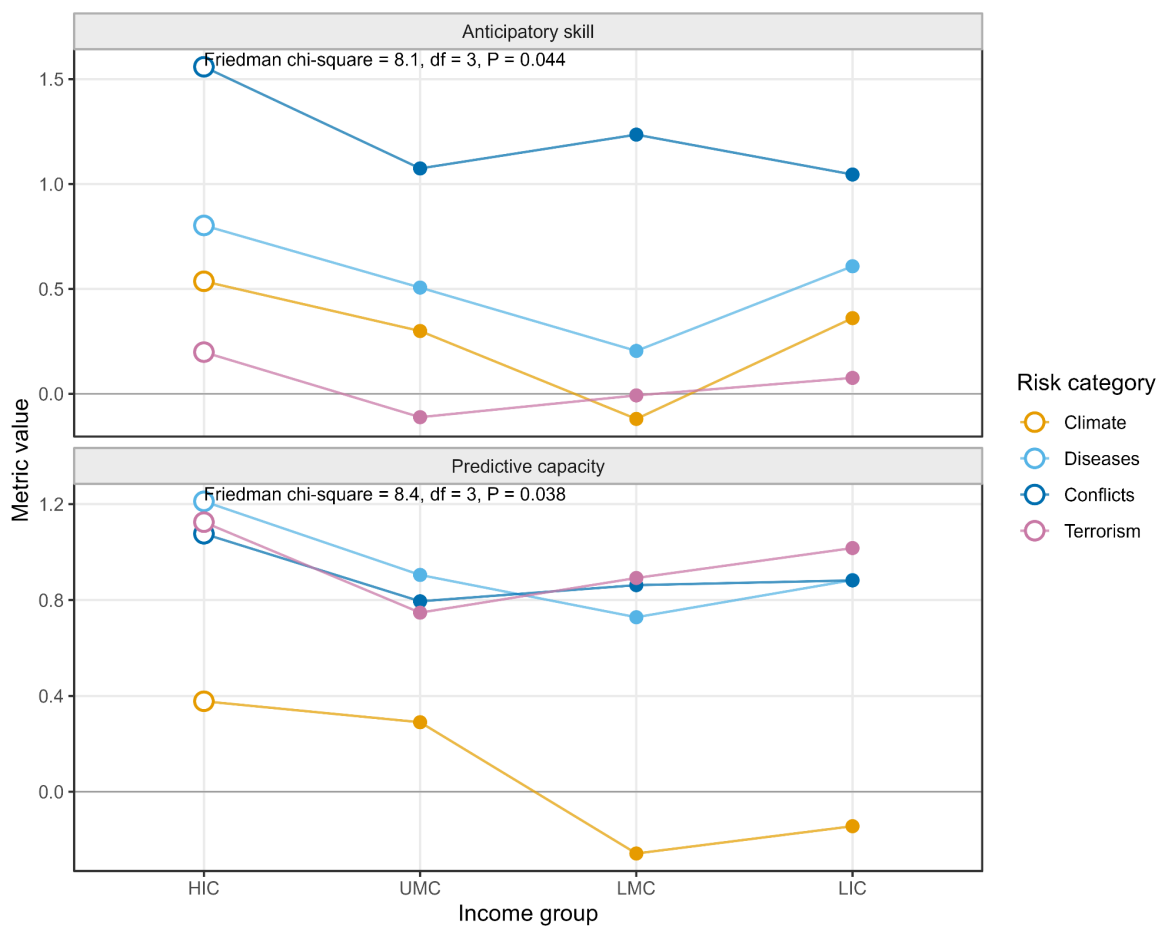
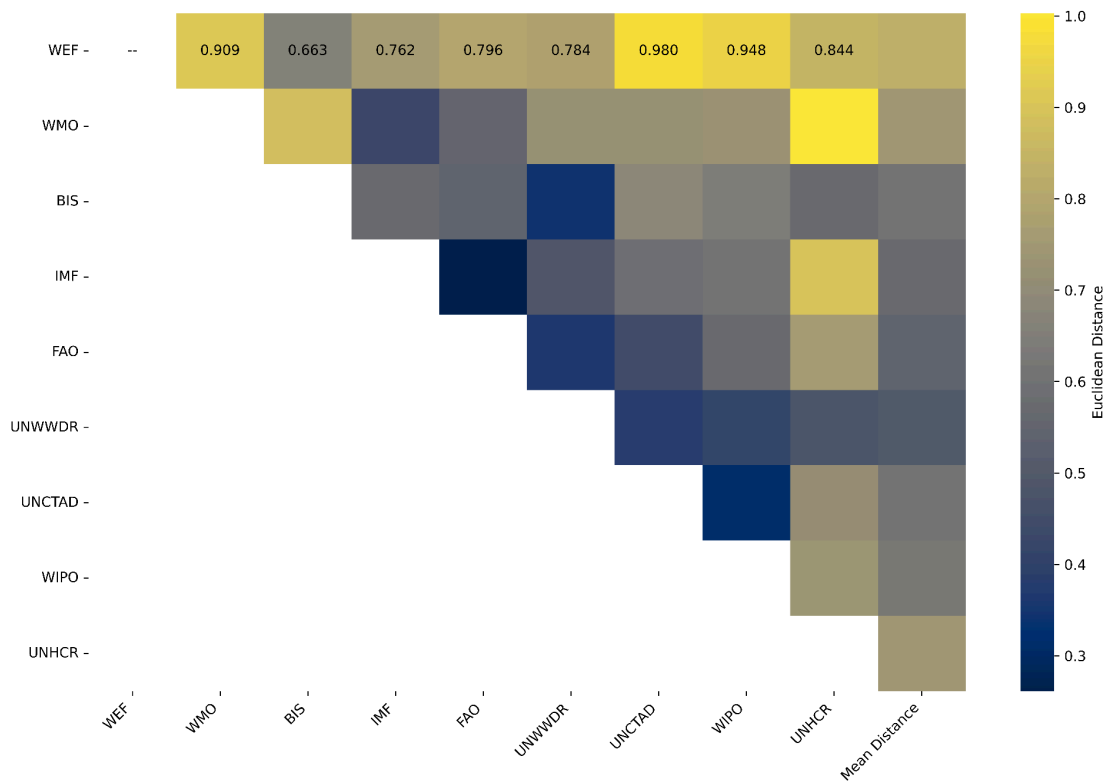


Figure S13 | Income-group differences in predictive capacity and anticipatory skill for risk categories with positive global predictive capacity.

