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Disorderly climate transition: the risks for financial markets?

If the transition to a low-carbon economy were to be delayed, abrupt and uncoordinated, it could lead to substantial losses on the financial markets. According to the forward-looking indicator presented in this article, equities would be the most exposed financial assets at global level, facing a sharp correction of 6.8% on average. However this number would vary considerably across different sectors. It could amount to as much as -24% for fossil fuels, where some companies would lose most of their value. Corporate and sovereign bonds would be less sensitive to these developments. The French financial sector (i.e. banks, insurers and investment funds) appears capable of absorbing the transition risk, particularly thanks to the sectoral diversification of portfolios, however, some players could face greater losses. These estimates do not take aggravating factors into account: the difficulties of adapting physical capital, the potential amplification of financial shocks, and the materialisation of physical risks linked to climate change whose effects could prove more severe in the medium term.

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JEL Codes
G11, G12,
G20, Q54

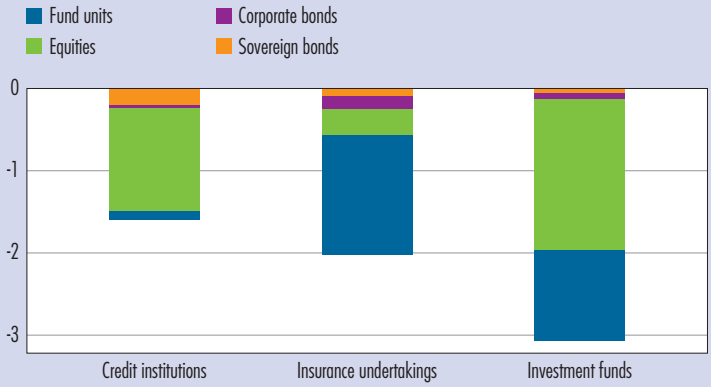
A disorderly climate transition would imperil

EUR 2,900 billion
in market capitalisation between now and 2045 (i.e. -6.8% on average)

-24%
the estimated loss in value on equities issued by the fossil fuel sector

EUR 29 billion
in impairment on assets managed by French investment funds (i.e. -3% on average)

Potential correction to French financial intermediaries' securities portfolios under a delayed transition scenario
(contribution to portfolio impairment, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHS-S, OPC-Titres, Lipper; Banque de France calculations.
Notes: Data at June 2024. The correction is calculated as the weighted average of potential losses on more than 94,000 securities held, based on their weight in the aggregate portfolio of each investor category. These estimates are based on the 2023-45 projection horizon of the NGFS scenarios (phase III).

BANQUE DE FRANCE
EUROSYSTÈME

1 A forward-looking transition risk indicator for the French financial sector

Climate change represents both an environmental challenge and a risk to economic and financial stability. Faced with tangible and accelerating global warming (World Meteorological Organisation, 2025), and inadequate international efforts to reduce greenhouse gas emissions (United Nations Environment Programme, 2024), the economic and financial system is exposed to increased climate risk – both **physical** (increased frequency and magnitude of natural disasters) and **transitional** (new climate policies, technological disruption or changes in consumer preferences). If these changes are not anticipated, they could lead to sharp corrections in the financial markets and impairment of the portfolios held by financial intermediaries (banks, insurance companies, investment funds).

Despite a scientific consensus and the worsening effects of climate change, the future direction of climate policy remains uncertain. This uncertainty is fuelled by mixed political signals. The US federal administration has backtracked on its climate change programme.[1] The European Union has simplified certain environmental regulations to safeguard the competitiveness of businesses,[2] putting a strain on the disclosure framework. Finally, geopolitical tensions have led to a prioritisation of energy security and defence in a context of severe budgetary constraints (International Energy Agency, 2022). For investors, these signals complicate efforts to anticipate the future framework, increase the cost of capital for green projects and may hamper the investments needed for the low-carbon transition. This lack of visibility increases the risk of a disorderly adjustment, which could threaten financial stability.

It is essential for financial intermediaries (as well as supervisory authorities) to be able to anticipate the effects of climate risk on financial markets. Traditional indicators, which focus on portfolio exposure to carbon-intensive assets or sectors affected by climate policy (see, for example, Gosset and Nefzi, 2023; Jourde, Piquard and Salakhova, 2024), do not provide a direct monetary quantification of the risk of a correction to financial portfolios. It is therefore necessary to develop forward-looking indicators capable of estimating the impacts of various climate scenarios on the value of financial assets. Such indicators can facilitate proactive risk management by public and private actors.

