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DASHBOARD ON CLIMATE RISK MITIGATION AND ADAPTATION AND THEIR DETERMINANTS AT THE FIRM LEVEL – TECHNICAL REPORT

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Dashboard on Climate Risk Mitigation and Adaptation and Their Determinants at the Firm Level - Technical Report

June 2025

Foreword

This report was prepared by the working group of the Department of Economics and Statistics "Cognetti de Martiis" at the University of Turin, as part of the activities of Spoke 1 within the extended partnership GRINS – Growing Resilient, INclusive and Sustainable, Work Package 4.

The objective of Work Package 4 is to support the long-term value creation of territories and industrial systems through research on business sustainability, with a focus on climate change mitigation and adaptation strategies, and their underlying drivers at the enterprise level.

The dashboard titled **Climate Risk Mitigation and Adaptation and Their Determinants at the Firm Level** is built on Superset, within the Amelia platform. It provides a graphical representation of the information collected through a sample survey of 9,630 Italian firms. This dashboard presents national-level data, but the same methodology was applied in the development of the regional dashboards.

The dashboard is composed of 12 sections: Sample, Risk Perception, Green Investments, Type of Investments, Adaptation and Mitigation Strategies, Drivers of Green Investments, Obstacles to Green Investments, Emission Reduction, Green Financing, Corporate Governance Mechanisms, Ownership Structure, and Biodiversity. The various sections and the graphs within each are described below.

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1)   Sample

This section describes the composition of the sample, consisting of 9,630 limited companies with at least 10 employees.

The **Provinces** graph is a map of the country in which the colour intensity of each province is proportional to the number of companies located there, relative to the total number of companies in the sample.

$$\frac{Number\ of\ firms\ \in Category}{Number\ of\ firms\ in\ the\ sample}\%$$

The mapping is made possible by generating an ISO code variable that assigns each observation the corresponding ISO code of the province to which it belongs.

Provinces
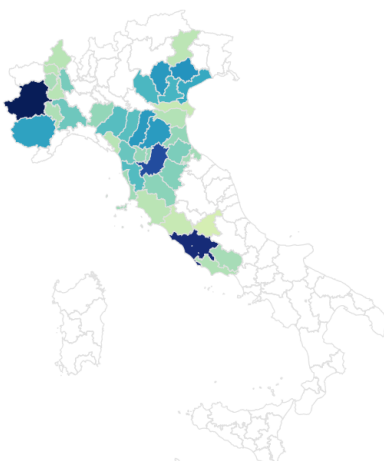
Since ISO codes were not included in the questionnaire, the variable was created in the Jupyter section of the Amelia platform using R code:

```
prov_codes <- c(
  "1" = "IT-TO", "2" = "IT-VC", "3" = "IT-NO", "4" = "IT-CN", "5" = "IT-AT",
  "6" = "IT-AL", "96" = "IT-BI", "103" = "IT-VB", "7" = "IT-BL", "8" = "IT-PD",
  "9" = "IT-RO", "10" = "IT-TV", "11" = "IT-VE", "12" = "IT-VR", "13" = "IT-VI",
  "14" = "IT-MS", "15" = "IT-LU", "16" = "IT-PT", "17" = "IT-FI", "18" = "IT-LI",
  "19" = "IT-PI", "20" = "IT-AR", "21" = "IT-SI", "22" = "IT-GR", "23" = "IT-PO",
  "24" = "IT-PC", "25" = "IT-PR", "26" = "IT-RE", "27" = "IT-MO", "28" = "IT-BO",
  "29" = "IT-FE", "30" = "IT-RA", "31" = "IT-FC", "32" = "IT-RN",
  "33" = "IT-AG",  "34" = "IT-AQ",
  "35" = "IT-VT", "36" = "IT-RI", "37" = "IT-RM", "38" = "IT-LT",  "39" = "IT-FR"
  , "40" = "IT-AV", "41" = "IT-BA", "42" = "IT-BN", "43" = "IT-BR",
  "44" = "IT-BT", "45" = "IT-CA", "46" = "IT-CB", "47" = "IT-CE", "48" = "IT-CH",
  "49" = "IT-CL", "50" = "IT-CS", "51" = "IT-CT", "52" = "IT-CZ", "53" = "IT-EN",
  "54" = "IT-FG", "55" = "IT-IS", "56" = "IT-KR", "57" = "IT-LE", "58" = "IT-ME",
  "59" = "IT-MT", "60" = "IT-NA", "61" = "IT-NU", "62" = "IT-OR", "63" = "IT-PA",
  "64" = "IT-PE", "65" = "IT-PZ", "66" = "IT-RC", "67" = "IT-RG", "68" = "IT-SA",
  "69" = "IT-SR", "70" = "IT-SS", "71" = "IT-SD", "72" = "IT-TA", "73" = "IT-TE",
  "74" = "IT-TP", "75" = "IT-VV"
)
```

To generate the chart, the programme counts the number of companies in each category within the **metric** section.

$f(x)$ COUNT(*)

Sample by province is a pie chart showing the distribution of the sample across the Italian provinces. The size of each slice is proportional to the number of enterprises in the corresponding province. In other words, the area of each segment reflects the ratio of enterprises in that province to the total number of enterprises in the sample.


Sample by province (%)
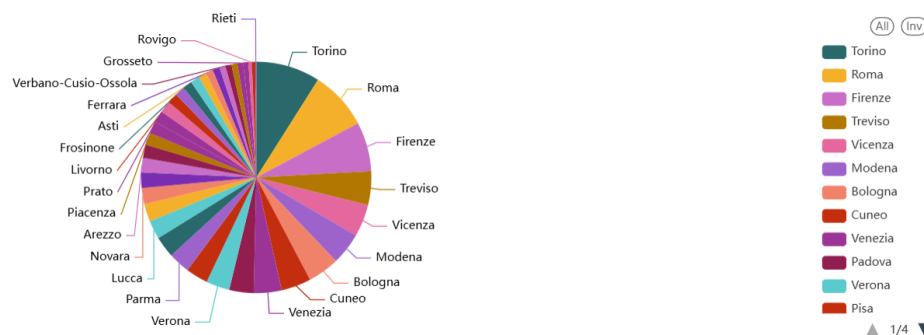
In the metric section, the programme counts the number of enterprises in each category.

$f(x)$ COUNT(*)

Sample by size is a bar chart showing the distribution of the sample by enterprise size. The length of each bar reflects the proportion of enterprises in that category relative to the total number of enterprises in the sample.

Sample by sector: eligible – not eligible is a bar chart showing the distribution of the sample according to whether the enterprise operates in an eligible or non-eligible sector. This classification is based on whether the company's sector of activity falls within the scope of the European taxonomy. The length of each bar reflects the proportion of enterprises in each category relative to the total number of enterprises in the sample
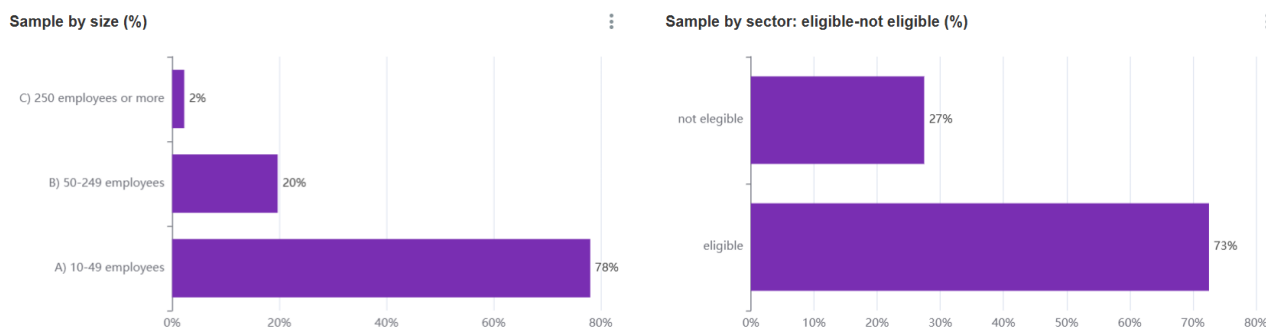
For the calculation of the bars, the programme uses the count metric and the "Series" contribution mode.