Table S4 | List of “stop” words.

Stop words			
https	could	th	ai
www	figure	com	many
nd	next	st	rd
org	two	e	c
october	al	g	b
pdf	may	term	http
n	w	ts	h
l	r	p	section
sectio	f	n	source
ranking	bn		

**Figure S14** | Euclidean distances among reports from international organizations, assessed over six linguistic criteria.

F - Thematic analysis.**Table S5** | Sustainable Development Goals description.

Sustainable Development Goals (SDGs)	Description
1. No Poverty	End poverty in all its forms everywhere.
2. Zero Hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
3. Good Health and Well-being	Ensure healthy lives and promote well-being for all at all ages.
4. Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Gender Equality	Achieve gender equality and empower all women and girls.
6. Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all.
7. Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all.
8. Decent Work and Economic Growth	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
9. Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10. Reduced Inequalities	Reduce inequality within and among countries.
11. Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient, and sustainable.
12. Responsible Consumption and Production	Ensure sustainable consumption and production patterns.
13. Climate Action	Take urgent action to combat climate change and its impacts.
14. Life Below Water	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
15. Life on Land	Protect, restore, and promote sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
16. Peace, Justice and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
17. Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Table S6 | Anthropocene Traps description. Relying on Søgaard Jørgensen et al. (2023, 2026).

Category of trap	Anthropocene Traps (ATs)	Description
G1 - global traps	1. Simplification	Increasing specialization produces simplified sub-systems that are vulnerable to shocks
	2. Growth-for-growth	Institutional lock-ins drive pursuit of growth at the cost of well-being
	3. Overshoot	Continued material growth leads to overshoot of Earth system tipping points
	4. Division	Unstable selection for global human cooperation increases risk of international conflict
	5. Contagion	Global connectivity increases the risk of large-scale contagion, e.g. of infectious diseases
Te - technology traps	6. Infrastructure lock-in	Complex material infrastructure becomes maladaptive, e.g. owing to sunk costs
	7. Chemical pollution	Capacity to produce complex or persistent compounds that can cause long-term harm to humans and ecosystem
	8. Existential technology	Technological arms-races drive the evolution of existential technology, such as weapons of mass destruction
	9. Technological autonomy	Reliance on automation can backfire if systems become misaligned to human needs
	10. Dis- and mis-information	Digitalization can amplify spread of mis- and disinformation e.g. destabilizing democracies
Te - temporal trap	11. Short-termism	Favour of short-term over long-term benefits reinforces other traps and promotes conflict
Co - connectivity traps	12. Overconsumption	Separation of production and consumption facilitates overconsumption
	13. Biosphere disconnect	Separation of human settlements and ecosystems reduces awareness about their benefits
	14. Local social capital loss	Digitalization can lead to loss of local social capital through reduced interaction and echo chambers

Table S7 | Corporate Sustainability Spectrum description. Relying on Landrum & Ohsowski (2017).

Corporate Sustainability Spectrum (CSSs)	Description
1. Compliance	Focuses on meeting externally enforced regulations and compliance requirements with an internally firm-centric perspective.
2. Business-Centered	Prioritizes incremental improvements and business benefits, using eco-efficiency as a tool to "do less bad" while maintaining an anthropocentric view.
3. Systemic	Integrates economic, environmental, and social sustainability by fostering systemic change through collaboration and partnerships.
4. Regenerative	Seeks to repair damage caused by industrial practices by operating within planetary boundaries and prioritizing ecological science.
5. Coevolutionary	Promotes a symbiotic relationship between humans and nature, aiming for mutual flourishing without growth in production or consumption

Notes S2 | Methodological details for screening process.

We imported the .txt files of each GRR in the Orange Data Mining software. We obtained the list of the most frequently used words in each report along with their associated frequencies (or weights), enabling us to compare the most used words across years. We then perform a cleaning process to remove words without relevance or meaning on their own. For words appearing closely in the ranking due to their frequent co-occurrence we opted to retain only one word. For example, in the 2018 report, the terms "fake" and "news" were assigned weights of 34 and 66, respectively, we excluded the word "news" from classification, retaining only "fake" to ensure more accurate weighting and mitigate potential bias and prevent overemphasis on the "fake news" concept. We finally carried out a consistency check across all reports through a comparative analysis and elaboration of a justification list. It is worth noting that the years 2006, 2009, 2012, and 2015 were initially poorly processed by the software. We opted to copy the text from these PDFs, paste it into a Word document, and then reprocess it using the Orange Data Mining software. The results were significantly more conclusive and relevant after this second treatment.

