



## Integrating political economy and financial markets in qualitative scenario analysis to elicit EU decarbonization pathways

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### ABSTRACT

Limiting global warming in line with the Paris Agreement requires net-zero emissions by mid-century. To address uncertainties in this transition, prior research has developed low-carbon scenarios. We contribute by eliciting expert judgement through online surveys with 21 experts and applying the Cross Impact Balances method to construct exploratory qualitative scenarios for the European Union. These scenarios complement quantitative approaches and reflect interactions among financial markets, technological innovation, political economy, and climate policy variables. We identify two internally consistent scenarios: one aligned with mitigation goals and one diverging. The mitigation scenario leads to 1.5 °C warming and features high and stable CO<sub>2</sub> prices, a green mandate from the European Central Bank, high-quality climate risk data, accelerated economic development, and reduced inequality, despite public resistance and corporate lobbying by high-carbon sectors. Within the expert-based scenario analysis, results indicate that green financial policies are not essential for shifting market expectations towards the low-carbon transition.

### 1. Introduction

To limit global warming in line with the Paris Agreement, achieving net-zero emissions by mid-century is crucial. The European Union (EU) aims to become the first climate-neutral economy by 2050 (European Commission, 2019), a critical step towards meeting the temperature goals of the Paris Agreement. However, achieving these objectives involves significant uncertainties. Regulatory measures such as green financial policies, carbon taxes, and command and control regulations are proposed, debated, and partially implemented (Nachtigall et al., 2024; Stechemesser et al., 2024). These policies may significantly impact both the real economy and financial markets (Fliegel et al., 2025; Monasterolo, 2020), may lead to stranded assets (Sen and Von Schickfus, 2020; von Dulong et al., 2023), and often face resistance from political lobby groups (Meng and Rode, 2019; Hagen and Schopf, 2024) and the public (Douenne and Fabre, 2022; Levi, 2021; de Oca Leon et al., 2024), making implementation politically challenging (Aklin and

Mildenberger, 2020). Distributional issues, lobbying efforts, and public opposition often render theoretically optimal policies, such as high CO<sub>2</sub> prices, politically infeasible. The increasing importance of climate risks in financial markets (Fliegel, 2025; Pástor et al., 2022) adds further complexity. Depending on whether market expectations are aligned or misaligned with the transition, they can either advance or hinder the shift to a low-carbon economy (Battiston et al., 2021). The financial sector, therefore, plays an important role in this process (Monasterolo et al., 2024).

To address these uncertainties, scenario techniques are widely used in climate research (e.g., O'Neill et al., 2017; Schweizer, 2020). However, most existing scenarios overlook crucial politico-economic factors and the interactions between financial markets and climate policies due to their complexity and the difficulty of quantifying them in simulation models (Schweizer, 2020). As a result, uncertainties persist regarding the interplay between financial markets, politics, and the economy in the context of the low-carbon transition, including the distributional

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effects of various policy combinations (Green and Gambhir, 2019; Eisenack et al., 2021).

In this study, we analyze the complex interdependencies and trade-offs among climate policies, financial markets, society, and the real economy. We focus on the EU context, explicitly incorporating politico-economic factors and interactions with financial markets into exploratory transition scenarios. By identifying and evaluating key descriptors, we assess the consistency of these scenarios, contributing to a deeper understanding of the low-carbon transition within the next 10 years and offering insights that extend beyond the regional context.

Given the challenges of integrating numerous factors into empirically calibrated quantitative models, we employ the Cross Impact Balances (CIB) methodology, a qualitative scenario-building method, to capture the intricate dynamics of the transition. The CIB methodology systematically elicits expert insights, gathered in our study from 21 field experts through surveys, to evaluate the mutual influences between different developments. This allows us to assess internal scenario consistency by analyzing the likelihood that descriptor states occur together (Weimer-Jehle, 2006; Schweizer and Lazurko, 2020). Unlike quantitative methods, the CIB methodology is particularly suited to examining complex systems that exceed the capacity of numerical models. Building on frequently used scenarios in sustainability research (for an overview see Guivarch et al., 2017), we apply the CIB methodology to 15 descriptors relevant to financial markets, the real economy, and the political economy of the low-carbon transition. This approach allows us to assess consistent transition scenarios and examine the role of specific policy descriptors in determining their success.

Through this analysis, we identify two internally consistent scenarios. The first aligns the EU with a 1.5 °C global warming pathway, characterized by high and stable carbon prices as well as the ECB adopting a climate mandate. Financial market expectations integrate climate-related risks, resulting in higher capital costs for carbon-intensive firms, and fostering green growth with reduced inequality. The second scenario leads to global warming above 3 °C, with fragmented policies and limited financial market alignment, resulting in higher transition costs and stalled political commitment. By identifying key policy variables, such as the predictability of EU climate policies and the ECB mandate, we highlight their critical role in achieving or failing climate targets. Additionally, we uncover areas where expert disagreement reveals gaps in either scientific consensus, or in the transmission of scientific findings into private and public sector practices.

Our contribution to the literature is threefold. First, we extend existing research on low-carbon transition scenarios by including underexplored variables, such as climate movements, corporate lobbying, green technology prices, and financial market expectations. Early scenario work begins with the Special Report on Emissions Scenarios (SRES) for the Intergovernmental Panel on Climate Change (IPCC) (Nakicenovic et al. (2000)), which incorporates key variables such as policy orientations, land use decisions, energy intensity, energy resources, carbon intensity of the energy supply, economic development, and population dynamics. The Shared Socioeconomic Pathways (SSPs) expand this framework, by introducing variables that cover demographics, human development, economy and lifestyle, policies and institutions, technology, environment and natural resources (O'Neill et al. (2017)). These SSPs, analyzed through integrated assessment models (IAMs), describe five distinct pathways of potential futures, providing a comprehensive framework for understanding diverse low-carbon transition scenarios.

Despite the comprehensive nature of the SSPs, subsequent research identifies areas for improvement. O'Neill et al. (2020) and Leimbach et al. (2023) advocate for the inclusion of additional variables such as structural change indicators to capture deeper economic transformations. Cuaresma (2017) and Dellink et al. (2017) propose methodological improvements in GDP calculations to refine economic projections within these scenarios. Additionally, Samir & Lutz (2017) recommend refining national population projections by incorporating

varying assumptions regarding fertility, mortality, education, and migration. These contributions address specific limitations of the SSP framework and aim to improve scenario realism.

However, many critical aspects remain underexplored, particularly those related to financial markets and socio-political dynamics. Schweizer (2020) highlights the potential of CIB to complement IAM-based scenarios by incorporating social variables such as governance quality, revealing system behaviors that IAMs alone might overlook. In contrast, the International Energy Agency's (IEA) World Energy Outlook (IEA, 2023) incorporates technology prices alongside traditional inputs like GDP, fossil fuel prices, CO<sub>2</sub> prices, and electricity costs but does not account for the political economy or financial market expectations. Similarly, the Global Change Assessment Models developed by the Network for Greening the Financial System (NGFS) (Richters et al., 2024; NGFS, 2024) incorporate variables like carbon prices, fossil fuel prices, energy consumption, GDP, housing prices, income, imports, employment, consumption, and production based on SSPs 1 and 2. Nonetheless, these comprehensive models often overlook critical politico-economic factors such as social movements and corporate lobbying efforts.

Second, we assess the internal consistency of transition scenarios by applying CIB. This approach complements established IAM-based approaches. Previous work identifies the application of CIB to climate transition scenarios as an important research need (Pedersen et al., 2022). Several studies incorporate real-world factors into climate transition scenarios: Lefevre et al. (2022) study structural change, Bertram et al. (2024) emphasize institutional feasibility constraints, and Iyer et al. (2015) examine the impact of national institutions on financing costs and investment risks in the electricity sector. These studies argue for the dominant importance of institutional reforms over purely technology-focused policies. However, their analyses rely on IAMs without employing the CIB methodology to assess scenario consistency and do not fully capture interactions between financial markets and politico-economic factors.