This study presents a new forward-looking indicator of climate transition risk for market portfolios in the French financial sector. It is based on the climate scenarios of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) and projects the impact of the low-carbon transition on corporate revenue and financial asset values on a granular scale. This revenue-based approach rounds out existing cost-based approaches – which model the impact of higher carbon prices on corporate margins[3] – by incorporating changes in sectoral production structures driven by consumer preferences, technological disruption and policy interventions. All in all, the revenue-based approach developed in this study provides a complementary perspective of the risks and opportunities associated with the low-carbon transition.

1 "Trump's 100 days of upending climate policy", *The New York Times*, 29 April 2025.

2 "Tout ce qu'il faut savoir sur la loi omnibus", *Novethic*.

3 For example, the European Central Bank's climate stress tests (Alogoskoufis et al., 2021; Emambakhsh et al., 2023) and the European Fit-for-55 climate scenario analysis (European Supervisory Authorities and European Central Bank, 2024).

BOX

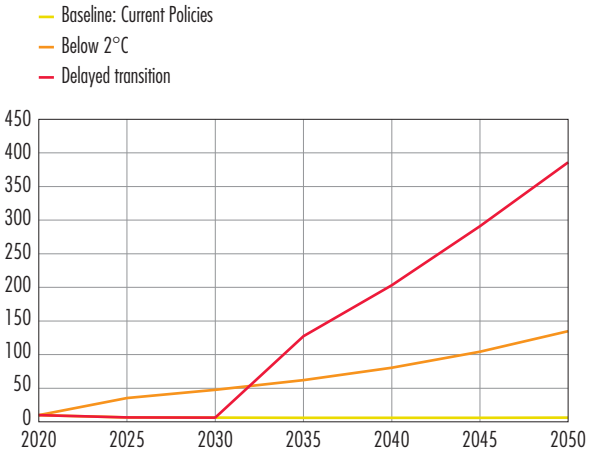
Climate scenarios and transmission channels to the financial sector

The forward-looking indicator of climate transition risk is based on sector-level economic projections of long-term climate scenarios developed by the Network for Greening the Financial System (NGFS, 2022, phase III scenarios), which are then broken out by company based on a breakdown of company revenue.

These hypothetical climate scenarios provide a common reference framework for analysing possible climate policy and low-carbon technology trajectories, as well as their potential effects on the economy. They also describe the associated physical risks, but this aspect is not covered in this article. Three scenarios are considered, covering a range of futures with varying degrees of transition risk:

- The "**Current Policies**" scenario, which serves as a **reference** in this study, reflects only current climate policies and does not incorporate any increased stringency (no transition risk). Such a scenario would lead to average warming of 3.2°C;
- The "**Below 2°C**" scenario, characterised by an orderly transition during which climate policies become gradually more stringent. It corresponds to a two-thirds probability of limiting global warming to less than 2°C (moderate transition risk). This scenario results in a loss of global GDP of 0.7% in 2045, compared to the baseline scenario, over the same period.
- The "**delayed transition**" scenario, in which drastic measures are taken suddenly and late to limit warming to below 2°C (high transition risk). This scenario results in a loss of global GDP of 1.8% in 2045, compared to the baseline scenario over the same timeframe.

Projected global price per tonne of CO_2
(in 2010 US dollars/tCO_2)



Source: NGFS (2022).
Note: The price represents the marginal cost of reducing greenhouse gas emissions and is an indicator of the ambition and effectiveness of climate policies under each scenario.

NGFS projections based on physical production factors are restated to assess the impacts of the transition on the future revenues of non-financial sectors and on a set of macroeconomic variables (GDP growth and inflation). More specifically, income projections by sector of activity (e.g. aluminium, cement, renewable energy production, etc.) are combined with company revenue segmentation data to obtain microeconomic projections.

These microeconomic data are sourced from BloombergNEF, based on phase III of the NGFS scenarios (2022). Therefore, they do not take account of the latest reported contributions and progress – and setbacks – since 2022. In comparison, phase V (NGFS, 2024) includes higher temperature increases and narrower transition windows for most scenarios. However, given the progress made by businesses and governments between 2022 and 2024 (e.g., the Inflation Reduction Act in the United States, whose main component concerns the climate, and the Fit-for-55 package