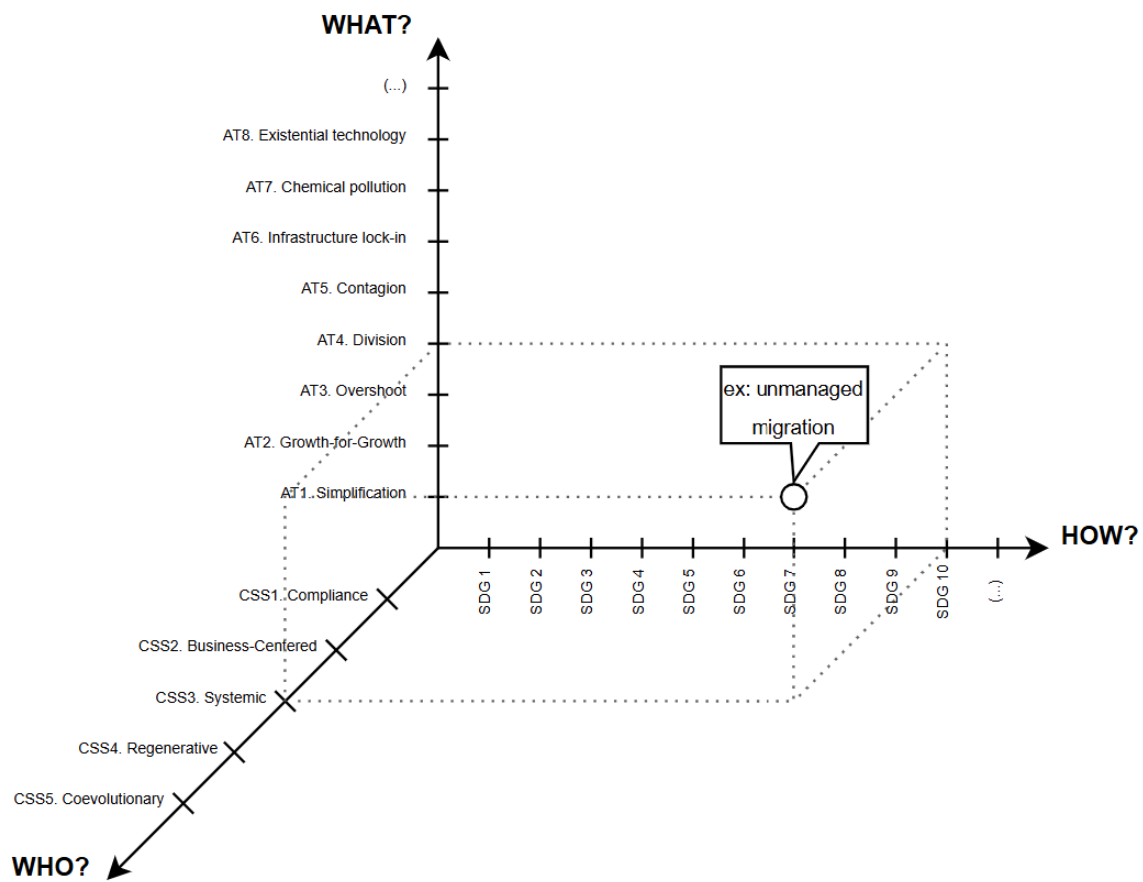


Figure S15 | Heuristic cube of thematic analysis. Source: own elaboration, inspired by Merino-Saum et al. (2018).

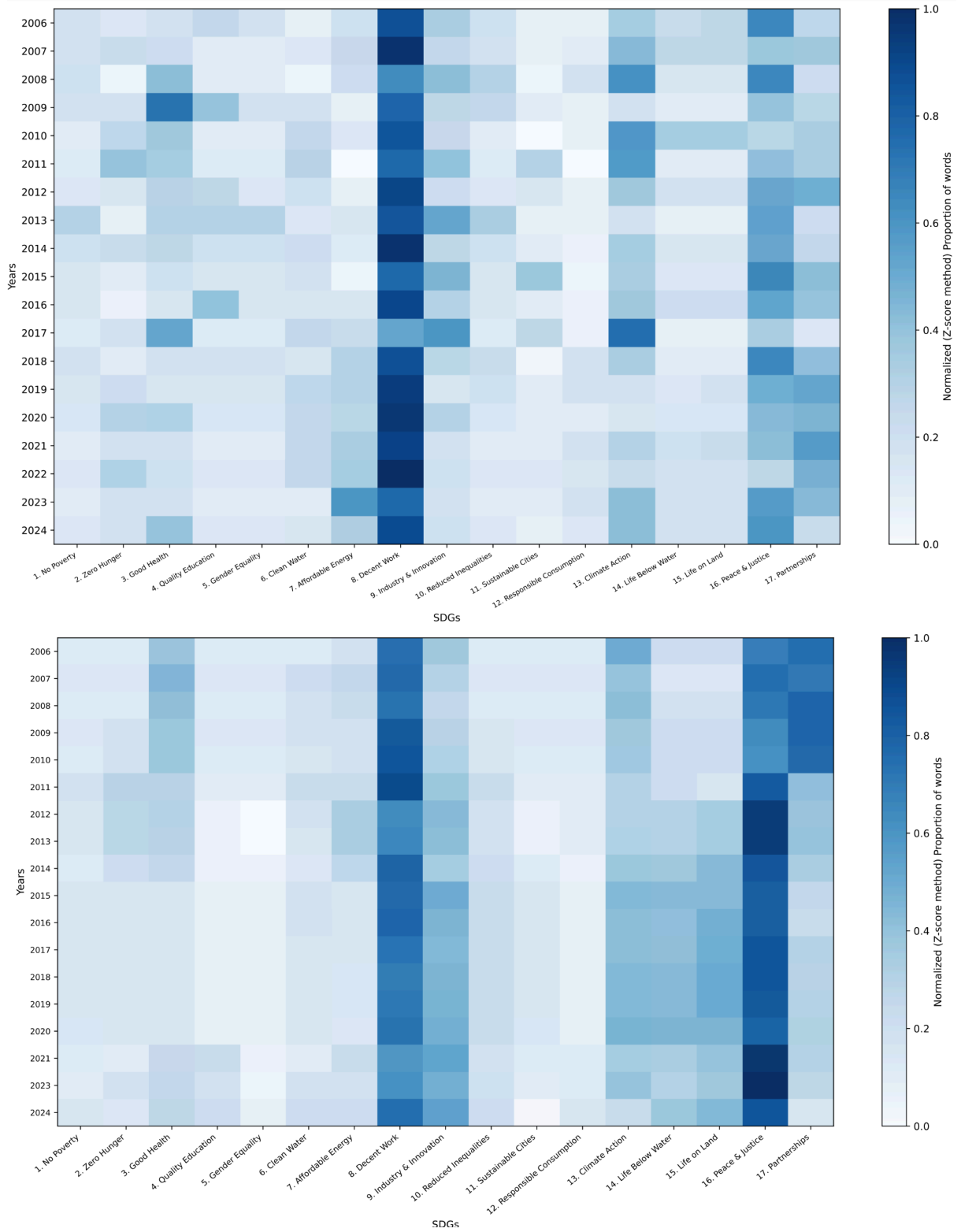


Figure S16 | Normalized proportion of screens screened against Sustainable Development Goals (SDGs) for words (top) and surveys (bottom).