We address this gap by extending low-carbon transition scenarios to include often overlooked variables, such as climate movements, corporate lobbying, green technology prices, and financial market expectations. Using CIB, we capture the complex interactions among these variables and provide a qualitative complement to traditional IAM-based quantitative approaches. This perspective helps explain resistance to low-carbon transitions and the trade-offs among stakeholders that can slow progress.

Third, we identify areas of high or low expert agreement and elicit expert views on scenarios, potential interventions, and points of disagreement through a transparently documented workshop. This can guide future research to address key uncertainties in the transition. By clarifying interactions among descriptors, we contribute to the literature by highlighting specific areas that require further investigation.

Our application of the CIB methodology at the interface of climate policy, financial markets and the political economy is novel. Schweizer et al. (2023) demonstrate the broad usefulness of CIB across diverse fields, but studies rarely apply CIB to the nexus of climate, finance, and political economy. The closest related works, such as Schweizer and Kriegler (2012) and Schweizer and O'Neill (2014), apply CIB to assess internal consistency within the IPCC SRES and to develop socioeconomic scenarios related to energy transitions, respectively. However, these studies do not explicitly incorporate financial markets or the political economy into their analyses.

Our approach uniquely combines expert elicitation through surveys and workshops, robustness testing, and intervention analyses. This combination is new in the CIB literature. While Stankov et al. (2021) utilize a two-step questionnaire, and Tori et al. (2023) and Kurniawan (2022) incorporate workshops, our study integrates these elements with novel robustness and intervention analyses. Our approach improves transparency in data collection and increases the reliability of our findings.

The remainder of this paper is organized as follows. First, we detail our methodological approach and data collection process. We then present key findings, discuss their implications, and conclude by highlighting the real-world relevance of our results, limitations of the study, and directions for future research.

## 2. Methods

We systematically elicit expert knowledge to construct consistent climate-finance-economy-policy scenarios using the CIB methodology. This approach comprises three essential steps: (1) defining the system under investigation, (2) collecting judgments for interrelated descriptors, and (3) evaluating the internal consistency of scenarios (Schweizer and Kriegler, 2012; Weimer-Jehle, 2023). We incorporate two further steps to expand our analysis: (4) we contextualize our results in a workshop with experts and (5) we conduct single and dual intervention analyses.

We use expert knowledge to numerically infer the direct effect of one descriptor's state on another's realization. As illustrated in Fig. 1, experts assess for example, whether a high cost of capital for carbon-intensive firms makes a global temperature path towards 1.5 °C or >3 °C more or less likely. Moreover, they evaluate the impact's strength. An algorithm then calculates impact scores by summing the impact values of all descriptors. We subsequently use these scores to construct inherently consistent descriptor realization combinations, termed consistent scenarios. Thus, scenarios derived through CIB systematically capture expert knowledge, providing insights into complex interactions, dependencies, and descriptor relevance within the system under investigation.

### 2.1. Definition of the system under investigation

We refer to the variables that characterize a specific system as descriptors following Weimer-Jehle (2006). We develop the final list of descriptors for the CIB matrix through an iterative process. Initially, we create a list of financial market, climate policies, and real economy descriptors, including their descriptor states. We then rank these descriptors according to transition relevance and select the top 20 key descriptors. Following detailed discussions, we send the list to selected experts for external validation. We consult four experts to rank and comment on the descriptors and to propose additional descriptors. After reevaluating the extended list, we select the top 15 descriptors, including two externally proposed descriptors. This selection balances the inclusion of relevant descriptors with managing the interactions between descriptor states. The descriptors are all forward looking and refer to the year 2035. The final descriptors are listed in Table 1.

The descriptors reflect a broad range of interacting forces that influence how the transition can emerge, be perceived, and managed. Key policy descriptors such as the CO<sub>2</sub> price, EU green financial policies, and the climate mandate of the ECB capture the regulatory environment in which financial institutions operate. Market-side descriptors, including investor expectations and the cost of capital for carbon-intensive firms, reflect how financial markets respond to climate-related signals and risks.

We also include descriptors that account for broader system dynamics, such as global climate policy ambition, GDP growth, income inequality, and the political influence of climate movements and carbon-intensive industries. These variables capture the enabling or constraining context within which policymakers and financial institutions make decisions, and they allow us to consider feedback mechanisms between economic performance, public support, and regulatory action.

We use two states per descriptor, resulting in four possible values per descriptor interaction (e.g., A1B1, A1B2, A2B1, A2B2). This approach aims to strike a balance between overloading respondents with too many options and oversimplifying the system under investigation. While we acknowledge that two states per descriptor do not capture the full

complexity of real-world dynamics and can obscure asymmetric or non-linear effects, it provides a strong and differentiated signal that allows us to differentiate between responses. Offering an in-between option such as moderate CO<sub>2</sub> prices or global warming towards 2 °C would likely result in answers regressing to the mean, which would make it harder to clearly identify different scenarios. Moreover, this linear system allows us to ask about only one of the four values between two descriptor interactions (e.g., A2B2), inferring the other three values, significantly reducing the complexity of the survey. For example, respondent A believes that global warming towards 3 °C will increase the odds of rising EU income inequality (+2). Logically we can infer that it reduces the likelihood of falling inequality (−2). At the same time, it implies that global warming towards 1.5 °C will lead to lower income inequality (+2), but lower chances of rising income inequality (−2). We note that this inference rule is a simplification and may omit information about intermediate or interaction-specific behavior. The complete CIB matrix is provided in Appendix B.

### 2.2. Collection of judgment

After defining the system through descriptors and descriptor states, we collect expert judgments on how one descriptor state directly influences another (Weimer-Jehle, 2006). Relationships between descriptor states are often elicited through open-ended survey responses, workshop transcripts or interviews (Kuniawan et al., 2022). Through the linearization we reduce the number of required judgments from 50,610 to 210 interactions ( $15^2 - 15$ ). However, even after this simplification, eliciting all 210 judgments from a single expert through interviews or workshops remains impractical and may introduce bias due to response fatigue. To address this issue, we reduce the matrix complexity and develop a user-friendly elicitation process.

First, we identify 21 descriptor interactions with no logical direct impact (e.g., the influence of EU income inequality on global warming) and pre-assign a zero in the matrix, in line with Schweizer and Kriegler (2012). The final matrix contains 189 explicit interactions. Second, we divide the matrix into five thematic groups, each containing three descriptors (see Appendix C). We assign experts to one of these groups, substantially reducing the number of questions per expert. Each expert answers interactions where they are highly familiar with at least one descriptor, ensuring balanced responses across interactions. This strategy significantly reduces the complexity of the CIB matrix, which contains 30\*30 descriptor state interactions (Vögele et al., 2017).

We select experts based on at least one year of work experience or a published peer-reviewed paper within the last three years in the relevant thematic field. Additionally, we exclude experts that do not work on EU specific topics in order to align experts with our geographic focus. We leverage personal networks to approach a diverse group of experts from economics, political economy, socio-ecological research, finance, and physics, with different nationalities. The final list of experts is attached in Appendix D: we have four experts for group I and II, five experts for group III and IV and three experts for group V.<sup>1</sup>

To further reduce complexity, we design a user-friendly online survey, aiming for high participation rates and low fatigue. To minimize dropout rates, we divide the questionnaire into two parts. From the 189 unique questions, each subgroup answers between 63 and 75 questions. This variation is due to pre-excluded interactions, affecting the groups unequally. We elicit each interaction score through two simple questions: existence and direction of impact, followed by the strength of impact (if confirmed), rated from 1 to 3 (see Fig. 1). The entire survey can be completed in two sessions of up to 30 min each. By doing so we are able to cover all 189 unique questions by at least one expert group,

<sup>1</sup> Appendix A provides a detailed overview of which groups answer which interaction and how many responses we receive per interaction. On average each interaction was answered by 6.2 experts.