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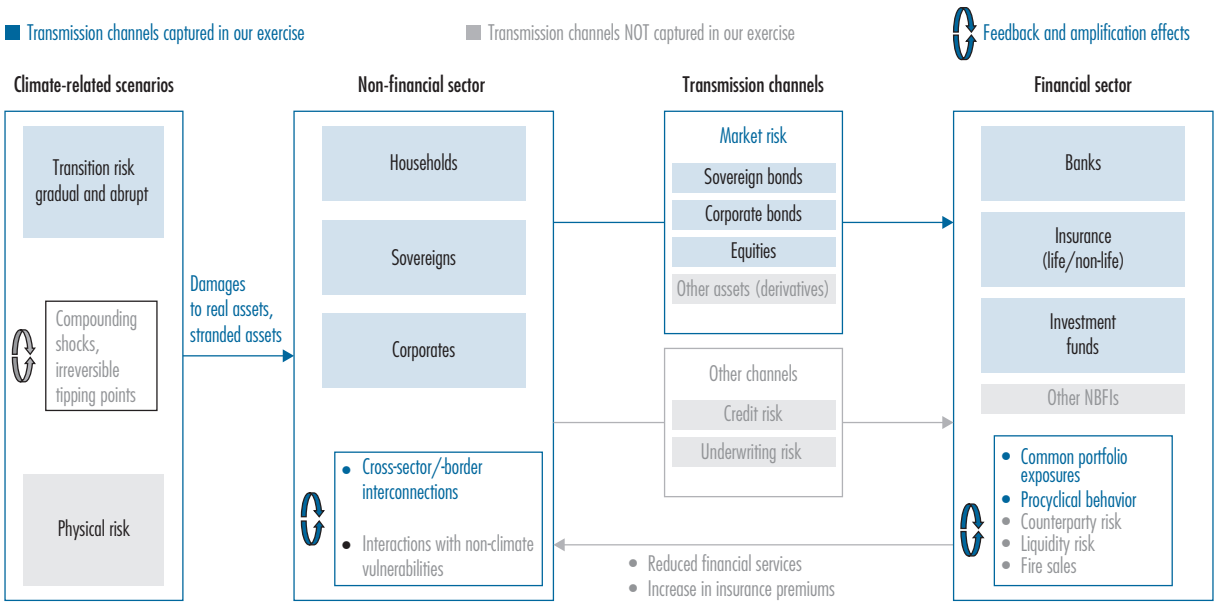
in the European Union), the effects of the transition on GDP are slightly more limited in Phase V than in Phase III. Changes after March 2024 (e.g. US backtracking) are not factored into phase V.

These revenue trajectories are subsequently integrated into a set of models (see Appendix) to estimate the risk of price correction for each financial instrument (in different countries), be they equities or bonds.[1] Financial losses are measured based on revenue growth trajectories through 2045, assuming that sector shares remain constant. The exposure of French financial intermediaries is then assessed for the market portfolios of credit institutions, insurance undertakings and investment funds. The repricing risk of a portfolio is calculated as the weighted average potential losses associated with each asset held.

This exercise covers only some of the channels through which climate shocks are transmitted to the financial sector (see chart). Only transition risk and its impact on financial markets are considered. Credit risk associated with bank loan portfolios and underwriting risk affecting the insurance sector are excluded.[2] Moreover, amplification and feedback effects within the financial system (e.g. a contraction in the supply of financial services or an increase in insurance premiums) are only partially incorporated.

The Financial Stability Board chart has been adapted to reflect the transmission channels of climate shocks considered in this exercise (in blue) and those that have not been modelled (in grey).

Framework for assessing climate-related economic and financial vulnerabilities



Sources: Financial Stability Board (2025), Banque de France (2025).
Notes: NBFI, non-bank financial institutions.

1 Other financial assets (e.g. derivatives) are not included within the scope of this exercise.

2 For an analysis of credit risk, see the European Central Bank's climate stress tests (Alogoskoufis et al., 2021; Emambakhsh et al., 2023) and the European Fit-for-55 climate scenario analysis (European Supervisory Authorities and European Central Bank, 2024). For an analysis of the insurance sector, see the stress test conducted by the *Autorité de contrôle prudentiel et de résolution* (ACPR – the French Prudential Supervision and Resolution Authority) (ACPR, 2025).

2 Repricing of financial assets according to different climate scenarios

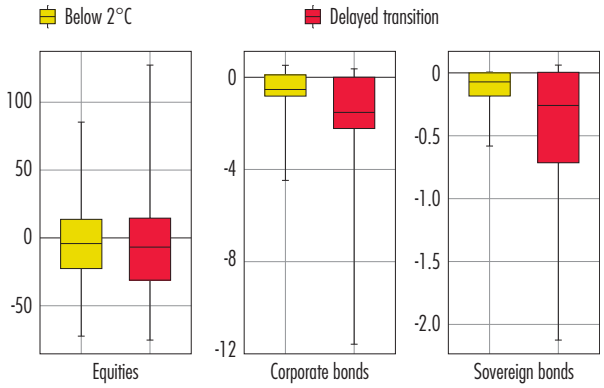
The risk of a correction is especially pronounced in the equity market

The **equity** market is most exposed to climate transition risk. On a global scale (by weighted average), potential corrections amount to -4.2% under the "below 2°C" scenario and -6.8% under the delayed transition scenario when compared to the baseline scenario, representing estimated losses of EUR 1.7 trillion and EUR 2.9 trillion, respectively, in market capitalisation (see Chart 1). However, the dispersion of losses is considerable: in some extreme cases, losses could amount to -72% ("below 2°C") and -75% ("delayed transition"). Although the economic projections used cover the period through 2045, this impairment could materialise rapidly if investors suddenly adjusted their expectations to reflect these transition scenarios. Conversely, prolonged uncertainty could lead to a period of sustained market volatility.