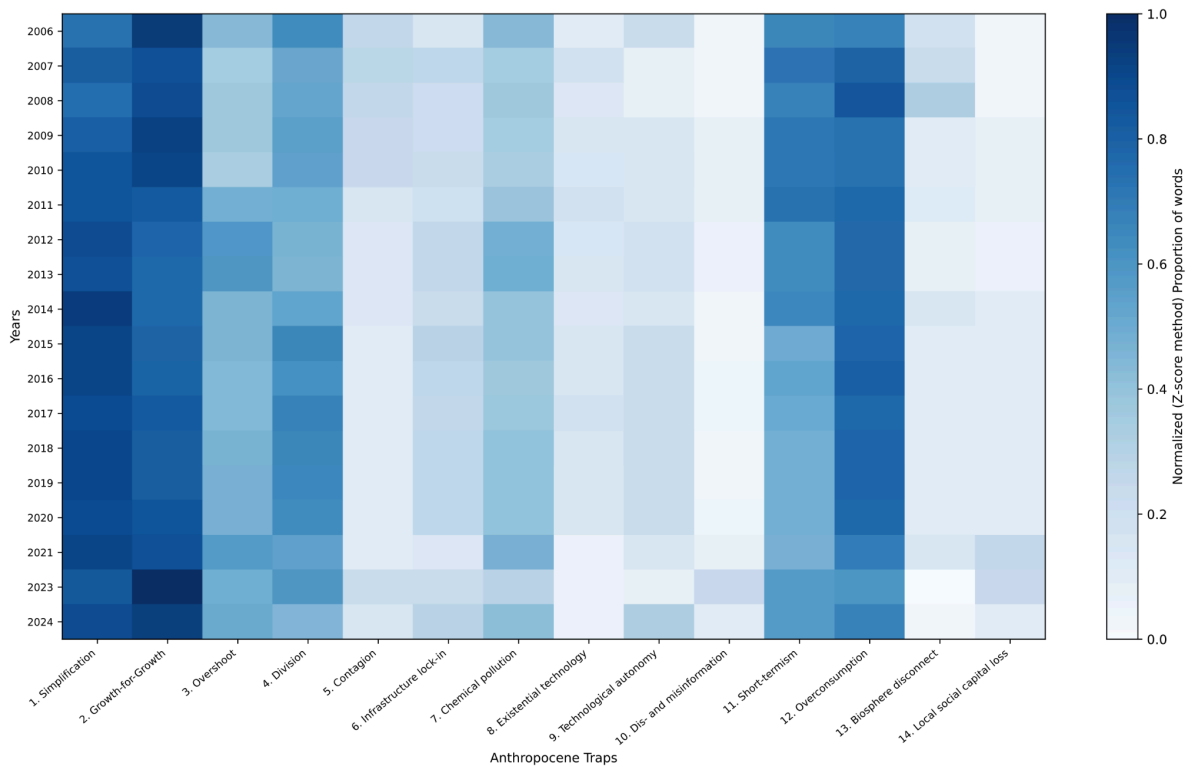
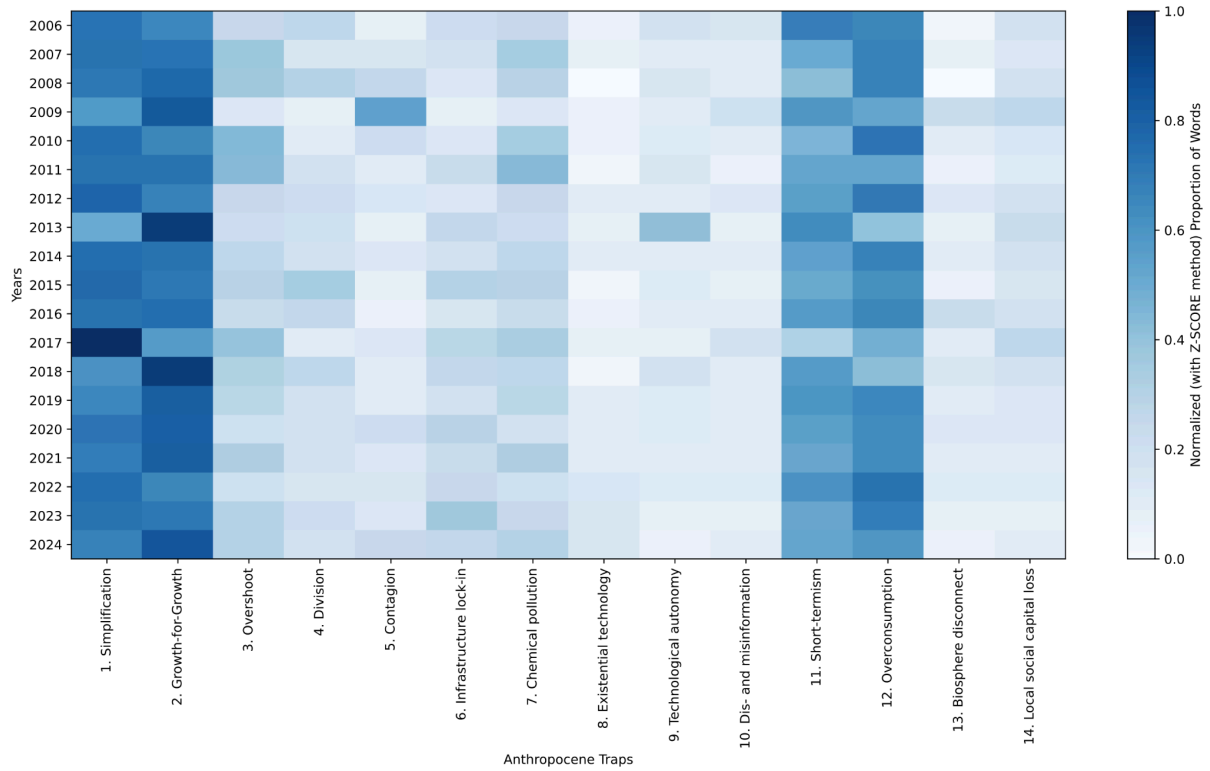


Figure S17 | Normalized proportion of words systematically screened against Anthropocene Traps for words (top) and surveys (bottom).