\* Direct impact of EU firms' cost of capital (bonds, credits, equity) on global emission path

If carbon-intensive firms have higher cost of capital than green firms, will this make the global mean temperature being on a path towards >3 °C ...?

Choose one of the following answers

more likely less likely no impact

\* How strong do you think the direct impact is? (1=weak, 2=medium, 3=strong)

Choose one of the following answers

1 2 3

Fig. 1. Screenshot of the survey.

User friendly survey design implementation in LimeSurvey with an exemplary question set.

thus, limiting the risk of introducing missing or distorted interactions due to matrix partitioning.

Before the final survey, we conduct internal pilot tests and run a first round of the survey with eight external experts. Based on the participants feedback, we adjust the survey design. We include pilot answers in our analysis. For questions with material changes after the pilot, we asked our pilot participants again to answer the revised version. We implement the final survey using LimeSurvey. We provide some limited accessible background information for participants (Appendix E). Out of 49 contacted experts, 21 have completed the questionnaire, covering the fields financial markets, financial policy, socio-political economy, real economy, and regulation.

### 2.3. Evaluation of internally consistent scenarios

In the survey, we focus exclusively on first-order direct impacts of one descriptor state on another. This focus is particularly relevant within the CIB framework, as it ensures that the aggregation of impact scores for creating consistent scenarios remains unbiased by excluding indirect interactions through intermediary variables. We consider all descriptor interactions using the CIB algorithm, which is based on the concept of a stable equilibrium. For each scenario, the algorithm calculates the impact balances of direct effects among descriptor states and assesses whether these states form a consistent scenario. A scenario is deemed consistent if its inconsistency value (ICV) is equal to or below a pre-defined significance threshold  $t$ . This criterion ensures that no descriptor state within the scenario can be improved by switching to its counterpart. The evaluation of internally consistent scenarios is a fundamental aspect of the CIB methodology, and focuses on coherence and plausibility in scenarios constructed from various descriptor states (Weimer-Jehle, 2023).

As all descriptors  $i \in (1, I)$  have the same number of states  $J$  with  $j \in (1, J)$  representing a specific descriptor state, we calculate the impact balance (IB) of a descriptor state in a random scenario  $K \in (1, J)^2$  by summing all direct impact scores from other descriptor states on it. This indicates how much the descriptor state is supported or weakened by other states within the scenario. Thus, the IB of descriptor  $i$  in state  $j$  is written as:

$$IB_{ijk} = \sum_{ikjK} \text{CrossImpact}_{ijkjK}$$

where  $\hat{i}_K \hat{j}_K$  represents all descriptor states in scenario  $K$  excluding  $ij$ .

The consistency value (CV) of a descriptor is the difference between its current impact balance and that of the second-best descriptor state.

<sup>2</sup> In this paper, each of the 15 descriptors has only two possible states, resulting in  $2^{15}$  different potential scenarios.

The CV measures whether a scenario or descriptor state is consistent. Since we have two states per descriptor ( $j \in (1, 2)$ ), the consistency value can be expressed as:

$$CV_{iK} = IB_{ijk} - IB_{iyK}, \text{ with } j \neq y \text{ and } j, y \in (1, 2)$$

The CV of the entire scenario  $K$  is the minimum of all descriptor-specific CVs:

$$CV_K = \min_i CV_{iK}.$$

The ICV is the negative of the CV and is defined as:

$$ICV_{ijk} = -CV_{ijk} \text{ or } ICV_K = -CV_K.$$

Due to underlying uncertainty when eliciting expert knowledge, a scenario can be considered inconsistent only if  $ICV_K$  exceeds a significance threshold. As the complexity of the system and uncertainty in expert responses increase with  $I$ ,  $ICV_K$  is likely to increase. Hence, following Weimer-Jehle (2023), the threshold  $t$  increases with  $I$  and is given by:

$$t = \frac{1}{2} \sqrt{I-1}.$$

This threshold ensures the scenario's consistency, avoiding logical flaws. If the minimum inconsistency value across all descriptors  $K$  is greater than or equal to threshold  $t$ , then even the least consistent descriptor state (identified by the minimum of  $IB_{ijk}$ ) remains below the inconsistency threshold  $t$ . In other words, changing the descriptor expected to have the greatest influence on the system when altering its state would not render the scenario implausible.

We first collect the survey results per thematic group and then aggregate them into a single matrix. Critically, all descriptor interactions between two thematic groups (for example between Real Economy and Regulation) are answered by experts from both groups. Interactions that remain in one group (two descriptors from the group Regulation) are only answered by experts from that very group. Fig. A1 in the Appendix shows how many answers we received per descriptor interaction from which expert groups. With a varying number of answers per interaction, we ensure that we do not introduce bias by summing the answers but instead rely on equally weighted averages. A key advantage of having a large number of experts is the possibility to generate disagreement scores for each interaction, measured by the standard deviation of responses per interaction. This facilitates the analysis of which interactions are agreed upon and which ones require further investigation. We analyze the final equally weighted CIB matrix with the ScenarioWizard software (Weimer-Jehle, 2021), which applies the CIB-algorithm to compute internally consistent scenarios. Before computing internally consistent scenarios we scale all equally weighted averages by ten since the ScenarioWizard only uses integers. In line with the specification for  $t$  we use a threshold of approximately 2 for the ICV.

**Table 1**  
Full list of the descriptors.

Abbreviation	Descriptor
<b>A</b>	<b>Ambition of EU green financial policies (e.g., stress tests, climate risk based capital requirements, climate disclosure policies)</b>
A1	<i>EU green financial policies will not exist</i>
A2	<i>EU green financial policies will be ambitious</i>
<b>B</b>	<b>ECB mandate</b>
B1	<i>ECB will not adopt a climate mandate</i>
B2	<i>ECB will adopt a climate mandate (e.g., including green collateral framework and green Quantitative Easing)</i>
<b>C</b>	<b>EU financial market actors' expectations (financial institutions, private investors)</b>
C1	<i>EU financial market actors will partially take climate transition risks into account</i>
C2	<i>EU financial market actors will fully take climate transition risks into account</i>
<b>D</b>	<b>EU firms' cost of capital (bonds, credits, equity)</b>
D1	<i>Carbon-intensive firms will have lower cost of capital than green firms</i>
D2	<i>Carbon-intensive firms will have higher cost of capital than green firms</i>
<b>E</b>	<b>EU CO<sub>2</sub> price</b>
E1	<i>EU CO<sub>2</sub> price will be low</i>
E2	<i>EU CO<sub>2</sub> price will be high (above 150€)</i>
<b>F</b>	<b>Climate adaptation Europe</b>
F1	<i>Investments in climate adaptation will be moderate</i>
F2	<i>Investments in climate adaptation will be high</i>
<b>G</b>	<b>Availability of EU data on physical/transition climate risk exposure</b>
G1	<i>Some fragmented climate risk data will be available</i>
G2	<i>Comprehensive climate risk data will be available</i>
<b>H</b>	<b>Lobbying efforts of EU's carbon-intensive sectors</b>
H1	<i>Carbon-intensive sectors will not lobby against the low carbon transition</i>
H2	<i>Carbon-intensive sectors will lobby strongly against the low carbon transition</i>
<b>I</b>	<b>Political influence of climate movements in the EU</b>
I1	<i>Climate movements have strong political influence (e.g., Fridays for future)</i>
I2	<i>Movements against climate policies have strong political influence (e.g., yellow vests)</i>
<b>J</b>	<b>EU GDP</b>
J1	<i>EU GDP will decrease</i>
J2	<i>EU GDP will increase</i>
<b>K</b>	<b>Global mean temperature path</b>
K1	<i>Global mean temperature is on a path towards 1.5 °C</i>
K2	<i>Global mean temperature is on a path towards &gt;3 °C</i>
<b>L</b>	<b>The climate policy ambition of the rest of the world</b>
L1	<i>Rest of the world will have more ambition in climate policies than the EU</i>
L2	<i>Rest of the world will have less ambition in climate policies than the EU</i>
<b>M</b>	<b>EU income inequality (Gini coefficient)</b>
M1	<i>EU income inequality will be higher than today</i>
M2	<i>EU income inequality will be lower than today</i>
<b>N</b>	<b>Price level of green technologies</b>
N1	<i>Green technology prices will remain at today's level</i>
N2	<i>Green technology prices will fall substantially compared to today's prices</i>