Corporate bonds present a more limited risk of correction than equities. Their value depends on the issuer's ability to repay a fixed amount, whereas the value of a share reflects the company's future profits; the climate transition reduces these profits well before it threatens the company's solvency. On average, corporate bond impairment is -0.5% under the "below 2°C" scenario and -1.5% under the delayed transition scenario, corresponding to a decline of EUR 24 billion and EUR 69 billion, respectively, in the outstanding value of the bonds. However, the bonds of certain issuers could be hit by losses of up to -11.5% (under a "delayed transition").

Aside from this impact on companies, a delayed transition could also lead to temporary spikes in inflation, which could cause sovereign interest rates to rise and become more volatile. This increase in interest rates would cause **sovereign bond** prices to fall, with a potential average loss of 0.25% under the delayed transition scenario, representing a loss in value of EUR 171 billion. This risk of correction varies by geographical area. Ireland, Canada and Austria are among the countries most sensitive to the delayed transition scenario (see Chart 2 below). This can be partly explained by the different inflation trajectories projected under the NGFS scenarios, including between European countries, and by duration differential.[4] These differences in inflation reflect different levels of exposure to transition risk, linked to the carbon intensity of economies and progress already made. This increase in rates would also amplify the correction to equity and corporate bond prices. Overall, the limited rise in interest rates in the estimates in this exercise is attributable to the fact that sovereign rates are considered risk-free and therefore do not factor in the formation of a possible credit risk component caused by a deterioration in public finances.

C1 Potential correction to global financial markets, by asset class
(correction to value, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHSS, Banque de France.
Scope: The chart only shows the 26,000 companies with sector-specific revenue segmentation (see Appendix) and the correction to sovereign bonds from 18 countries.
Key: The horizontal line in the box represents the weighted average by market capitalisation (equities) or outstanding amount (bonds). The extremities of the box represent deciles 1 and 9, and the extended lines indicate percentiles 1 and 99.
Notes: Data at June 2024.
Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios.

4 For example, Canada is exposed to a greater interest rate shock than Ireland, but this shock may lead to greater impairment of Irish bonds due to their longer maturities.

C2 Potential correction to sovereign bonds, by issuing country

(x-axis: issuing country; y-axis: correction to value, in %)

Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHSS; Banque de France calculations.
Key: The horizontal line in the box represents the weighted average by sovereign bond outstandings. The extremities of the box represent deciles 1 and 9, and the extended lines percentiles 1 and 99.
Notes: Data at June 2024.
The countries represented are the ten largest bond issuers in the database (SHSS). Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios. For each country and each scenario, the shock applied to interest rates corresponds to the maximum impact of the transition observed over the entire period.

The transition to a low-carbon economy will affect the main economic sectors to varying degrees

The fossil fuel sector (according to the CPRS classification)[5] is the sector most vulnerable to the transition: the average potential repricing of equity in this sector would be -20% under the "below 2°C" scenario and -24% under the delayed transition scenario (see Chart 3 below). Almost all companies in the sector are exposed to impairment, with extreme corrections of up to -87%. However, a minority of companies (less than 10%) could benefit from the transition and record an increase in their share value of up to 78% thanks to diversification into subsectors that would benefit from the low-carbon transition.