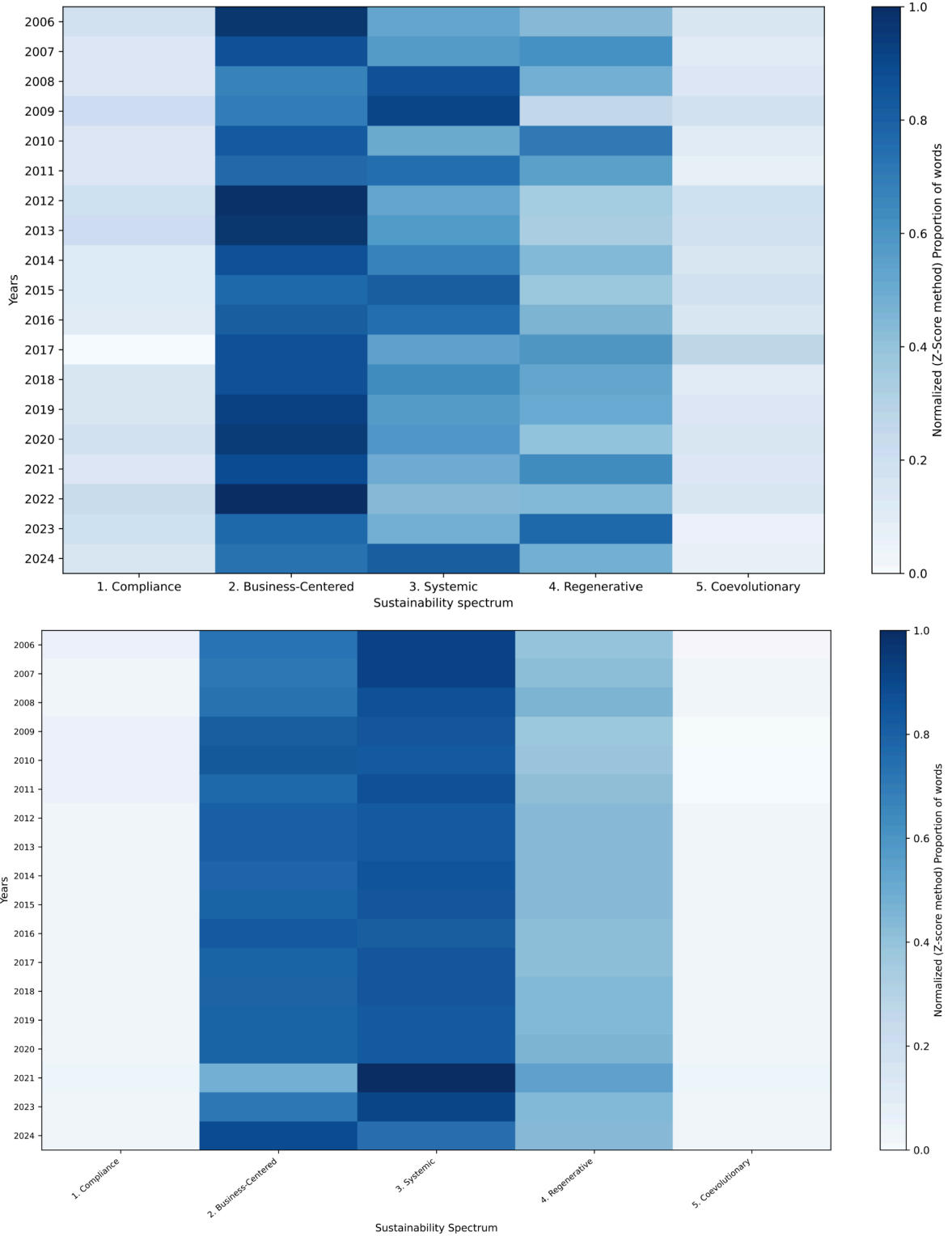


Figure S18 | Normalized proportion of words systematically screened against Corporate Sustainability Spectrums for words (top) and surveys (bottom).

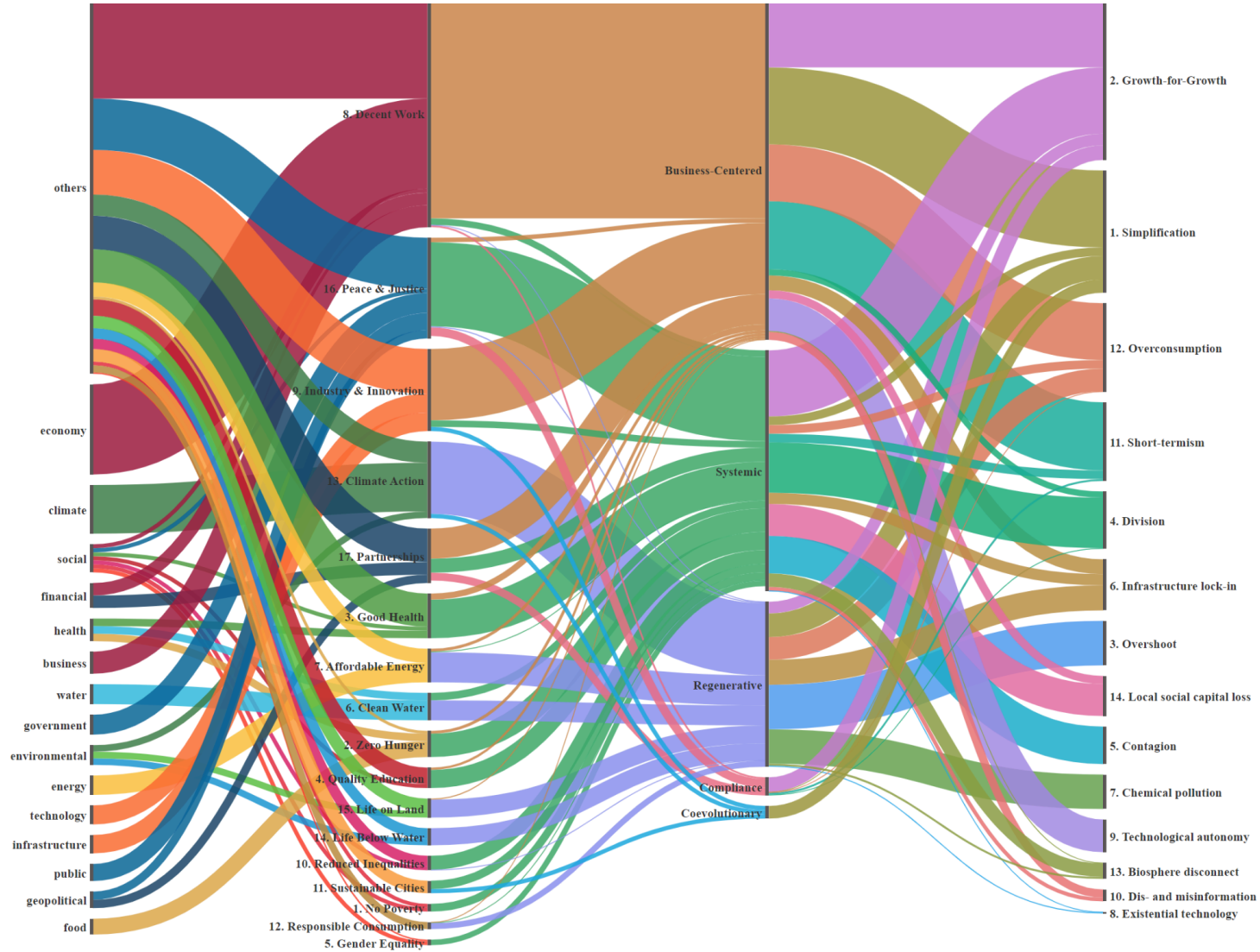


Figure S19 | Sankey diagram representing the interconnections between (left) words of the GRRs, and screens against (middle left) Sustainable Development Goals, (middle right) Corporate Sustainability Spectrums, (right) Anthropocene Traps.