**Table 1 (continued)**

Abbreviation	Descriptor
<b>O</b>	<b>Credibility of EU climate policies</b>
O1	<i>EU climate policies will not be stable and will not be predictable over time</i>
O2	<i>EU climate policies will be stable and predictable over time</i>

The 15 descriptors, and their abbreviations, for analyzing the system of financial market, climate policies, and real economy. These descriptors are developed through an iterative process, including expert ranking of their relevance to the low-carbon transition.

#### 2.4. Contextualizing results with workshop insights

In order to discuss and interpret our survey results, we organized a workshop with 50 experts, both researchers and practitioners, which have a professional focus on the low carbon transition. We first presented our scenario results and then split all participants in four heterogeneous groups. We asked participants to (a) provide names for the scenarios, (b) assess interactions where experts exhibit the highest disagreement, (c) think of barriers to the scenarios and (d) score the 15 descriptors on a scale from  $-10$  to  $+10$  along five dimensions capturing systemic impacts—probability of occurrence, political stability, financial stability, transition risk and social coherence—where negative (positive) values indicate adverse (beneficial) implications. We aggregated the scores from task (d) to the scenario level by averaging the participants' valuation across all descriptors associated with each scenario, forming the basis of the radar plots shown in Fig. 3.

During the workshop, we collected the group discussion results on posters. Additionally, we recorded and transcribed tasks (a) - (c) of the workshop sessions. We use the data of the workshop to evaluate the resulting scenarios and identify challenges and barriers to achieving the 1.5° goal and to conduct robustness checks and sensitivity analysis as described in Appendix F. We provide the exact phrasing of the questions, as well as all other material generated during the workshop in Online Appendix I.

#### 2.5. Single and dual intervention analysis

Based on the set of internally consistent scenarios, we conduct intervention analyses to assess the relative importance of individual descriptor states for the system outcome (Weimer-Jehle, 2023), in particular the temperature pathway. While the internally consistent scenarios describe coherent scenarios, the intervention analysis examines how fixing specific descriptor states constrains the set of consistent scenarios, thereby indicating the importance of those descriptors for the system outcome.

In the single intervention analysis, one descriptor is fixed to a specific state by removing its alternative state from the CIB matrix. This constrains the system and allows us to evaluate how the set of internally consistent scenarios changes under that condition. For example, we fix descriptor O to state O2 ("EU climate policies will be stable and predictable over time") by removing O1 from the CIB matrix entirely.<sup>3</sup> If only one consistent scenario remains and it is 1.5 °C-aligned, this descriptor state can be interpreted as highly policy-relevant. We repeat this procedure for descriptors that can be directly influenced by policymakers (A, B, E, G, O). By systematically exploring all policy-relevant descriptors, we assess which ones are key for a 1.5 °C-aligned scenario.

Building on the single intervention analysis, we examine dual interventions by fixing combinations of two descriptor states simultaneously. By systematically exploring all pairwise combinations of

<sup>3</sup> We deploy all intervention analysis using the option strong consistency (equal to a maximum ICV of zero) when forcing descriptor states in the ScenarioWizard. This allows us to examine which interventions are most effective in forcing the system into a strongly consistent scenario with 1.5 °C outcome.

policy-relevant descriptors, we assess whether specific combinations consistently produce 1.5°C-aligned scenarios. This allows us to identify interactions between policy levers that are capable of producing broader systemic shifts toward low-carbon outcomes.

### 3. Results

#### 3.1. Pathways to 1.5 °C and 3 °C

Using the CIB methodology, we identify two internally consistent scenarios (Fig. 2). One scenario predicts global warming exceeding 3 °C, while the other aligns with the 1.5 °C target set by the Paris Agreement.<sup>4</sup> The binary nature of the descriptors naturally reduces the possible number of scenarios as more ambivalent descriptors would have made a higher number of scenarios more likely. However, having only two bipolar scenarios, where each descriptor combination in one scenario is the reverse of the other, is not predetermined by the survey set-up. Notably, the two scenarios cannot be classified as purely “good” and “bad”, as both scenarios feature descriptor states which are desirable from an environmental and social point of view. Our methodology integrates information collected at our workshop where 50 field experts discussed the scenarios (see Section 3.3). During the workshop, participants referred to the 1.5 °C scenario as “Private Sector Activism,” “Ambitious Green Growth,” and “Financial Heroes” (see Online Appendix I). These names reflect the transformative impact of financial market expectations and political will. The >3 °C scenario was labeled “Don’t Look Up,” “Business as Usual,” and “Fatalist,” highlighting the lack of coordinated climate action and its adverse consequences.

The 1.5 °C scenario hinges on strong, stable, and predictable climate policies, such as a carbon price exceeding €150. Notably, it does not rely on specific green financial policies but includes a climate mandate for the ECB. This policy combination sufficiently incentivizes investors to account for climate risks, increasing the cost of capital for carbon-intensive firms compared to green firms. This scenario benefits from comprehensive climate data and rapidly falling prices for green technology, reducing overall transition costs. Despite strong opposition from anti-climate movements and lobbying by high-carbon sectors, political will for climate action remains steadfast. Macroeconomically, this scenario fosters GDP growth and reduces inequality, embodying an optimistic green growth model.

Conversely, the 3 °C scenario reflects fragmented and ineffective EU climate policies, characterized by a low carbon price and the absence of an ECB climate mandate. Although EU green financial policies are in place, they are insufficient to drive a low-carbon transition. Consequently, high-carbon sectors face minimal pressure, as there are no stringent policies threatening their business models. This scenario results in negative outcomes, including failure to meet EU policy goals, GDP decline, and increased inequality. The specific descriptor combinations for both scenarios are detailed in Fig. 2.

Fig. 3 presents expert evaluations from the workshop for each scenario across five dimensions: Financial Stability, Political Stability, No Transition Risk, Social Coherence, and Probability of Occurrence. The >3 °C scenario consistently exhibits negative impacts across all dimensions indicating significant challenges in maintaining economic and political stability, and in ensuring social cohesion. In contrast, the 1.5 °C scenario demonstrates positive, albeit moderate, effects in each of these dimensions, with Financial Stability showing the most significant improvement.

Interestingly, the >3 °C scenario is associated with climate transition risk (i.e. a negative value for “No Transition Risk”). Moreover, it seems that this coincides with lower financial stability worsening the economic

<sup>4</sup> Whilst ending up with two scenarios may sound like a low number, it is rather common, as Weimer-Jehle (2023) finds that 20% of CIB studies have two or less scenarios.

outlook of this scenario. In comparison, our findings suggest that a successful low-carbon transition, as depicted in the 1.5 °C scenario, enhances economic resilience and financial stability through stable and predictable climate policies, comprehensive climate data, and rapidly falling green technology prices. These factors collectively foster an optimistic green growth model. Notably, experts perceive the 1.5 °C scenario as slightly more probable than the >3 °C scenario, reflecting a cautiously optimistic outlook towards achieving the Paris Agreement targets under the proposed policy frameworks.