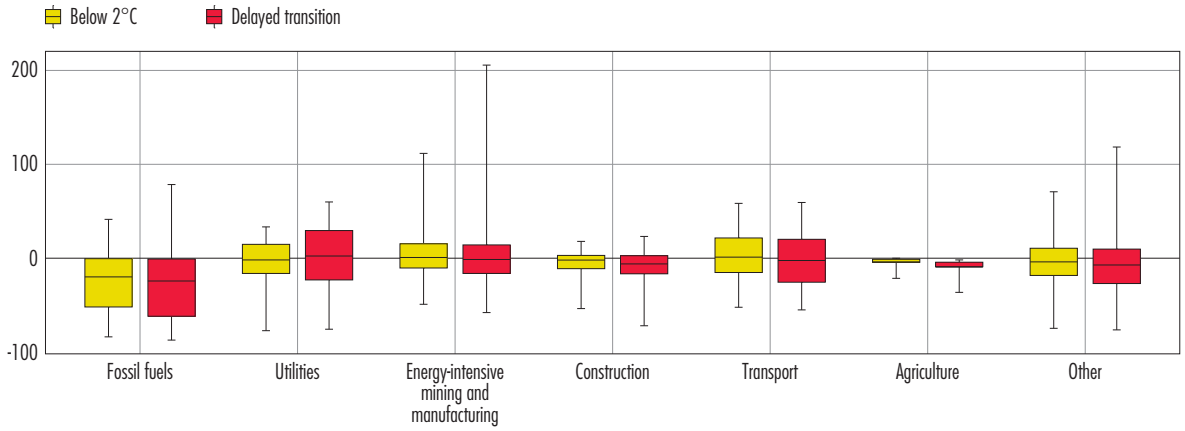
Other sectors – utilities, energy-intensive mining and manufacturing, construction, transport and agriculture – also reveal significant exposure. Nevertheless, changes in valuation are more balanced.

For corporate bonds, the projected repricing remains moderate across most sectors, with the notable exception of fossil fuels, where some companies could suffer losses of up to -6.7% under the "below 2°C" scenario and -34.5% under the delayed transition scenario.

5 Climate Policy Relevant Sectors. CPRS classification corresponds to groups of economic sectors selected based on their exposure to non-renewable energy and electricity, and therefore their potential exposure to transition risk (Battiston et al., 2017).

C3 Potential correction to global equities markets, by sector

(x-axis: CPRS sector; y-axis: correction to value, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHSS; Banque de France calculations.
Scope: The chart only shows the 26,000 companies with sector-specific revenue segmentation (see Appendix).
Key: The extremities of the box represent deciles 1 and 9, and the extended lines percentiles 1 and 99.
Notes: Data at June 2024.
Companies are grouped and classified by Climate Policy Relevant Sectors (CPRS). Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios.

3 Repricing of the portfolios of French financial intermediaries according to different climate scenarios

Overall, French investors are exposed to a moderate but non-negligible risk of correction

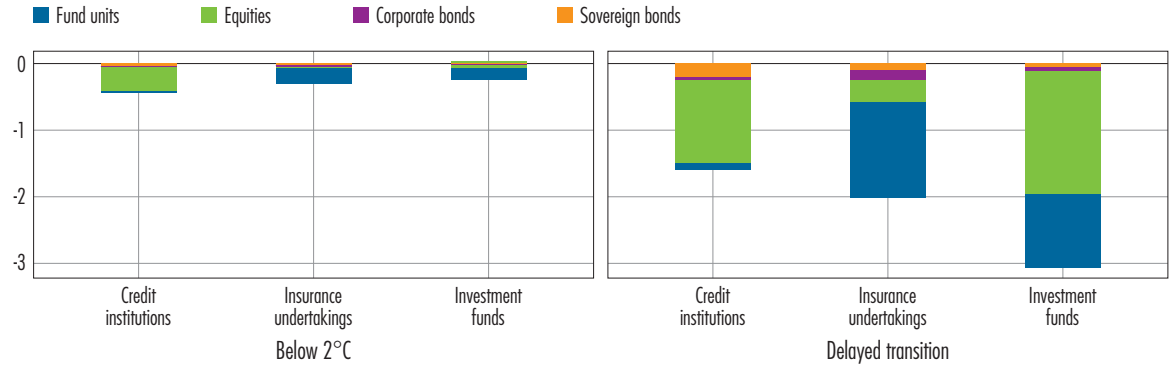
Certain categories of investors appear to be more vulnerable than others (see Chart 4 below). **Investment funds** present the highest average losses: their portfolios would shed an average of 3% of their value (i.e. EUR 29 billion) under the delayed transition scenario, compared with the baseline scenario. This sensitivity is mainly due to the high proportion of equities in their portfolios.

Credit institutions with losses of 1.5%, or EUR 14 billion, under the delayed transition scenario, and **insurance undertakings** – losses of 2%, or EUR 28 billion – are less exposed. Their securities portfolios are mainly composed of sovereign and corporate bonds, asset categories for which the estimated transition risk is more limited.

The potential correction to insurers' securities portfolios is mainly due to their substantial holdings of investment fund units. Nevertheless, net losses for life insurance companies would be lower than the decline in value of their assets. For example, if a unit-linked contract managed by the insurer loses 3%, the value of the customer's policy falls by 3%: the loss is borne by the policyholder, not the insurer.