G - Statistical significance tests.

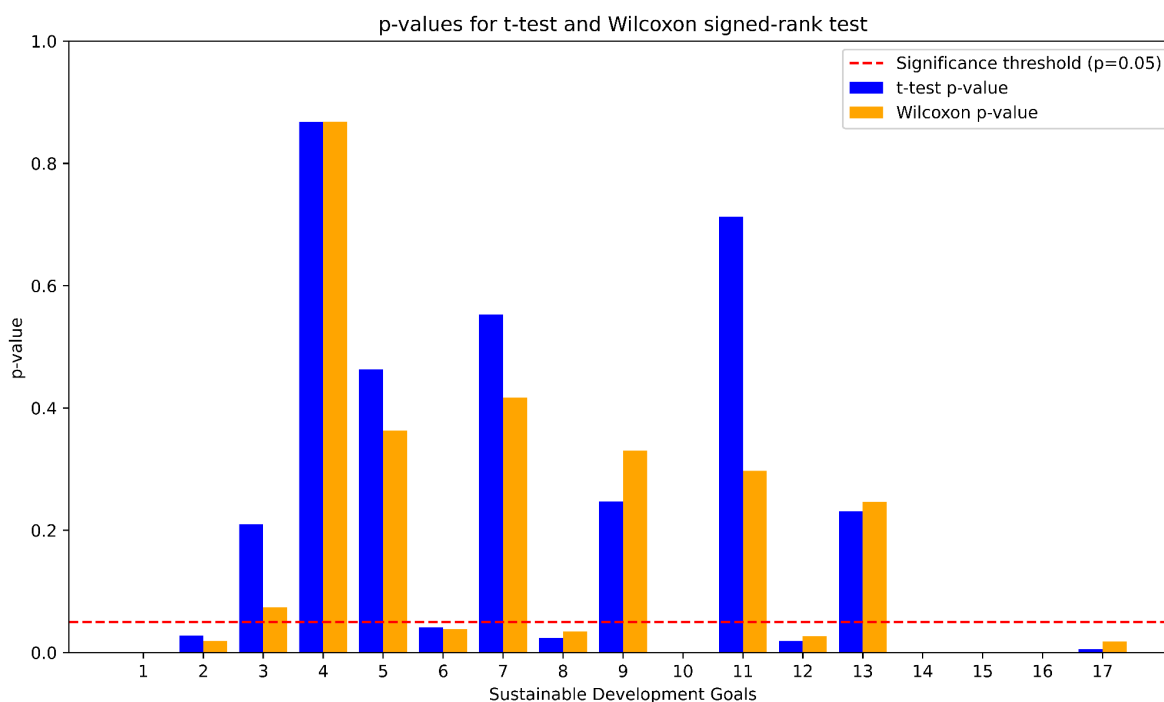


Figure S20 | P-values of t-test and Wilcoxon signed-rank test between survey and text-Based screens against Sustainable Development Goals.

Table S8 | P-values of t-test and Wilcoxon signed-rank test between survey and text-based screens against Sustainable Development Goals. Differences between survey and text-based screens are considered statistically significant if p-values are below 0.05.

Sustainable Development Goals	t-pvalue	Wilcoxon-pvalue	Interpretation
1	2.558297e-08	0.000008	Significant in both tests
2	2.796694e-02	0.018556	Significant in both tests
3	2.097044e-01	0.073685	No significant difference
4	8.681325e-01	0.868333	No significant difference
5	4.626984e-01	0.363101	No significant difference
6	4.148293e-02	0.038490	Significant in both tests
7	5.525635e-01	0.417114	No significant difference
8	2.389084e-02	0.034233	Significant in both tests
9	2.468350e-01	0.330536	No significant difference
10	1.789556e-05	0.000252	Significant in both tests
11	7.128115e-01	0.296995	No significant difference
12	1.855754e-02	0.026848	Significant in both tests
13	2.312315e-01	0.246208	No significant difference
14	9.733674e-07	0.000023	Significant in both tests
15	2.141602e-06	0.000023	Significant in both tests

16	5.263195e-07	0.000351	Significant in both tests
17	5.407244e-03	0.017857	Significant in both tests