We further use the CIB results to create a (dis)agreement heatmap for each descriptor interaction (Fig. 4), based on the deviations in experts' survey responses. The results reveal which descriptor interactions are well understood and which ones require further research due to high disagreement. Notably, there is a lack of consensus on how green technology prices influence global warming<sup>5</sup> and corporate lobbying. Furthermore, the effect of financial market participants considering climate risks on EU green financial policies is also debated. Significant disagreement exists regarding the impact of global warming on income inequality and the predictability of EU climate policies. In contrast, most other interactions demonstrate relatively high agreement among experts.

Based on the disagreement results depicted in Fig. 4, we conduct additional robustness and sensitivity tests for the consistent scenarios shown in Fig. 2. Specifically, for the four descriptor interactions with the highest inconsistency in the expert survey responses, we engaged in detailed discussions with field experts during the workshop (see Section 2.3). In most cases, the majority of workshop participants were more aligned than the survey respondents, as detailed in Appendix F. When we adjust the controversial interactions based on the workshop discussions, we still find the same consistent scenarios as before. Additionally, moderately varying the inconsistency threshold does not change the two consistent scenarios (see Appendix F). The model yields these two scenarios for maximum inconsistency values between zero and nine, whereas higher maximum inconsistency values such as 10 (20) result in 8 (20) scenarios.

#### 3.2. Key policy descriptors for effective low-carbon transition

To identify the most critical descriptors for a successful low-carbon transition, we conduct single and dual intervention analyses (Weimer-Jehle, 2023). These analyses assess how fixing one or two descriptor states influences scenario consistency. When an intervention reduces the solution space to a single internally consistent scenario, the corresponding descriptor (or combination of descriptors) strongly constrains the system and can be interpreted as critical for the outcome. In contrast, when multiple consistent scenarios remain the intervention has a less decisive effect. This distinction allows us to identify policy-relevant descriptors that are most influential in shaping 1.5 °C-aligned transition pathways.

Fig. 5 provides an example of a single intervention analysis for descriptor O. In our system, we enforce descriptor state O2 (“climate policies will be stable and predictable over time”), thereby excluding O1 as a possible descriptor state. On the left side of Fig. 5, we display the potential for a >3 °C scenario before applying the intervention. As a result of constraining the analysis with O2, only one consistent scenario emerges, shown on the right side of Fig. 5. In this new scenario, all other descriptor states align perfectly with those observed in the 1.5 °C scenario, underscoring the importance of stable and predictable climate policies. We provide figures for each single intervention in Appendix G.

Since it is oftentimes impossible to directly alter descriptors such as global warming or financial market expectations, we concentrate on

<sup>5</sup> The lack of consensus on this interaction is noteworthy as it seems counterintuitive at first. One potential explanation might be different expectations about related rebound effects (Greening et al., 2000).

>3°C Scenario	1.5°C Scenario
A2: EU green financial policies will be ambitious	A1: EU green financial policies will not exist
B1: ECB will not adopt a climate mandate	B2: ECB will adopt a climate mandate (e.g., including green collateral framework and green Quantitative Easing)
C1: EU Financial market actors will partially take climate transition risks into account	C2: EU Financial market actors will fully take climate transition risks into account
D1: Carbon-intensive firms will have lower cost of capital than green firms	D2: Carbon-intensive firms will have higher cost of capital than green firms
E1: EU CO <sub>2</sub> price will be low	E2: EU CO <sub>2</sub> prices will be high (above 150€)
F1: Investments in climate adaptation will be moderate	F2: Investments in climate adaptation will be high
G1: Some fragmented climate risk data will be available	G2: Comprehensive climate risk data will be available
H1: carbon-intensive sectors will not lobby against the low carbon transition	H2: carbon-intensive sectors will lobby strongly against the low carbon transition
I1: Climate movements have strong political influence (e.g., Fridays for Future)	I2: Movements against climate policies have strong political influence (e.g., Yellow Vests)
J1: EU GDP will decrease	J2: EU GDP will increase
K2: Global mean temperature is on a path towards >3 degrees	K1: Global mean temperature is on a path towards 1.5 degrees
L2: Rest of the world will have less ambition in climate policies than the EU	L1: Rest of the world will have more ambition in climate policies than the EU
M1: EU income inequality will be higher than today	M2: EU income inequality will be lower than today
N1: Green technology prices will remain at today's level	N2: Green technology prices will fall substantially compared to today's prices
O1: EU climate policies will not be stable and will not be predictable over time	O2: EU climate policies will be stable and predictable over time

Fig. 2. Internally consistent scenarios.

Results from the Cross Impact Balances methodology based on expert opinions regarding the expected outcomes of fifteen key socioeconomic variables. The left scenario leads to a >3 °C temperature increase, while the right scenario aligns with the 1.5 °C target.

specific policy interventions that policymakers can actually influence. By setting interventions that support decarbonization, we generate one or two consistent scenario(s) as depicted in Fig. 6. Our analysis indicates that adopting a climate mandate for the ECB would eliminate the >3 °C scenario, while implementing ambitious EU green financial policies can result in either a 1.5 °C or a 3 °C scenario. Specifically, incorporating a climate mandate, ensuring the availability of comprehensive climate data, or establishing stable and predictable EU climate policies only leads to the 1.5 °C consistent scenario.

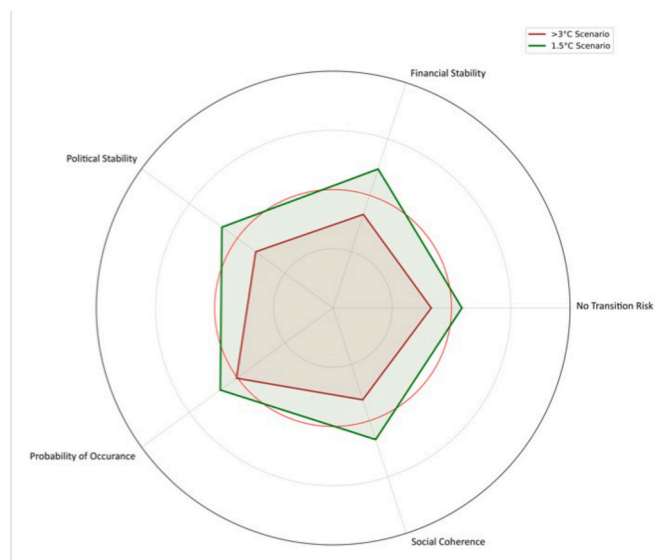
Next, we conduct a dual intervention analysis that examines the impact of simultaneously fixing two distinct descriptor states, effectively combining two policy interventions. By utilizing all possible combinations of the five single interventions (Fig. 6), we find that any dual intervention incorporating the availability of comprehensive climate data results in a scenario aligned with the 1.5 °C target. Additionally, three out of four dual interventions involving stable and predictable climate policies lead to similar outcomes. In contrast, dual interventions that include the ECB climate mandate result in alignment with the 1.5 °C scenario only when combined with either the availability of comprehensive climate data or stable and predictable climate policies. Notably, combining interventions that individually would result in two scenarios when implemented as single interventions also leads to two scenarios when combined. A detailed overview of all dual interventions that result in a scenario closely aligned with the 1.5 °C target is provided in Appendix G.

### 3.3. Challenges and barriers to achieving the 1.5° goal

We discuss the challenges in achieving the 1.5 °C scenario during our workshop, where field experts identified key obstacles (see also Appendix H). One major concern is that the global geopolitical landscape, including conflicts outside the EU's control, could divert attention from long-term climate mitigation efforts. Additionally, experts expressed doubts regarding the influence of the EU's climate ambition, given that EU countries account for approximately 7% of global emissions (EDGAR/JRC, 2023). However, our scenarios, to some extent, account for other countries as they incorporate interactions with the rest of the world.