As the variables in the questionnaire are represented by numerical values without category labels, the programme assigns a label to each numerical value in the Y-axis section using custom SQL:
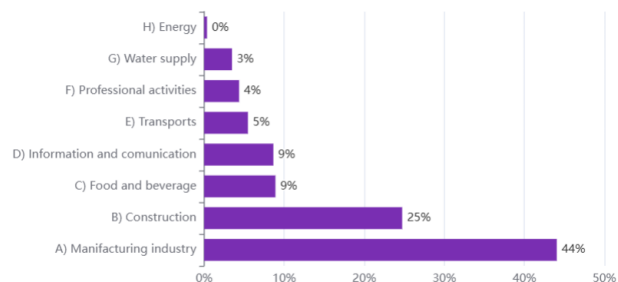
Sample by sector – eligible sectors is a bar chart that examines the distribution of companies in the sample limited to eligible sectors. The length of each bar reflects the proportion of firms in each category relative to the total number of eligible firms in the sample.

$$\frac{Numero\ imprese\ \in Categoria}{Numero\ di\ imprese\ del\ campione\ eligible}\%$$

**Sample by sector (%) - eligible sectors**

Sector	%
H) Energy	0%
G) Water supply	3%
F) Professional activities	4%
E) Transports	5%
D) Information and comunication	9%
C) Food and beverage	9%
B) Construction	25%
A) Manufacturing industry	44%

2) Risk perception

Climate risk perception is a bar chart showing firms' perceptions of climate risk. The height of each bar is proportional to the percentage of companies in the sample that indicated belonging to that category that is: the number of companies in the category divided by the total number of companies in the sample.
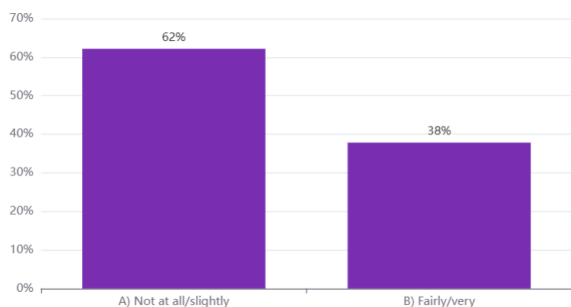
Climate risk perception (%)

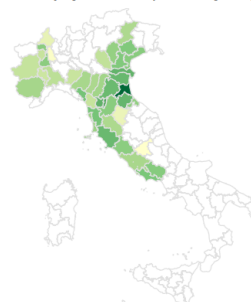| Category	%
A) Not at all	22%
B) Slightly	31%
C) Fairly	39%
D) Very	8%
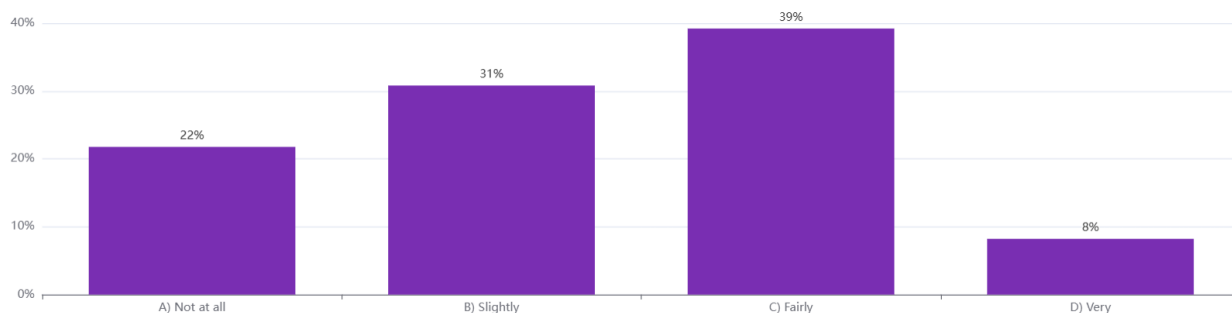
Climate risk perception: acute physical risk is a bar chart presenting the perception of acute physical risk among the sample companies. The categories have been merged pairwise from the previous chart. The height of each bar reflects the proportion of enterprises in each category relative to the total sample.

Climate risk perception: acute physical risk (% "Fairly–very") is a country map where the colour intensity of each province corresponds to the proportion of enterprises that responded "Fairly–Very" regarding their perception of acute physical risk, relative to the total number of enterprises in the province. The higher the value, the more intense the colour.

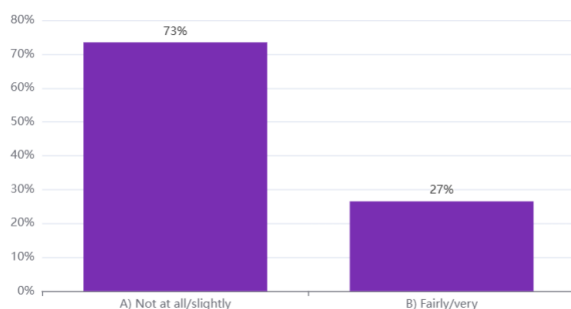Climate risk perception: acute physical risk (%)

Climate risk perception: acute physical risk (% "Fairly-very")

Climate risk perception: chronic physical risk is a bar chart illustrating companies' perception of chronic physical risk. The height of each bar represents the proportion of enterprises in each category relative to the total sample.

Climate risk perception: chronic physical risk (% "Fairly–very") is a country map where the colour intensity of each province depends on the proportion of companies responding "Fairly–Very" to the perception of chronic physical risk, compared to the total companies in the province. Higher values correspond to more intense colours.

Climate risk perception: chronic physical risk (%)

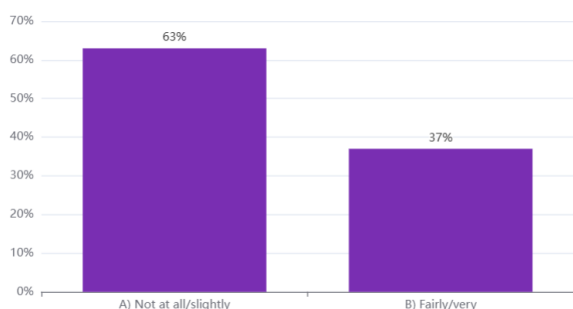Climate risk perception: chronic physical risk (% "Fairly-very")
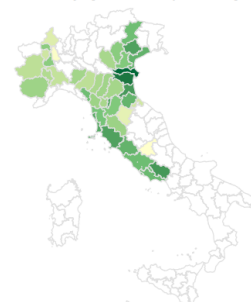
Climate risk perception: transition risk is a bar chart showing firms' perceptions of transition risk. The height of each bar indicates the proportion of firms in each category relative to the total sample.