C4 Potential correction to French financial intermediaries' securities portfolios

(contribution to negative correction to portfolio, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHS-S, OPC-Titres, Lipper; Banque de France calculations.
Notes: Data at June 2024.
The correction is calculated as the weighted average of potential losses on more than 94,000 securities held, based on their weight in the aggregate portfolio of each investor category. The chart distinguishes the main sources of negative value by asset class: fund units, equities, corporate bonds and sovereign bonds. Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios (phase III).

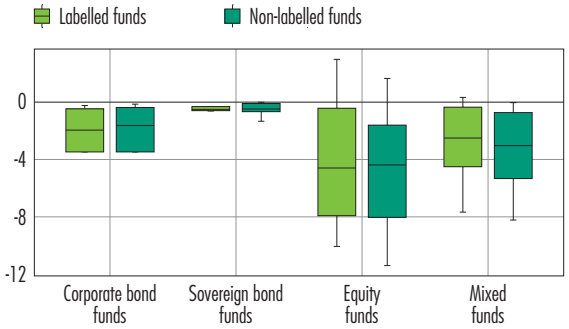
A granular analysis of French investment funds

Although the average potential repricing of investment fund portfolios remains moderate, it masks large disparities. **Equity funds** and mixed funds have the highest exposure to delayed transition risk, whereas **fixed-income funds** appear to be less exposed (see Chart 5).

The dispersion of results remains considerable depending on the management strategies deployed, even within the same fund category: the loss in value can amount to -11.4% for equity funds, -8.2% for mixed funds, -3.4% for corporate bond funds, and -1.3% for sovereign bond funds. These differences reflect the relative concentration of assets sensitive to climate transition in certain portfolios. Some equity funds, especially those with green labels, could still outperform under the delayed transition scenario, due to investments in assets benefitting from the transition (see Chart 3 above).

C5 Potential correction by type of French investment fund under a delayed transition scenario

(correction to value, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHSS, OPC-Titres; Banque de France calculations.
Scope: 3,219 French investment funds are analysed, including 513 corporate bond funds (99 labelled), 100 sovereign bond funds (16 labelled), 1,218 equity funds (412 labelled) and 1,388 mixed funds (124 labelled). Real estate investment funds, money market funds and alternative investment funds (hedge funds) are not represented.
Key: The horizontal line in the box represents the weighted average by outstandings. The extremities of the box represent deciles 1 and 9, and the extended lines percentiles 1 and 99.
Notes: Data at June 2024.
The correction is calculated as the weighted average of potential losses on the securities held, based on their weight in the overall portfolio of each investor category. The labels included in the analysis were CIES, Finansol, Greenfin, ISR and Relance. The distinction between corporate bond funds and sovereign bond funds is made based on their respective shares in the fund portfolio. Mixed funds are an intermediate fund category that hold both equities and bonds. Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios.

A granular analysis of French banks and insurers

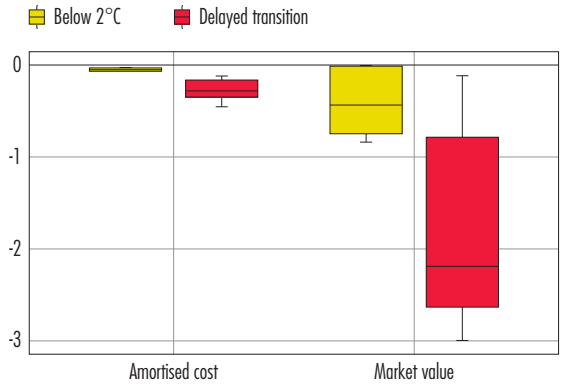
The securities portfolios of French banks and insurers are exposed to relatively limited potential losses, due to a sufficient diversification of assets held between vulnerable and resilient sectors.

The proportion of **bank** securities portfolios marked to market highlights average potential losses related to transition risk of -2.1% under the delayed transition scenario, with significant dispersion between institutions: some banks appear to have little exposure, whereas others could suffer losses of up to -3% (see Chart 6). Losses on assets carried at amortised cost, which are lower on average, would only be recorded in the income statement in the event of an early sale. However, even if the assets are not sold, these unrealised losses would weigh on the economic value of the balance sheet and therefore on investors' perception of the bank's valuation.

The results for **insurance undertakings** are presented by distinguishing between two categories of portfolio: (i) those held for unit-linked contracts, whose allocation is determined by the policyholders who also bear the risk; and (ii) non-unit-linked portfolios, whose losses are absorbed by the insurer itself (only in part in the case of life insurance). Transition risk is mainly concentrated in unit-linked portfolios (-3.7% on average) and would therefore be largely passed on to policyholders (see Chart 7).