Another identified barrier is the perceived conflict between the legitimacy and rationale of the European Central Bank's strong climate mandate and the absence of corresponding EU green financial policies. This issue could be exacerbated by significant opposition movements against climate policies. Financial and economic considerations also emerged as major obstacles. Experts questioned the feasibility of implementing high CO<sub>2</sub> prices and ensuring access to adaptation finance. Although high CO<sub>2</sub> prices are considered essential for achieving the Paris Agreement targets, public acceptance remains low due to concerns over unfair distributional effects and the lack of affordable, low-emission alternatives (Maestre-Andrés et al., 2019; Funke et al., 2024).

Furthermore, experts expressed concerns regarding the realism, reliability, and availability of data on climate risk. They noted that most Environmental, Social, and Governance (ESG) data is currently held by a



**Fig. 3.** Evaluation of the two consistent scenarios across systemic impacts. The figure shows the impact of each scenario on the five dimensions: Financial Stability, No Transition Risk, Social Coherence, Probability of Occurrence, Political Stability. Impacts are based on aggregated experts' valuations of each scenario descriptor on a scale from  $-10$  to  $+10$  (see Method Section 2.4), where negative (positive) values indicate adverse (beneficial) effects. Each scenario's impact is calculated as the average of its descriptor values. The green and brown areas represent the  $1.5\text{ }^{\circ}\text{C}$  and  $>3\text{ }^{\circ}\text{C}$  scenario respectively. The red circle represents a value of zero with values becoming negative (positive) towards the center (outer circle) of the radar plot.

few private, profit-oriented firms (Fichtner et al., 2023), raising questions about data accessibility and transparency. These insights highlight the complex challenges for policymakers associated with the  $1.5\text{ }^{\circ}\text{C}$  scenario and its descriptor states.

#### 4. Discussion and limitations

This study aims to explore the complex interactions of various factors influencing the low-carbon transition by utilizing expert elicitation, applying the CIB methodology, and presenting a range of outcomes. In the following sections, we discuss and contextualize some of these results, their implications, and the limitations of our approach.

##### 4.1. Implications of the $1.5\text{ }^{\circ}\text{C}$ and $>3\text{ }^{\circ}\text{C}$ scenarios

The  $>3\text{ }^{\circ}\text{C}$  scenario is characterized by a weaker and less stable mix of EU and non-EU climate policies. This fragility likely contributes to fragmented data availability and the absence of climate risk accounting among financial market participants, as policymakers and financial regulators fail to envision and act upon a coherent transition pathway. When firms and investors do not form credible expectations about the climate transition, uncertainty persists and investment in green technologies might remain weak. Over time, this can weigh on economic growth and exacerbate income inequality. Notably, the  $>3\text{ }^{\circ}\text{C}$  scenario includes ambitious green financial policies and influential public climate movements (e.g., Fridays for Future). However, these efforts alone are insufficient to achieve a consistent  $1.5\text{ }^{\circ}\text{C}$  scenario, likely because financial market participants require a credible and coherent climate policy mix in order to coordinate on a  $1.5\text{ }^{\circ}\text{C}$  pathway.

In contrast, the  $1.5\text{ }^{\circ}\text{C}$  scenario features a robust policy mix that includes a high  $\text{CO}_2$  price, stable and predictable EU climate policies, a green mandate for the ECB, comprehensive climate risk data, and ambitious global climate policies. These credible long-term signals allow firms and investors to form more robust expectations and reduce

uncertainty. This can support investment and economic growth and, when combined with appropriate distributional policies, help limit increases in income inequality, despite opposition from anti-climate lobby groups and public resentment (e.g., yellow vests). This underscores the critical importance of a policy environment that fosters the development of long-term expectations about the climate transition and its underlying risks.

##### 4.2. Expert perceptions of scenarios

As part of our mixed-methods approach, we elicited experts' perceptions of the scenarios during a one-day workshop. The experts unanimously agreed that the  $1.5\text{ }^{\circ}\text{C}$  scenario strictly dominates the  $>3\text{ }^{\circ}\text{C}$  scenario across all categories presented in Fig. 3. This consensus reinforces the clear preference for the  $1.5\text{ }^{\circ}\text{C}$  scenario from both economic and socio-political perspectives. The  $1.5\text{ }^{\circ}\text{C}$  scenario aligns more closely with the concept of a just transition (European Commission, Directorate-General for Climate Action, 2019), as it promotes greater social coherence and political stability compared to the  $>3\text{ }^{\circ}\text{C}$  scenario. Nevertheless, the only moderately positive responses indicate potential fears of unemployment, protests, and migration, reflecting risk aversion and a preference for maintaining the status quo. Furthermore, the finding that the  $1.5\text{ }^{\circ}\text{C}$  scenario entails lower climate transition risk can be attributed to stable and predictable policies, which enable financial market actors to facilitate an orderly transition. Conversely, the  $>3\text{ }^{\circ}\text{C}$  scenario, characterized by late, sudden, and unanticipated climate policies triggered by escalating global warming, presents substantial transition risks and stranded assets (Battiston et al., 2021).

##### 4.3. The role of policy interventions

The results from the intervention analysis highlight the critical role of comprehensive climate data, the ECB's mandate, and stable EU climate policies in facilitating the climate transition. Although climate data availability has improved in line with more stringent reporting standards, caution is warranted due to increasing greenwashing activities and growing mistrust in certain climate risk proxies (Berg et al., 2022; Bingler et al., 2022; In and Schumacher, 2021). Additionally, there is no consensus on the best methods to measure firms' climate risks, and research shows that using different metrics can significantly change outcomes (Fliegel, 2026). Our findings emphasize the urgent need for valid and comprehensive climate risk data that can be trusted and relied on by financial market actors.

Interestingly, a green ECB mandate could facilitate a consistent  $1.5\text{ }^{\circ}\text{C}$  scenario. Such a green ECB mandate is controversial but underscores the potential influence of financial markets in the climate transition if the ECB adopts a proactive stance. We argue that a green ECB mandate has a comparable function to stable and predictable EU climate policies. Such policies are crucial for signaling a trustworthy long-term policy trajectory, allowing market participants to develop reliable expectations and sustain long-term investments (Rosenbloom et al., 2019). Companies and investors seek a predictable climate policy mix to effectively plan their long-term investment decisions (Sitarz et al., 2024; Kang and Létourneau, 2016; Ascher, 2006).

##### 4.4. Policy implications

Our findings offer critical insights for policymakers, who navigate the complexities of the climate transition. While the  $1.5\text{ }^{\circ}\text{C}$  scenario is preferable, achieving it requires overcoming significant barriers, particularly in terms of policy coherence and aligning financial market expectations. Policymakers should focus on developing more robust climate data disclosure standards. Policymakers and central banks must also act decisively to establish a stable and predictable climate policy environment to facilitate necessary long-term investments and mitigate transition risks. Although our study focuses on EU experts and explicitly