Climate risk perception: transition risk (% "Fairly–very") is a country map where the colour intensity of each province reflects the proportion of enterprises responding

"Fairly–Very" to the perception of transition risk, relative to the total enterprises in the province. The higher the proportion, the more intense the colour.
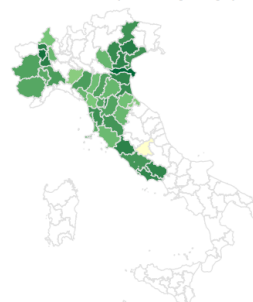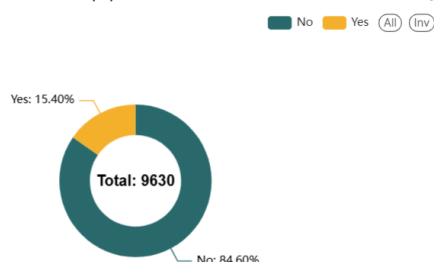

3) Green investments

Green investments 2021–2023: Acute Physical Risk (APR) is a donut chart displaying companies' responses to the question of whether they made investments during the period 2021–2023 in response to acute physical risk. The size of each slice is proportional to the number of companies in the sample that identified with the corresponding response category. Specifically, the area of each segment of the donut represents the proportion of companies in that category relative to the total number of companies in the sample.
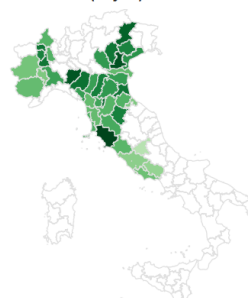
Green investments 2021–2023: APR (% yes) is a country map in which the intensity of the colour of each province reflects the proportion of companies that responded "Yes" to having made investments in response to acute physical risk during the period 2021–2023, relative to the total number of companies in that province. The higher this proportion, the more intense the colour.
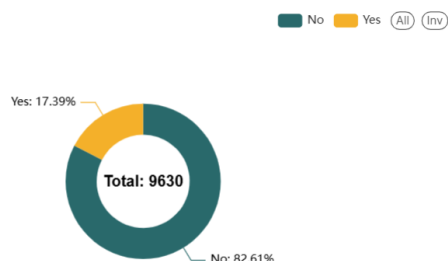
What was done for the three-year period 2021–2023 is also replicated for the same questions relating to investment intentions for the three-year period 2024–2026.

Green investments 2024-2026: APR (%)

No   Yes (All) (Inv)

Yes: 17.39%

Total: 9630

No: 82.61%

Green investments 2024-2026: APR (% yes)
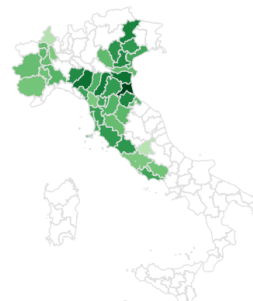
Similarly, the analysis conducted for acute physical risk is repeated for chronic physical risk and transition risk.

Chronic physical risk (CPR)

Green investments 2021-2023: CPR (%)

No   Yes (All) (Inv)

Yes: 8.20%

Total: 9630

No: 91.80%
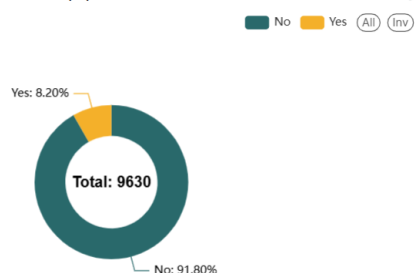
Green investments 2021-2023: CPR (% yes)

Green investments 2024-2026: CPR (%)

No   Yes (All) (Inv)

Yes: 10.16%

Total: 9630

No: 89.84%

Green investments 2024-2026: CPR (% yes)

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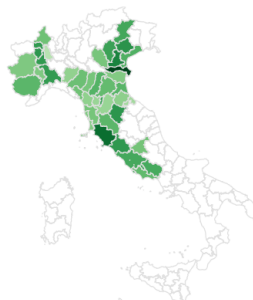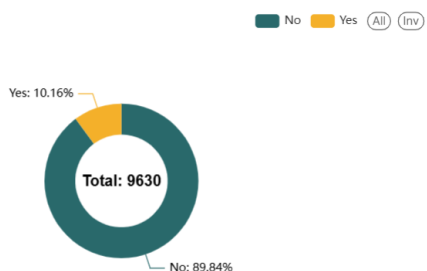
Transition risk (TR)

Green investments 2021-2023: TR (%)

No   Yes   (All) (Inv)

Yes: 23.39%

Total: 9630

No: 76.61%
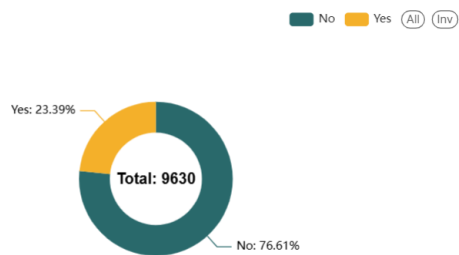
Green investments 2021-2023: TR (% yes)

Green investments 2024-2026: TR (%)
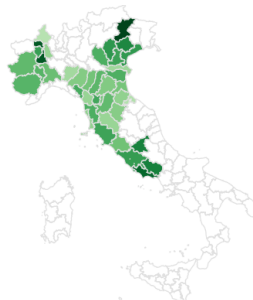
No   Yes   (All) (Inv)

Yes: 25.57%

Total: 9630

No: 74.43%
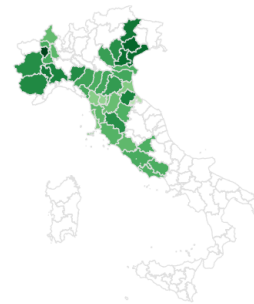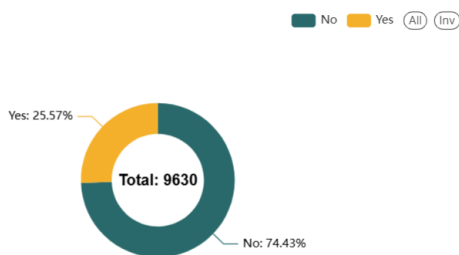
Green investments 2024-2026: TR (% yes)
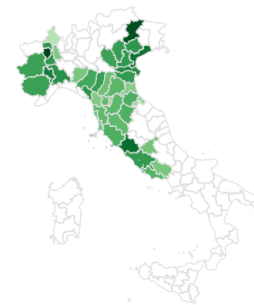
4) Risk perception

Green investments physical risk 2021–2023 is a bar chart illustrating the types of investments companies reported making in response to physical risk over the three-year period 2021–2023. The height of each bar is proportional to the number of companies in each category divided by the total number of investments made in response to physical risk.