C6 Potential correction to French bank portfolios

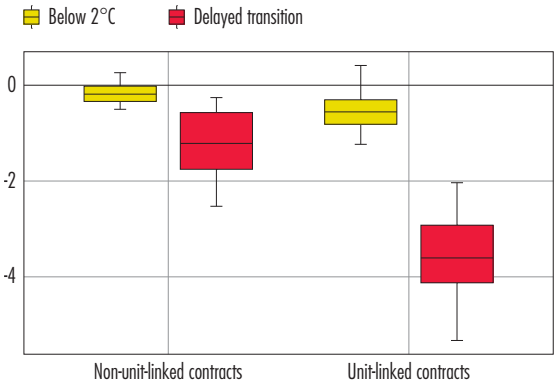
(correction to value, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, SHSG, OPC-Titres, Lipper; Banque de France calculations.
Scope: 11 French banks are evaluated here.
Key: The horizontal line in the box represents the distribution median. The extremities of the box represent deciles 1 and 9, and the extended lines the minimum and maximum.
Notes: Data at June 2024.
The chart distinguishes between assets recognised at amortised cost (24% of the total) and those recorded at market value (76% of the total); the latter are directly sensitive to price corrections caused by climate shocks. Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios.

C7 Potential correction to the portfolios of French insurance undertakings

(correction to value, in %)



Sources: NGFS (2022), BloombergNEF, Refinitiv Eikon, Solvency II, OPC-Titres, Lipper; Banque de France calculations.
Scope: 152 French insurance undertakings are evaluated here.
Key: The horizontal line in the box represents the distribution median. The extremities of the box represent deciles 1 and 9, and the extended lines percentiles 1 and 99.
Notes: Data at June 2024.
The chart distinguishes between assets held in unit-linked (or indexed) contracts and assets held outside of unit-linked contracts, where losses are partially absorbed by the insurer themselves. Unit-linked portfolios account for 24% of the total, compared with 76% for non-unit-linked portfolios. Estimated corrections to value are based on the 2023-45 projection horizon of the NGFS scenarios.

4 Limitations on modelling the effects of climate risk on financial markets

The results presented provide an initial estimate of the potential repricing of financial assets under the low-carbon transition. Nevertheless, they are based on sometimes simplistic assumptions and do not reflect the full complexity of the dynamics likely to be unleashed in the event of a climate transition shock. Several factors could lead to a more severe price correction than anticipated:

- The results are sensitive to the intensity, rapidity and nature of the simulated climate shocks. The projections used are based on the NGFS' – relatively conservative – long-term scenarios. The long-term horizon of these scenarios tends to smooth out short-term shocks, which may mask transitional dynamics that could compromise the resilience of the financial system. The NGFS' short-term scenarios (2025) related to transition risk suggest price corrections of the same order of magnitude but concentrated over a five-year horizon. A diversification of approaches is therefore necessary to capture a realistic range of possible price corrections;

- The magnitude of the correction depends on the current degree to which climate risks are integrated by investors, which is difficult to estimate. The approach models a sudden adjustment in investor expectations, initially anchored in a scenario where there is no tightening of current climate policies. In reality, expectations may change more slowly and differently depending on the category of investor, or, conversely, adapt more sharply to extreme climate events in a context of uncertainty over adjustment policies. These dynamics render the repricing trajectory particularly uncertain;

- The approach used assumes that companies can seamlessly adapt their supply in phase with changes in their sector, however, this conflicts with two realities. First, it does not necessarily reflect the current strategy of the companies concerned. Second, it overlooks the fact that in the event of an unexpected shock, their physical capital (machinery, buildings or vehicles) could be abruptly impaired, creating a risk of default and stranded assets;

- The approach used only partially incorporates the amplification effects that may accompany a climate transition shock and assumes that the composition of financial intermediaries' portfolios remains static. However, financial feedback loops can accentuate a drop in prices. For example, an extreme climate event can trigger a sudden revision in investor risk perception, leading to a sharp drop in the prices of exposed assets. Moreover, fire sales can fuel a downward spiral of disengagement and a general decline in asset values. The European Fit-for-55 climate scenario analysis (European Supervisory Authorities and European Central Bank, 2024) shows that such effects can amplify the initial impact of transition shocks on asset portfolios by nearly 30%.

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The climate transition is as necessary as it is inevitable, but it can pose risks for financial intermediaries if it is delayed and abrupt, and in the event of excessive exposure to carbon-intensive sectors. The financial sector can absorb a delayed transition shock, provided that markets do not overreact and amplification mechanisms are contained. Although the risk of correction remains moderate on average, certain sectors, particularly fossil fuels, are exposed to significant capital losses. A gradual and anticipated transition, allowing economic agents time to adapt within a stable and credible regulatory framework, would limit losses.