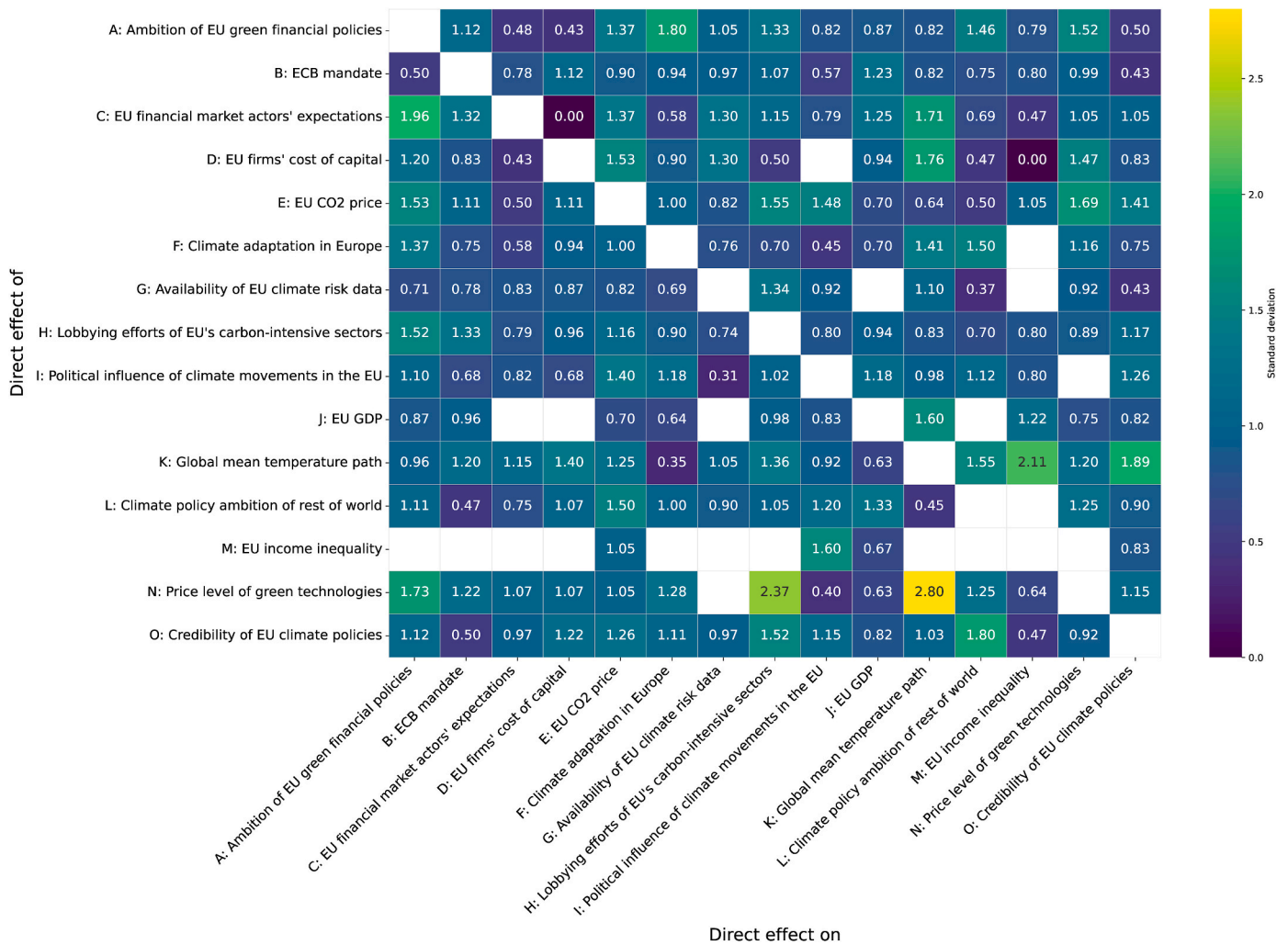


Fig. 4. Disagreement heat map.

The heatmap shows the standard deviation of experts' opinions on descriptor state interactions. The standard deviation was calculated based on the answers received by experts ranging from -3 to +3 including 0. Since we assume linear relationships between different descriptor states, the standard deviation is identical within a descriptor interaction, thus, we report the standard deviation per descriptor interaction once. The y- and x-axis depicts all the descriptor states and should be read as follows: how descriptor state y affects x. Uncolored blank cells state that this interaction was not elicited from experts.

addresses EU descriptors, we argue that our findings possess external validity beyond the EU, particularly for economically advanced countries and regions, such as the USA. Key descriptors, including CO<sub>2</sub> prices, central bank mandates, and lobbying efforts of carbon-intensive sectors, are also relevant in other countries, albeit with some contextual adaptations.

#### 4.5. Limitations

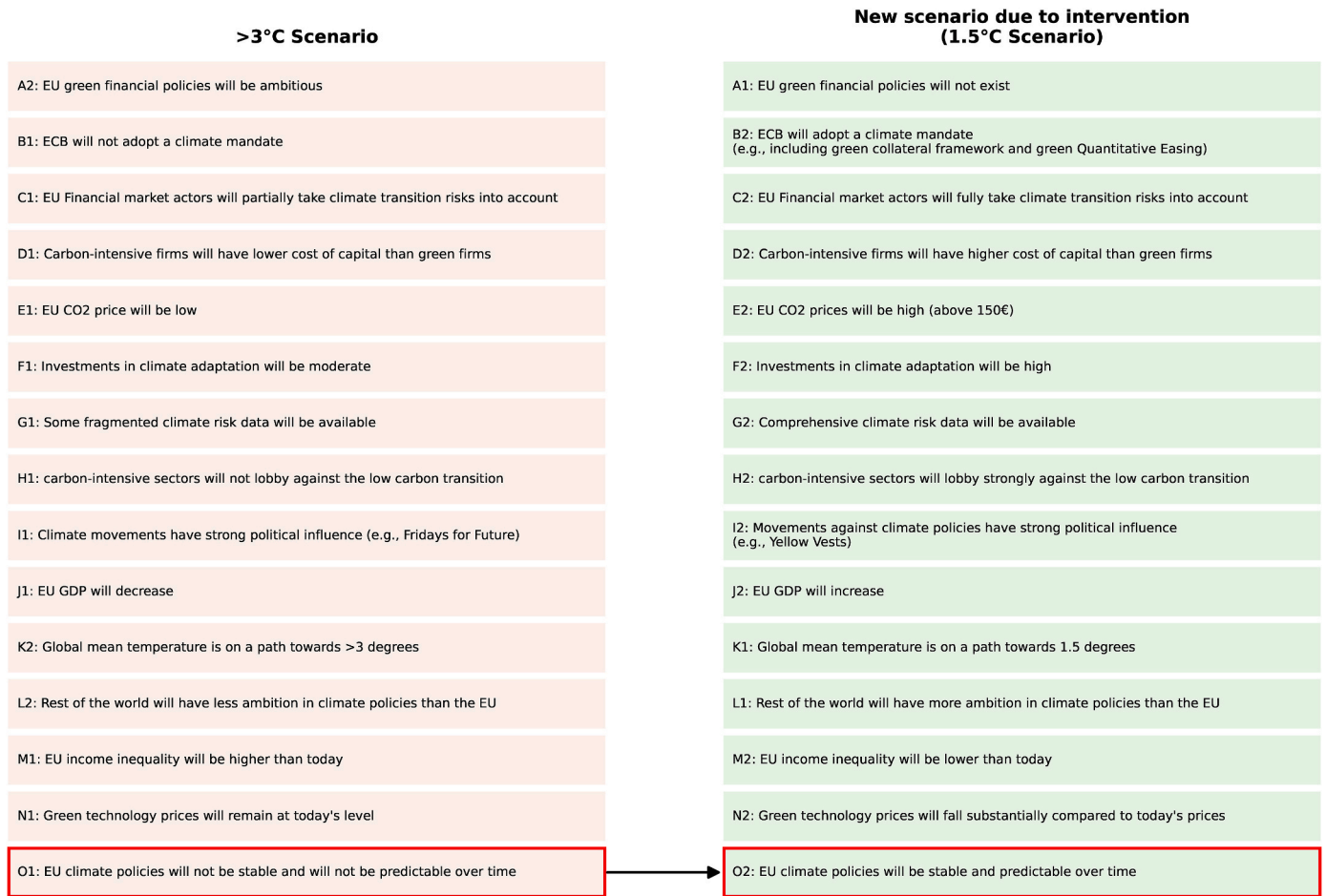
This study has several limitations. We apply strict selection criteria to ensure that the expert sample includes qualified and knowledgeable individuals. However, the results rely on the collective qualitative judgement of 21 experts using the CIB methods. Thus, any misunderstanding or error in the online survey might bias the results. To mitigate potential bias, we account for uncertainty in expert responses by applying a significance threshold for inconsistencies. As shown in Appendix F, robustness and sensitivity tests indicate that changes in the inconsistency threshold do not substantially alter the results.