Green investments physical risk 2021-2023 (%)

(All) (Inv)

- Insurance contracts
- Water waste reduction
- Damage protection
- Business model change
- Production diversification
- Other
- Production relocation
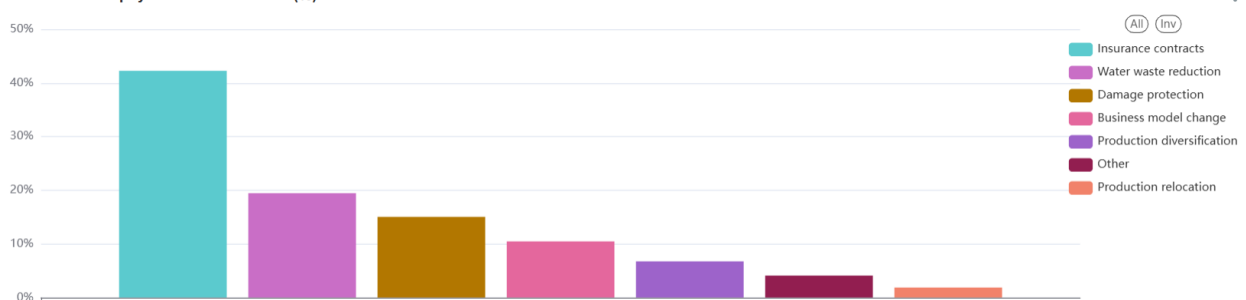
To generate this chart, a metric was defined for each possible response, counting the number of companies selecting that category:

```
Business model change ✏️

SAVED        SIMPLE        CUSTOM SQL

SUM(inv_pass_rf_cambiamento_business)/ SUM(
    CASE
        WHEN d3_1 = 1 OR d3_2 = 1 THEN 1
        ELSE 0
    END
)

        CLOSE              SAVE
```

The same approach is applied to analyse investment intentions for 2024–2026.

Green investments physical risk 2024-2026 (%)

- Insurance contracts
- Water waste reduction
- Damage protection
- Business model change
- Production diversification
- Other
- Production relocation
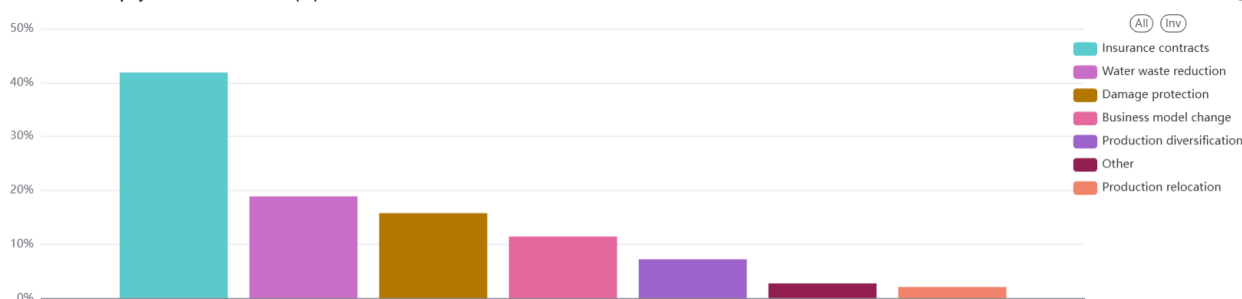
The same structure is also adopted for transition risk.

Green investments transition risk 2021-2023 (%)

- Increase in renewable
- Emissions reduction
- Waste reduction
- Introduction of sustainable mobility
- Trees planting
- Carbon credit
- Other

Green investments transition risk 2024-2026 (%)

- Increase in renewable
- Emissions reduction
- Waste reduction
- Introduction of sustainable mobility
- Carbon credit
- Trees planting
- Other
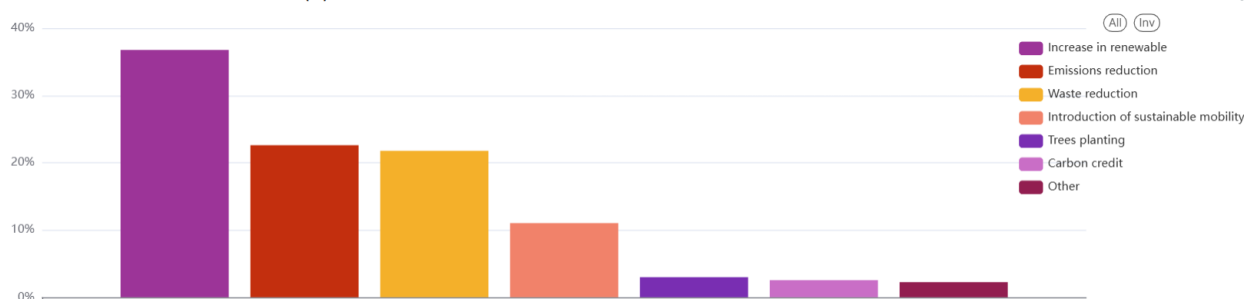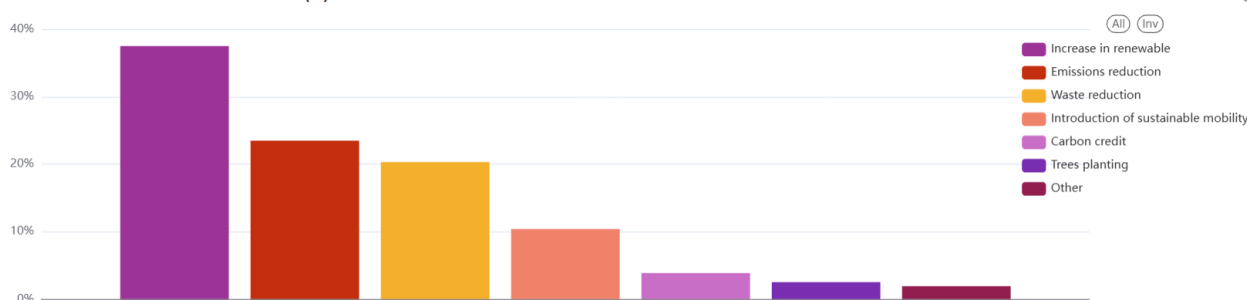
5) Adaptation and mitigation strategies

Four investment strategies are defined in response to climate risks:

4 climate strategies:

- **Wait-and-See**: firms didn't invest in the **2021-2023** period and don't plan to invest in the **2024-2026** period;
- **Planner**: firms didn't invest in the **2021-2023** period, but plan to invest in the **2024-2026** period;
- **Foresighted**: firms invested in the **2021-2023** period, but don't plan to invest in the **2024-2026** period;
- **Proactive**: firms invested in the **2021-2023** period and plan to invest in the **2024-2026** period.

Adaptation strategies: acute physical risk is a pie chart showing the percentage of companies associated with each of the four defined strategies in response to acute physical risk. The size of each slice is proportional to the number of companies following that strategy, relative to the total sample.

The variable defining strategy in response to acute physical risk was generated using R as follows:

```
strategia_rfa <- with(dataset_totale, ifelse(d3_1 == '2' & d6_1 == '2', 'Wait and see',
        ifelse(d3_1 == '2' & d6_1 == '1', 'Planner',
        ifelse(d3_1 == '1' & d6_1 == '2', 'Foresighted',
        ifelse(d3_1 == '1' & d6_1 == '1', 'Proactive', 'Altro')))))
```
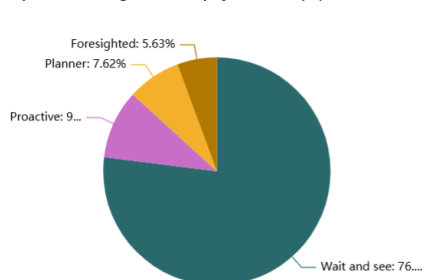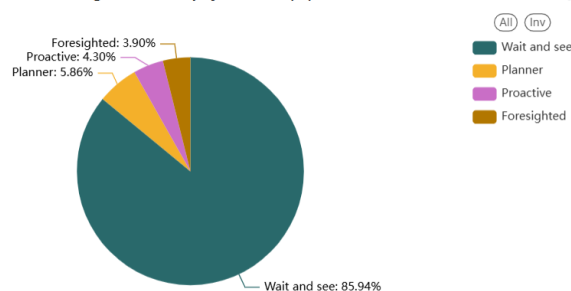
Where d3_1 indicates whether the firm invested in the period 2021–2023 in response to acute physical risk (value = 1 if yes, 2 if no), and d6_1 indicates whether the firm intends to invest in the period 2024–2026 (value = 1 if yes, 2 if no)

The same analysis is conducted for chronic physical risk and transition risk.