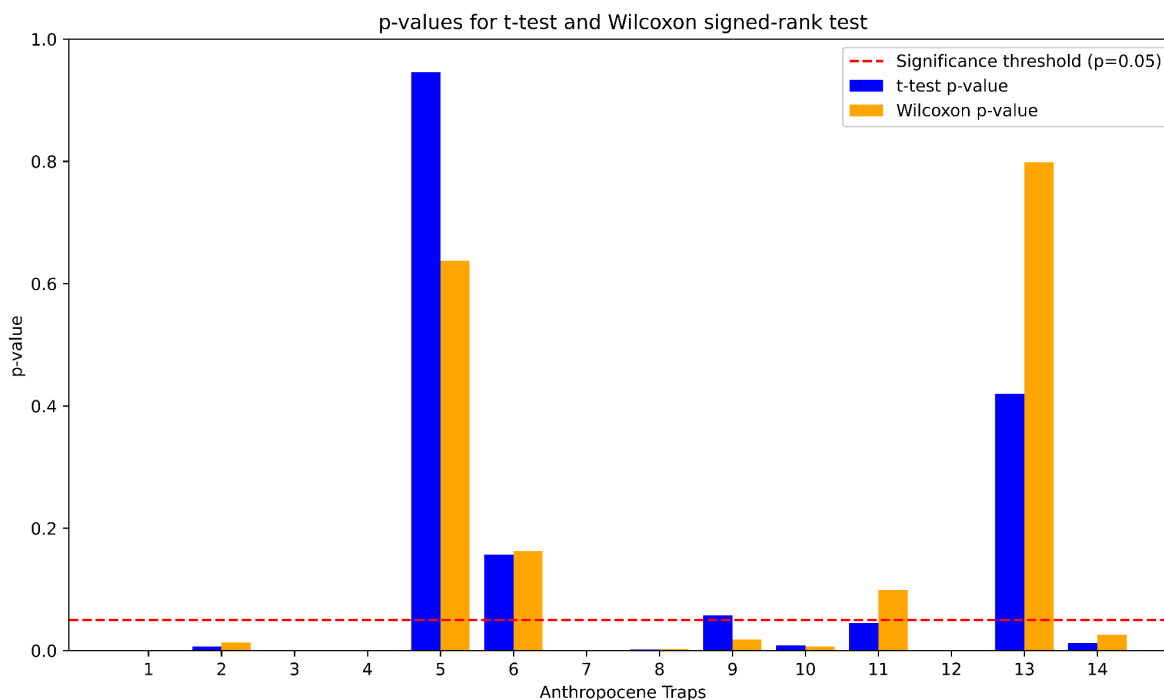


Figure S21 | P-values of t-test and Wilcoxon signed-rank test between survey and text-Based screens against Anthropocene Traps.

Table S9 | P-values of t-test and Wilcoxon signed-rank test between survey and text-based screens against Anthropocene Traps. Differences between survey and text-based screens are considered statistically significant if p-values are below 0.05.

Anthropocene Traps	t-pvalue	Wilcoxon-pvalue	Interpretation
1	2.047749e-05	0.000145	Significant in both tests
2	6.435382e-03	0.012921	Significant in both tests
3	4.063399e-05	0.000706	Significant in both tests
4	3.807430e-12	0.000008	Significant in both tests
5	9.462313e-01	0.637518	No significant difference
6	1.564924e-01	0.162336	No significant difference
7	3.437256e-05	0.000650	Significant in both tests
8	1.751242e-03	0.002335	Significant in both tests
9	5.755169e-02	0.018234	Significant in Wilcoxon only
10	8.455982e-03	0.006393	Significant in both tests
11	4.517324e-02	0.098740	Significant in t-test only
12	1.131957e-04	0.000145	Significant in both tests
13	4.198936e-01	0.798706	No significant difference

14	1.211354e-02	0.025775	Significant in both tests
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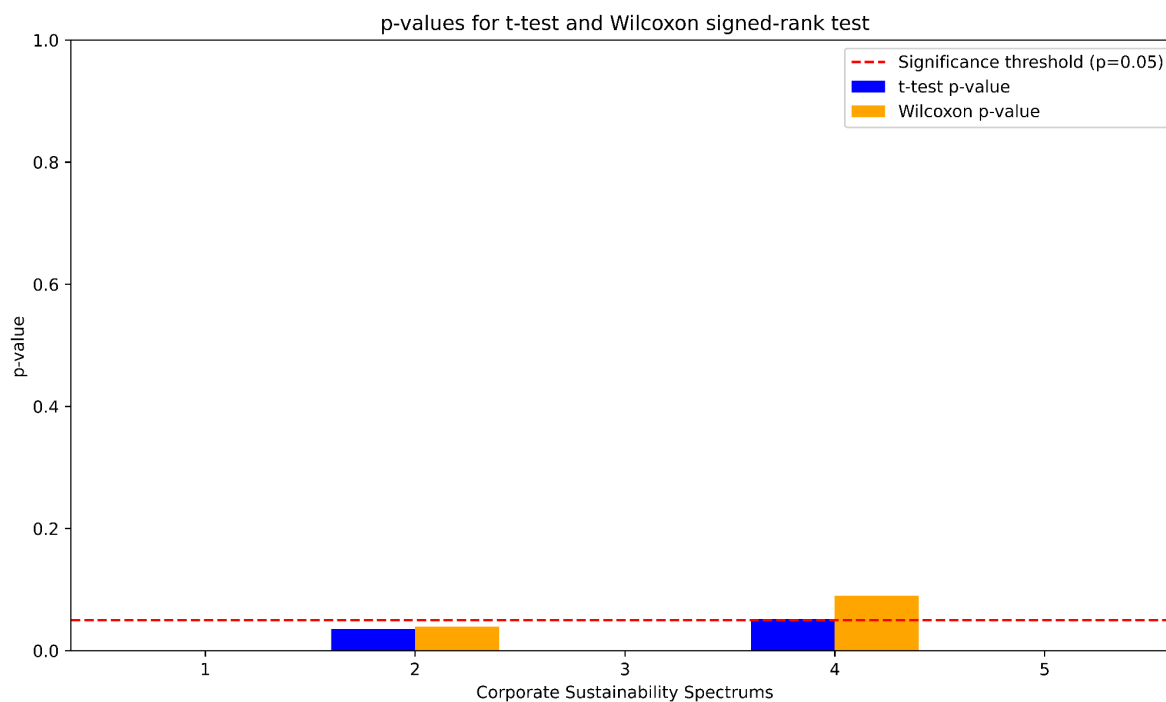


Figure S22 | P-values of t-test and Wilcoxon signed-rank test between survey and text-Based screens against Corporate Sustainability Spectrums.

Table S10 | P-values of t-test and Wilcoxon signed-rank test between survey and text-based screens against Corporate Sustainability Spectrums. Differences between survey and text-based screens are considered statistically significant if p-values are below 0.05.

Corporate Sustainability Spectrums	t-pvalue	Wilcoxon-pvalue	Interpretation
1	2.830489e-08	0.000015	Significant in both tests
2	3.557458e-02	0.039447	Significant in both tests
3	5.747100e-05	0.000252	Significant in both tests
4	5.203275e-02	0.089767	No significant difference
5	2.315405e-08	0.000008	Significant in both tests

H - Evolution of the screening proportions per year.**Table S11** | Evolution of the difference (absolute values of normalized screenings) between the surveys and the text, for the Sustainable Development Goals.