Additionally, the data collection method introduces limitations. We use an online survey, which avoids biases common in face-to-face or telephone interviews, such as observer bias. However, this approach may cause participant fatigue due to the survey's length and order bias,

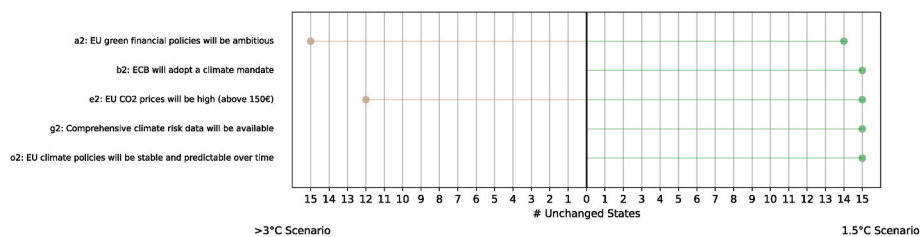
as we could not randomize the questions without increasing cognitive load. To address these issues, we grouped questions into topic clusters and assigned them to experts in their respective fields. Thereby, we reduce survey fatigue and improve response quality.

Geographically, this study focuses on the EU. This focus limits external validity and does not fully capture the global complexity of climate mitigation. For example, faster policy tightening in the EU may lead to carbon leakage (Dechezleprêtre et al., 2022) or to the relocation of capital to other regions. Including descriptor L (climate policy ambition of the rest of the world) partially addresses such strategic interactions. For example, in the 1.5 °C scenario with high EU carbon prices, experts expect high climate policy ambition in the rest of the world. However, the broader issue of international cooperation for climate mitigation, including the formation of international environmental agreements and the potential use of trade sanctions to stabilize climate clubs (Nordhaus, 2015; Hagen and Schneider, 2021, 2022), is beyond the scope of this analysis.

Finally, we assume linear relationships between different descriptor states and exclude certain interactions to simplify the survey. The design reduces respondent fatigue and improves response quality. We recognize that this linearization is a simplification that may obscure asymmetric or non-linear effects and may miss responses that experts would



**Fig. 5.** Impact of key policy intervention on temperature scenarios. Results from a single intervention show how an intervention can alter the consistent scenarios. The left scenario shows the former scenario highlighting the descriptor used as an intervention. On the right, we display the newly established scenario with highlighted descriptor states that changed in comparison to the former scenario.



**Fig. 6.** Overview of all single interventions. For each intervention (y-axis), dots indicate the number of descriptor states (x-axis) that remain unchanged when comparing the newly established 1.5 °C and >3 °C scenarios with the original scenarios. Dots on the right (left) denote alignment with the original 1.5 °C (>3 °C) scenario. Interventions yielding only one single consistent scenario (one dot on either side) indicate a decisive determinant of the outcome, whereas multiple consistent scenarios (one dot on each side) reflect more context-dependent effects. Interventions without dots do not produce the respective scenario, allowing the figure to distinguish more influential from less influential determinants.

have provided under more detailed elicitation. While this limits our ability to capture more nuanced, non-linear dynamics, it provides a clear structure that allows us to infer the full set of interactions from a single input. Using two states per descriptor creates strong contrasts and discourages neutral answers. Experts can still express intermediate judgments through impact strength. For example, a weak impact on a strong descriptor can reflect a similar assessment as a strong impact on a weaker outcome in the same direction. This design makes additional states redundant. We thus preserve the strengths of the CIB approach to capture complex interdependencies and trade-offs, while making the data elicitation more user-friendly to access a larger pool of experts.

Future research can address this limitation by conducting pilot cognitive interviews to identify descriptors with asymmetric or non-linear behavior and by selectively expanding the number of states for key variables. Given the very large number of elicitation items in our study, such extensions are not feasible here but may suit CIB applications with fewer descriptors.

### 5. Conclusion

In this paper, we elicit expert opinions on descriptor interactions within the complex system of the EU low carbon transition. The CIB

methodology enables us to explore these interactions and identify internally consistent future scenarios. Additionally, we complement our analysis with qualitative information gathered during an expert workshop, where we discussed inconsistencies, potential barriers, and conducted further scenario evaluations. Our study contributes to a deeper understanding of the low-carbon transition as an unprecedented and highly complex endeavor involving many societal stakeholders, including private companies, investors, citizens, and politicians. By incorporating political economy, technological, and financial market descriptors into our scenario exercises, we ensure a holistic and comprehensive understanding of the system. Furthermore, we identify three key policy interventions that can help to achieve a green transition scenario aligned with the 1.5 °C pathway, namely the provision of comprehensive climate risk data, the ECB's mandate, and stable EU climate policies. Through transparent documentation of each step in our elicitation process, including simplification, piloting, distribution, workshop participation, and analysis, we maintain transparency throughout our analysis.

Our findings offer several novel insights and implications for policymakers. Notably, we discover that a green transition scenario does not necessarily require ambitious green financial policies to shift expectations and pricing within financial markets. Instead, our results emphasize that a green mandate for the ECB, readily available climate risk data, and stable and predictable EU climate policies are powerful enabling interventions for the economic climate transition and warrant particular focus. Additionally, our consistent 1.5 °C scenario suggests that declining technology prices and high CO<sub>2</sub> prices further support the shift to financial market expectations, positioning financial markets as key enablers of the transition. While the transition under this scenario successfully aligns the EU with the Paris Agreement's decarbonization pathway, it encounters significant resistance from both civil society protests and lobbying activities by high-carbon sectors.

Future research could focus on descriptor interactions with high disagreement scores, as these may indicate promising research opportunities. Notably, important interactions include the influence of falling green technology prices on the lobbying efforts of carbon-intensive firms, the impact of rising temperatures on the stability of climate policies over time, and the effect of financial market expectations on the implementation of ambitious green financial policies. In terms of descriptors, this study could be extended by adding descriptors on political developments (e.g. left or right wing populist leaders are elected) as well as geopolitical tensions (e.g. energy security becomes the main political objective or regional wars overshadow climate action).

#### CRediT authorship contribution statement

**Marc-Philipp Bohnet:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Philip Fliegel:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Anne Schoenauer:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Cosima van Mierlo:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Maria Zioga:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Achim Hagen:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

#### Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Paperpal and Chat GPT in order to improve readability and grammar. After using these tools, the authors reviewed and edited the content as needed and

take full responsibility for the content of the published article.

#### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Anne Schoenauer reports a relationship with tilt SMEs GmbH that includes: board membership, employment, and equity or stocks. Anne Schoenauer reports a relationship with 2 Degrees Investing Initiative, Germany e. V that includes: employment. Anne Schoenauer reports a relationship with German Federal Bank that includes: employment and non-financial support. Marc-Philipp Bohnet reports a relationship with Climate & Company gGmbH that includes: employment. Anne Schoenauer, advisory group member of Perseus, initiated by IcebreakerOne and Bankers for Net zero: <https://ib1.org/perseus/> and working group member in the green finance platform: <https://www.greenfinanceplatform.org/>. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.esg.2026.100329>.

#### Data availability

All code, data and further materials produced for this analysis are publicly available at: [https://github.com/MarcPhilippBohnet/CIB\\_EU\\_Decarbonization\\_Pathways.git](https://github.com/MarcPhilippBohnet/CIB_EU_Decarbonization_Pathways.git).

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