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Mitigation strategies: transition risk (%)
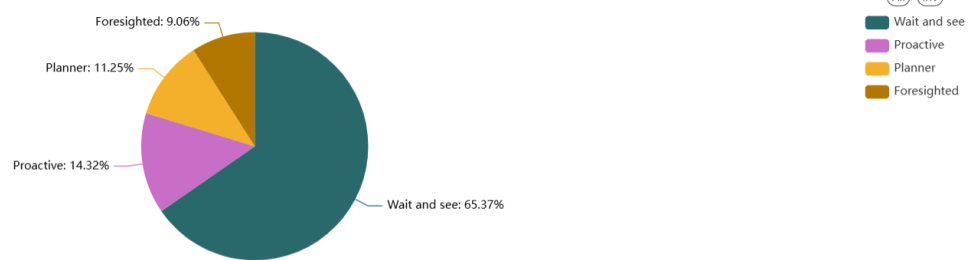
- Wait and see
- Proactive
- Planner
- Foresighted

Foresighted: 9.06%
Planner: 11.25%
Proactive: 14.32%
Wait and see: 65.37%

Adaptation strategies and climate risk perception is a bar chart showing the distribution of acute physical risk perception across different strategies. The height of each bar is proportional to the number of firms in each perception category (e.g., high or low) among those adopting each strategy, divided by the total number of firms adopting that strategy.

Adaptation and mitigation strategies and climate risk perception
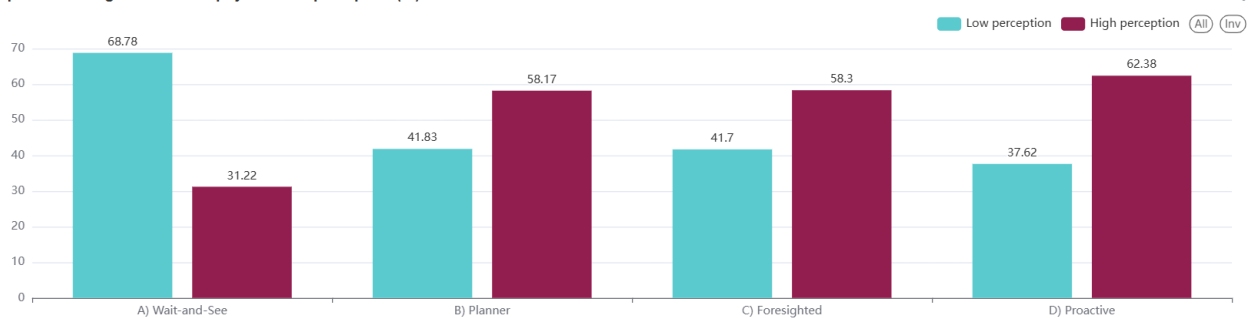
Adaptation strategies and acute physical risk perception (%)

Legend: Low perception, High perception (All) (Inv)

Strategy	Low perception	High perception
A) Wait-and-See	68.78	31.22
B) Planner	41.83	58.17
C) Foresighted	41.7	58.3
D) Proactive	37.62	62.38

The same visualisation is provided for chronic physical risk and transition risk.

Adaptation strategies and chronic physical risk perception (%)

Legend: Low perception, High perception (All) (Inv)

Strategy	Low perception	High perception
A) Wait-and-See	77.71	22.29
B) Planner	50.35	49.65
C) Foresighted	51.86	48.14
D) Proactive	40.1	59.9
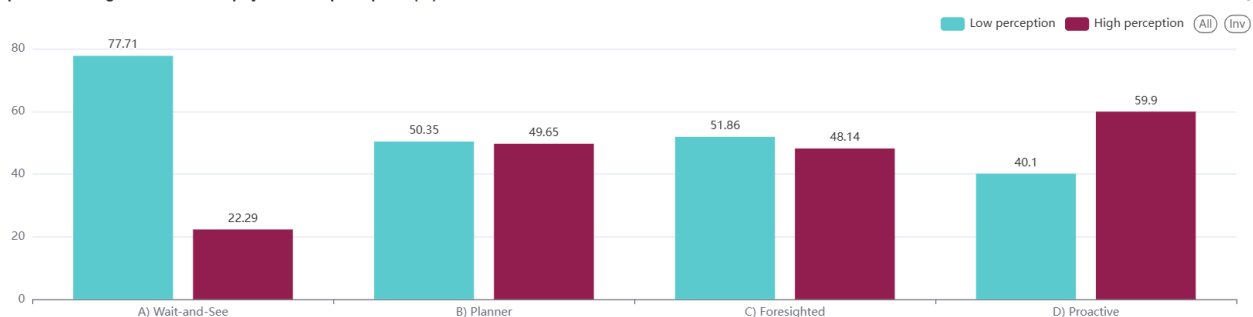
Mitigation strategies and transition risk perception (%)

Wait and See, Planner, Foresighted and Proactive firms by size is a bar chart showing the distribution of strategies across firm size categories. The height of each bar represents the number of firms in each size category adopting each strategy, divided by the total number of firms adopting that strategy.

Adaptation and mitigation strategies and firm size
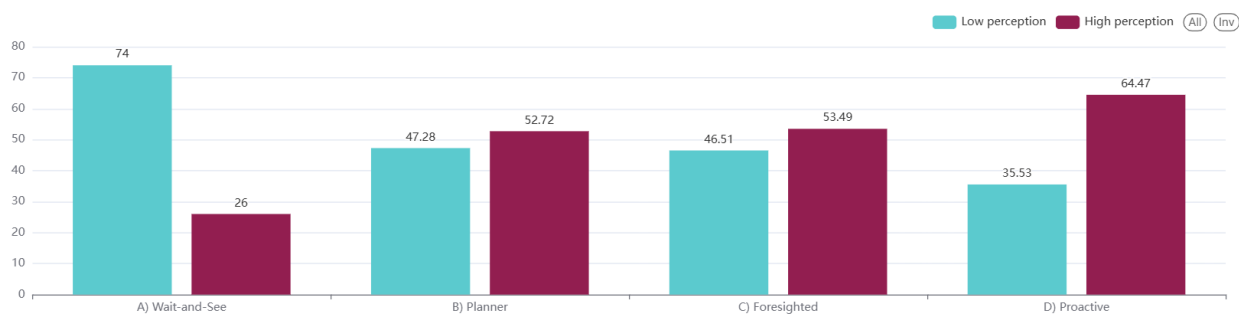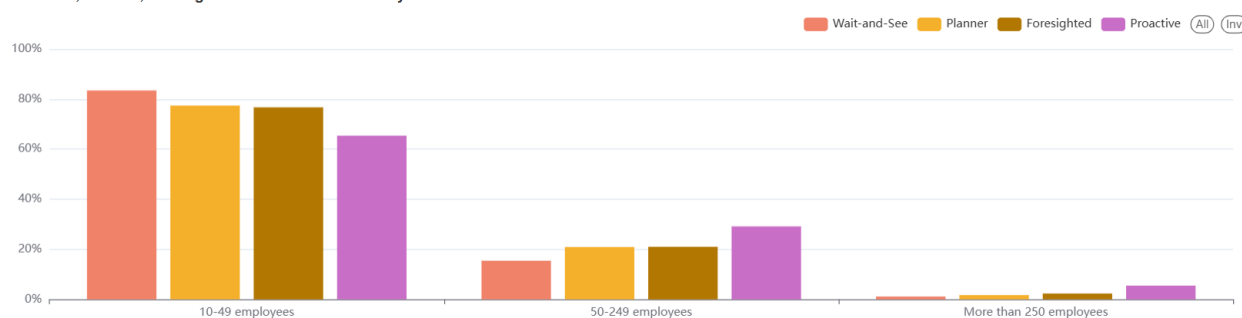

In this case, the strategies are not considered separately for each type of risk. Rather, they are combined across acute physical risk, chronic physical risk, and transition risk.