SDG	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	2024
1	0,04	0,05	0,04	0,05	0,08	0,15	0,09	0,04	0,03	0,09	0,08	0,11	0,06	0,07	0,06	0,06	0,04	0,07
2	0,04	0,05	0,09	0,08	0,00	0,04	0,12	0,20	0,00	0,07	0,11	0,08	0,08	0,06	0,06	0,02	0,09	0,03
3	0,30	0,33	0,02	0,31	0,16	0,12	0,10	0,17	0,13	0,04	0,08	0,38	0,06	0,07	0,07	0,12	0,08	0,05
4	0,02	0,09	0,10	0,22	0,08	0,08	0,15	0,07	0,05	0,01	0,30	0,04	0,01	0,00	0,01	0,17	0,11	0,14
5	0,04	0,09	0,10	0,05	0,08	0,08	0,07	0,12	0,05	0,01	0,01	0,05	0,01	0,00	0,01	0,01	0,03	0,00
6	0,06	0,08	0,15	0,06	0,01	0,02	0,00	0,02	0,07	0,05	0,01	0,03	0,02	0,12	0,03	0,13	0,11	0,12
7	0,02	0,05	0,08	0,13	0,06	0,22	0,27	0,17	0,13	0,12	0,02	0,03	0,08	0,13	0,13	0,08	0,37	0,03
8	0,13	0,19	0,04	0,07	0,03	0,28	0,31	0,19	0,18	0,01	0,10	0,21	0,13	0,22	0,23	0,35	0,17	0,09
9	0,00	0,02	0,15	0,01	0,03	0,16	0,25	0,25	0,06	0,00	0,14	0,07	0,13	0,36	0,20	0,35	0,39	0,37
10	0,00	0,05	0,09	0,01	0,10	0,21	0,10	0,00	0,12	0,18	0,18	0,20	0,15	0,08	0,15	0,13	0,13	0,14
11	0,06	0,07	0,09	0,06	0,09	0,19	0,04	0,03	0,03	0,26	0,07	0,00	0,10	0,08	0,07	0,06	0,04	0,05
12	0,06	0,03	0,04	0,07	0,07	0,10	0,05	0,03	0,02	0,03	0,03	0,04	0,07	0,06	0,00	0,00	0,02	0,06
13	0,22	0,01	0,06	0,20	0,18	0,27	0,04	0,12	0,08	0,17	0,16	0,26	0,12	0,30	0,32	0,10	0,05	0,17
14	0,07	0,02	0,12	0,14	0,00	0,15	0,19	0,22	0,27	0,36	0,29	0,36	0,35	0,36	0,36	0,24	0,19	0,28
15	0,05	0,02	0,12	0,14	0,00	0,10	0,24	0,27	0,33	0,36	0,37	0,44	0,42	0,39	0,36	0,25	0,26	0,34
16	0,10	0,43	0,12	0,34	0,43	0,40	0,55	0,60	0,44	0,27	0,34	0,55	0,24	0,39	0,45	0,61	0,49	0,29
17	0,53	0,44	0,62	0,58	0,52	0,18	0,02	0,23	0,15	0,01	0,02	0,19	0,01	0,06	0,01	0,06	0,00	0,02

Table S12 | Evolution of the difference (absolute values of normalized screenings) between the surveys and the text, for the Anthropocene traps.

ATs	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	2024
1	0,01	0,08	0,05	0,23	0,11	0,11	0,10	0,37	0,18	0,14	0,18	0,11	0,29	0,25	0,17	0,23	0,11	0,22
2	0,30	0,14	0,11	0,10	0,25	0,09	0,10	0,17	0,03	0,08	0,04	0,26	0,14	0,01	0,06	0,06	0,29	0,09
3	0,19	0,03	0,00	0,24	0,10	0,04	0,33	0,38	0,19	0,17	0,21	0,05	0,15	0,19	0,27	0,25	0,19	0,21
4	0,36	0,37	0,22	0,47	0,44	0,31	0,25	0,26	0,34	0,31	0,37	0,56	0,40	0,46	0,46	0,35	0,38	0,27
5	0,18	0,14	0,00	0,30	0,04	0,05	0,00	0,05	0,00	0,03	0,03	0,04	0,00	0,01	0,11	0,04	0,11	0,09
6	0,06	0,09	0,08	0,12	0,11	0,03	0,13	0,00	0,07	0,02	0,10	0,02	0,02	0,09	0,02	0,09	0,13	0,04
7	0,19	0,00	0,08	0,22	0,02	0,05	0,24	0,28	0,13	0,10	0,14	0,04	0,13	0,12	0,23	0,15	0,05	0,12
8	0,04	0,10	0,13	0,09	0,09	0,16	0,04	0,07	0,05	0,13	0,10	0,09	0,13	0,04	0,04	0,04	0,09	0,08
9	0,06	0,03	0,07	0,05	0,03	0,00	0,08	0,24	0,04	0,11	0,11	0,15	0,05	0,11	0,10	0,06	0,01	0,27
10	0,13	0,08	0,08	0,11	0,02	0,01	0,08	0,02	0,08	0,04	0,07	0,14	0,05	0,07	0,06	0,01	0,17	0,01
11	0,02	0,22	0,26	0,12	0,25	0,21	0,08	0,01	0,11	0,01	0,03	0,19	0,09	0,11	0,08	0,04	0,05	0,04
12	0,02	0,12	0,17	0,21	0,01	0,24	0,06	0,36	0,10	0,16	0,14	0,29	0,36	0,13	0,13	0,05	0,09	0,08
13	0,16	0,16	0,32	0,11	0,01	0,06	0,06	0,01	0,07	0,03	0,12	0,01	0,04	0,00	0,02	0,06	0,07	0,03
14	0,16	0,11	0,14	0,19	0,05	0,05	0,12	0,16	0,10	0,05	0,07	0,17	0,07	0,04	0,03	0,16	0,17	0,01

Table S13 | Evolution of the difference (absolute values of normalized screenings) between the surveys and the text, for the Corporate Sustainability Spectrums.

CSS	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	2024
1	0,13	0,10	0,11	0,15	0,07	0,08	0,18	0,20	0,09	0,10	0,08	0,02	0,14	0,14	0,17	0,09	0,18	0,14
2	0,25	0,15	0,06	0,13	0,01	0,01	0,18	0,16	0,10	0,02	0,01	0,07	0,09	0,13	0,15	0,41	0,06	0,16
3	0,39	0,35	0,01	0,07	0,32	0,12	0,30	0,25	0,18	0,02	0,07	0,30	0,21	0,27	0,24	0,50	0,43	0,08
4	0,04	0,19	0,02	0,12	0,32	0,14	0,07	0,09	0,01	0,05	0,04	0,16	0,07	0,06	0,05	0,08	0,33	0,05
5	0,15	0,08	0,11	0,19	0,10	0,09	0,18	0,15	0,14	0,15	0,13	0,25	0,08	0,11	0,13	0,09	0,02	0,06

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