The combined strategy variable is defined as follows: d3_1, d3_2, and d3_3 represent investment responses for acute, chronic, and transition risk, respectively, during 2021–2023. And d6_1, d6_2, and d6_3 represent investment intentions for the same three risks during 2024–2026.

```
strategia <- with(dataset_totale, ifelse((d3_1 == 2 & d3_2 == 2 & d3_3 == 2) &
            (d6_1 == 1 | d6_2 == 1 | d6_3 == 1), 'B) Planner',
      ifelse((d3_1 == 1 | d3_2 == 1 | d3_3 == 1) &
            (d6_1 == 2 & d6_2 == 2 & d6_3 == 2), 'C) Foresighted',
      ifelse((d3_1 == 1 | d3_2 == 1 | d3_3 == 1) &
            (d6_1 == 1 | d6_2 == 1 | d6_3 == 1), 'D) Proactive',
      'A) Wait and See'))))
```

The Proactivity Index is defined using the variables described above.

Adaptation and mitigation startegies: proactivity index

The proactivity index at the provincial level is calculated as the average of the strategy variable defined in this way:

- **Wait-and-See** = 1;
- **Planner** = 2;
- **Foresighted** = 2;
- **Proactive** = 3.

Proactivity index physical risk is a country map in which the colour intensity of each province reflects the value of the proactivity index. A higher intensity corresponds to a higher level of proactivity in response to physical risks.

```
AVG(
    CASE
        WHEN d3_3 = '2' AND d6_3 = '2' THEN 1
        WHEN d3_3 = '2' AND d6_3 = '1' THEN 2
        WHEN d3_3 = '1' AND d6_3 = '2' THEN 2
        WHEN d3_3 = '1' AND d6_3 = '1' THEN 3
    END
)
```

This analysis is also replicated for chronic physical risk and transition risk.

Proactivity index acute physical risk
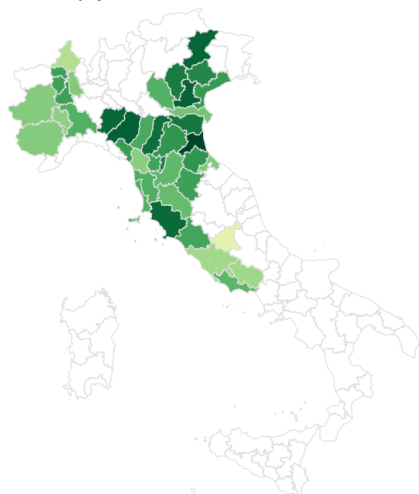
Proactivity index chronic physical risk
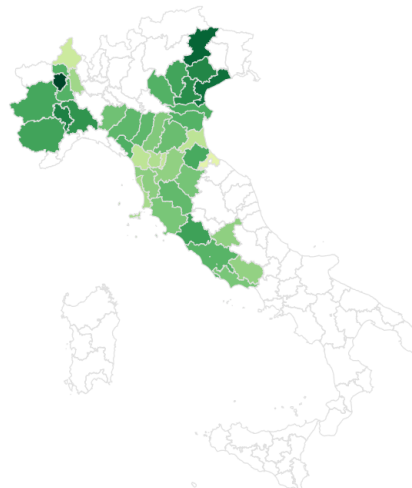
6)   Green investments drivers

Green investment drivers is a bar chart showing the factors that motivated companies to invest (among those that reported having done so). The height of each bar is proportional to the number of firms indicating each driver, divided by the total number of declared drivers.
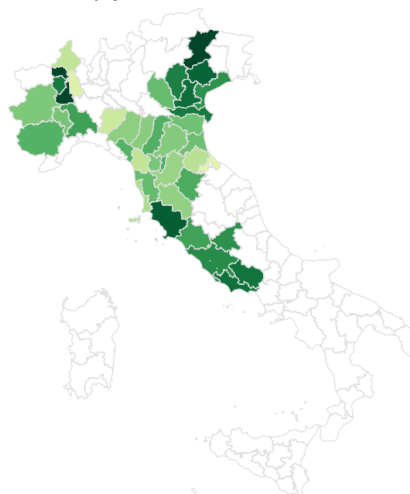
Green investments drivers (%)

Legend:
- Personal sensitivity
- Increase in energy prices
- Regulatory pressure
- Customer pressure
- Competitive advantage
- Past losses
- Bank pressure
- Supplier pressure
- Pressure from other financiers
- Other
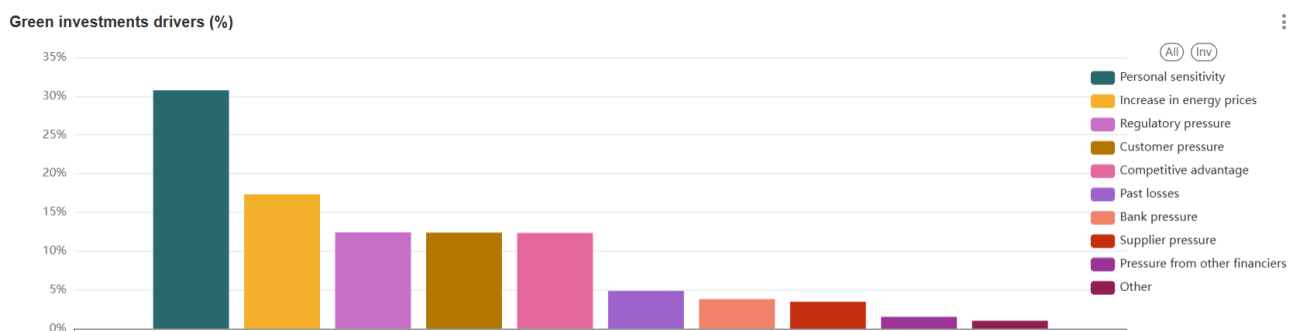
7)   Green investments obstacles

Green investment obstacles is a bar chart showing the main barriers to investment (among firms that reported not having invested). The height of each bar is proportional to the number of companies citing each obstacle, divided by the total number of obstacles reported.

Green investments obstacles (%)

Legend
High cost
Uncertainty
No obstacles
Insufficient external funding
Energy costs drain resources
Lack of internal resources
Lack of interest
Lack of expertise
Other
Bureaucracy
The type of activity is not suitable
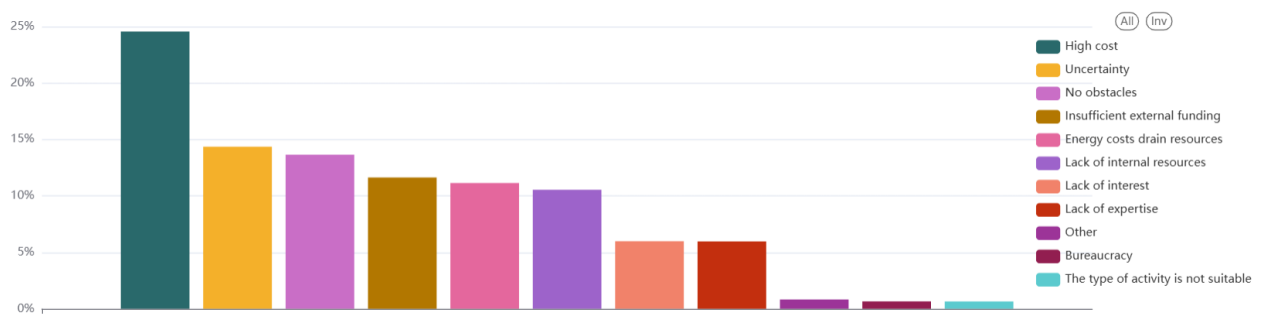
8)   Emission reduction

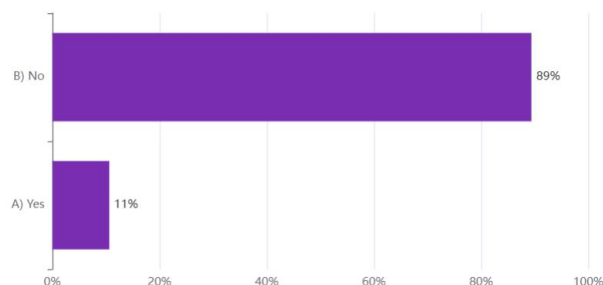**Emission reduction targets** is a bar chart presenting responses to whether firms have set targets to reduce CO_2 emissions. The height of each bar is proportional to the number of companies in each category, divided by the total number of companies in the sample.

Emission reduction targets (% yes) is a country map showing the share of companies responding "Yes" in each province. The intensity of the colour corresponds to the percentage of positive responses: the higher the percentage, the more intense the colour.

Emission reduction targets (%)

**Emission reduction targets (% yes)**

Emission reduction plan is a bar chart that illustrates the types of plans adopted by companies that reported having set emission reduction targets. The height of each bar is proportional to the number of companies in each category, divided by the number of companies that declared having a target.

Emission reduction plan (%)
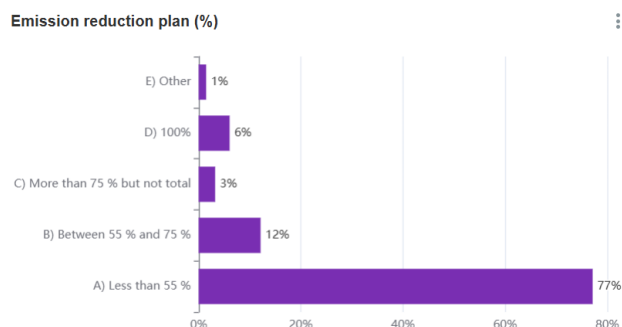
9) Green financing

Interest rate on green financing more favorable is a bar chart showing how companies responded to the question of whether they received a more favourable interest rate on green loans compared to conventional non-green financing. The height of each bar reflects the proportion of companies in each category.

Interest rate on green financing more favorable (% yes) is a country map showing, by province, the proportion of companies responding "Yes" to having received a favourable rate. Colour intensity increases with the percentage of affirmative responses.

Interest rate on green financing more favorable (%)

Interest rate on green financing more favorable (% yes)
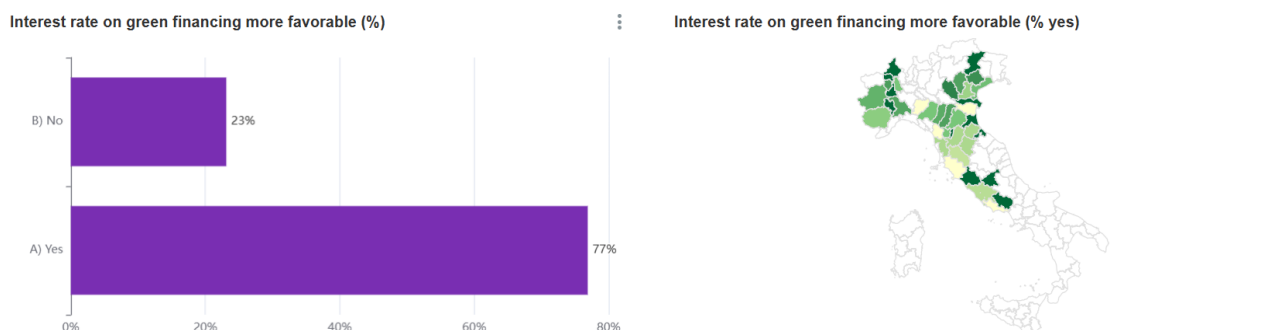
10) Corporate governance mechanism and strategy

The charts in the Corporate Governance Mechanism and Strategy section are bar charts showing the percentage of companies following each investment strategy that report having specific governance mechanisms in place. The length of each bar is proportional to the number of firms within each strategy possessing the mechanism, divided by the total number of firms in that strategy.

Enviromental manager (%)

Strategy	Value
D) Proactive	30.1
C) Foresighted	16.3
B) Planner	17.2
A) Wait and See	7.5

Sustainability report(%)
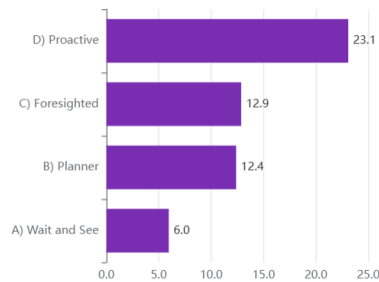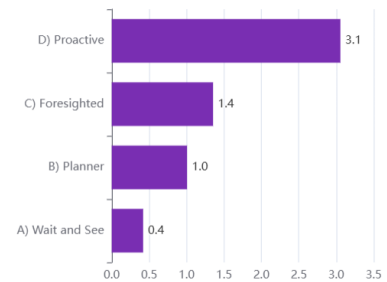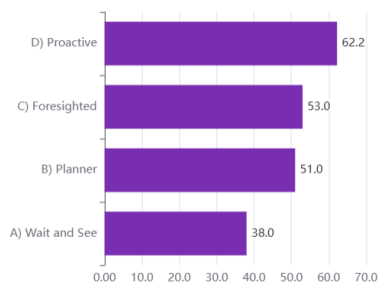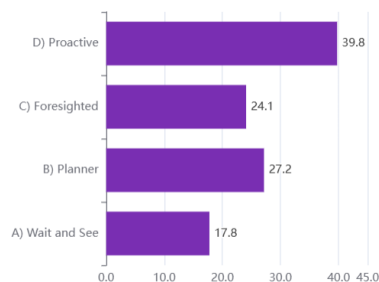
Strategy	Value
D) Proactive	23.1
C) Foresighted	12.9
B) Planner	12.4
A) Wait and See	6.0
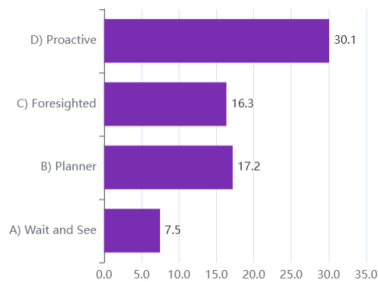
Remuneration linked to climate targets (%)

Strategy	Value
D) Proactive	3.1
C) Foresighted	1.4
B) Planner	1.0
A) Wait and See	0.4

Sustainable finance knowledge (%)

Strategy	Value
D) Proactive	62.2
C) Foresighted	53.0
B) Planner	51.0
A) Wait and See	38.0

Training on sustainable finance (%)

Strategy	Value
D) Proactive	39.8
C) Foresighted	24.1
B) Planner	27.2
A) Wait and See	17.8

Adherence to UN Global Compact (%)

Strategy	Value
D) Proactive	2.2
C) Foresighted	0.3
B) Planner	0.4
A) Wait and See	0.3

Adherence to SBTI (%)

Strategy	Value
D) Proactive	1.2
C) Foresighted	0.4
B) Planner	0.6
A) Wait and See	0.3

Benefit company (%)

Strategy	Value
D) Proactive	3.5
C) Foresighted	2.1
B) Planner	1.5
A) Wait and See	1.0
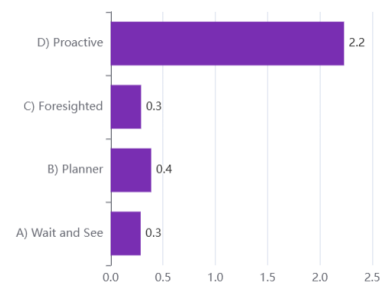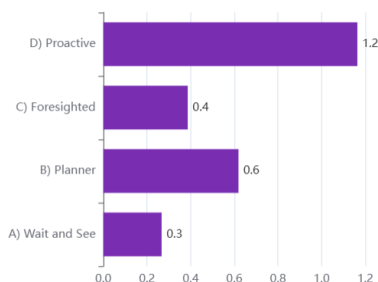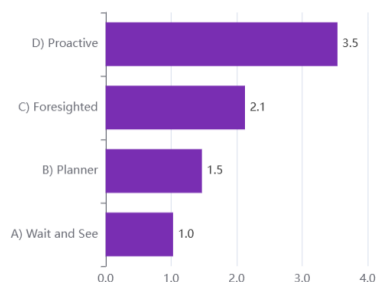
11)   Ownership structure and proactivity

Ownership structure and proactivity is a bar chart showing how companies are distributed across different ownership types for each strategy. The length of each bar represents the number of firms in each ownership category within a given strategy, relative to the total number of firms adopting that strategy.
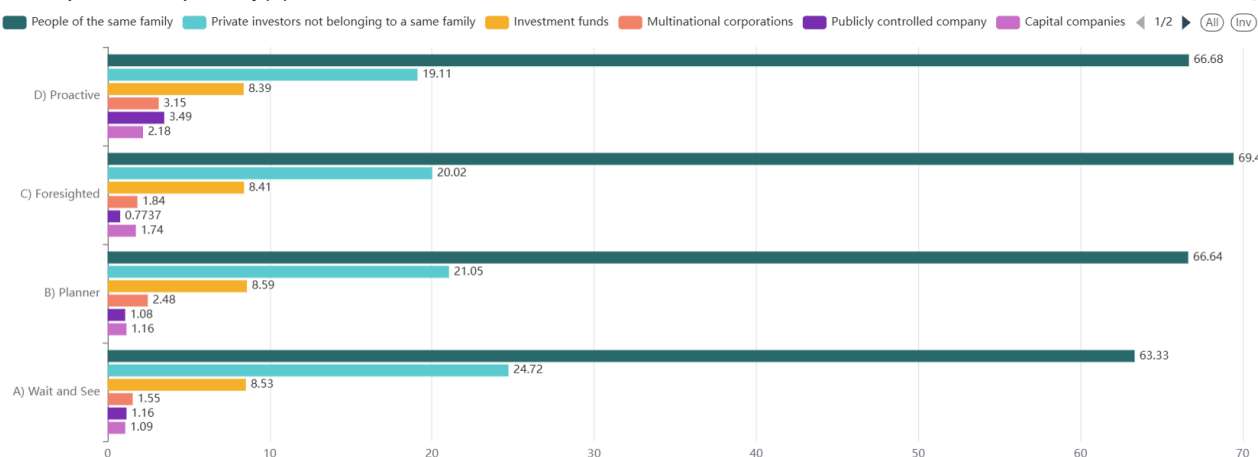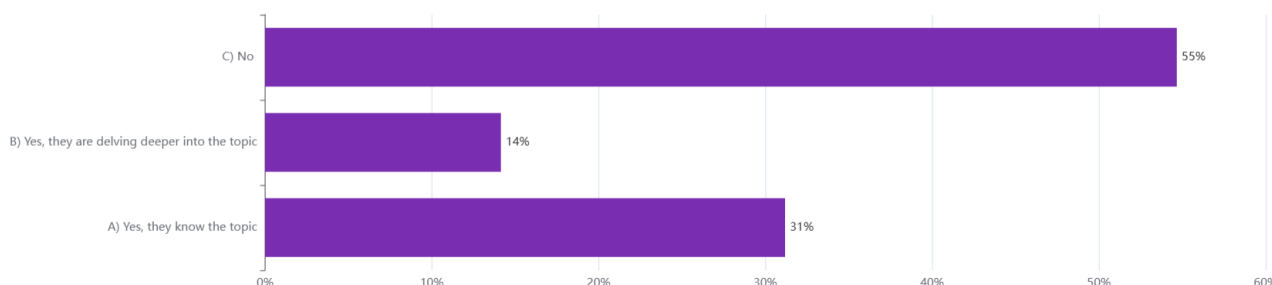
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Ownership structure and proactivity (%)

■ People of the same family ■ Private investors not belonging to a same family ■ Investment funds ■ Multinational corporations ■ Publicly controlled company ■ Capital companies ◀ 1/2 ▶ (All) (Inv)

D) Proactive	66.68 / 19.11 / 8.39 / 3.15 / 3.49 / 2.18
C) Foresighted	69.4 / 20.02 / 8.41 / 1.84 / 0.7737 / 1.74
B) Planner	66.64 / 21.05 / 8.59 / 2.48 / 1.08 / 1.16
A) Wait and See	63.33 / 24.72 / 8.53 / 1.55 / 1.16 / 1.09

12) Biodiversity

Knowledge of biodiversity is a bar chart displaying how firms responded to the question on their knowledge of biodiversity. The height of each bar corresponds to the number of enterprises in each category, divided by the total sample.
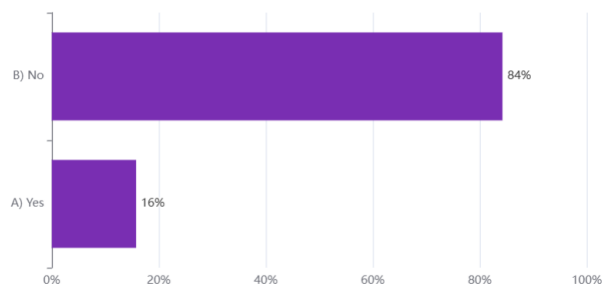
Knlowledge of biodiversity(%)

C) No	55%
B) Yes, they are delving deeper into the topic	14%
A) Yes, they know the topic	31%

Formal inclusion of biodiversity is a bar chart showing responses to whether companies have formally integrated biodiversity into their organisational practices. The height of each bar represents the proportion of enterprises in each category.

Formal inclusion of biodiversity (% yes) is a country map in which the intensity of each province's colour reflects the proportion of companies responding "Yes" to including biodiversity in their operations. The higher the proportion, the more intense the colour.

Formal inclusion of biodiversity (%)

Formal inclusion of biodiversity (% yes)