These estimates do not factor in the physical risk associated with climate change. Some studies show that this risk is of a greater magnitude than transition risk (see, for example, Alogoskoufis et al., 2021; NGFS, 2025). In the medium term, it could lead to substantial losses, particularly for certain sectors (agriculture, transport, energy), with very mixed consequences depending on the region. Therefore, just like the economic costs, the financial costs of a poorly anticipated transition, although

real, remain lower than the costs of climate inaction and increased physical risk.

Lastly, a lack of ambition or delays in implementing climate transition policies are not neutral: they simultaneously increase both physical and transition risk, further undermining financial stability. Uncertainty over future policies can also create difficulties for players already engaged in the transition and complicate the coordination of medium-term expectations. In this context, it is essential that financial agents strengthen their climate risk assessment and management frameworks.

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Appendix
Granular approach to forecasting corporate revenue

Assessing the effects of climate transition on financial markets and portfolios is based on estimating future corporate revenue trajectories. To do this, BloombergNEF applies a three-tiered approach, depending on the availability of sector-specific revenue segmentation data:

- Tier 1 (companies with detailed segmentation data): sectoral demand projections from Network for Greening the Financial System scenarios (NGFS, 2022) are applied directly to the revenue component of 26,000 companies worldwide, based on their sector-specific exposure;

- Tier 2 (companies with partial segmentation data): for approximately 32,000 companies, BloombergNEF identifies subcontracting relationships with Tier 1 companies. Unallocated revenue is assumed to grow at the same rate as national GDP under a given climate scenario;

- Tier 3 (companies without any available segmentation data): for 14,000 companies whose revenue structure is unknown, future growth is assumed to be aligned with national GDP.

Methodological limitation: This approach assumes that a company's growth trajectory is a weighted average of the trajectories of the sectors in which it operates and does not consider the specific characteristics of each company. One possible improvement would be to incorporate additional microeconomic data to reflect their economic reality and exposure to transition risk more effectively.

Modelling the risk of sovereign bond repricing

Repricing of sovereign bonds is based on projections of macroeconomic variables (GDP growth and inflation rates) from the NGFS scenarios (2022), factoring in their impact on nominal interest rate projections obtained using the procedure described below. These variations are then translated into bond price adjustments using a standard formula based on their modified duration and convexity.

The procedure adopted to calculate the projected sovereign yield curve for each country[1] and each NGFS scenario (for several projection horizons) is as follows:

- An affine Gaussian model of the interest rate curve is used, with macrofinancial variables (main components of rates, economic activity and inflation), inspired by Joslin, Priebsch and Singleton (2014). The model is estimated using the methodology of Adrian, Crump and Moench (2013), and macroeconomic variables and rates (for maturities of one to ten years) are observed through December 2024. These data are downloaded from Bloomberg and the Federal Reserve's FRED database;

1 Sovereign yield curve projections are calculated for a group of 18 countries representing almost all sovereign bonds held by French financial intermediaries.

- The historical dynamics of the government variables, represented by a Gaussian VAR (1) model, and the affine nature of the yield curve formula, allow this valuation model to be represented as a linear Gaussian state-space model (in the absence of any arbitrage opportunities);

- This representation can then be used to calculate the projected sovereign yield curve (for several projection horizons), contingent on the future trajectories of the two macroeconomic variables, dictated by the relevant NGFS scenario and fixed between 2025 and 2050. These forecasts (known as 'conditionals') are obtained using the methodology of Waggoner and Zha (1999), based on Kalman filtering and smoothing;

- Given the country of interest *i* and a projection horizon *h*, the conditional projection of the yield curve for the baseline scenario $(RF^{ref}_{i,t+h} = RF^{ref}_{i,t+h}(1y), \dots, RF^{ref}_{i,t+h}(10y)')$, , and for an alternative scenario *s* $(RF^{s}_{i,t+h})$ is calculated, as well as the difference $(\Delta RF^{s}_{i,t+h})$, to ascertain the distortion of the curve caused by the transition from one scenario to another. See Pegoraro (2026) for a detailed presentation of the methodology.

For each country and each scenario, the shock applied to rates corresponds to the maximum impact of the transition observed for the entire period 2023-45. Generally speaking, the transition causes an inflationary shock, resulting in an increase in rates followed by a gradual return to equilibrium. This approach assumes that investor expectations focus on the peak of the shock, leading to an anticipated decline in sovereign bond prices.

Modelling the risk of corporate bond repricing

A regression analysis of historical panel data (2010-24), downloaded from Refinitiv Eikon, allows us to estimate the sensitivity of credit spreads to companies' financial characteristics:

$$spread_{i,t} = \alpha_t + \beta_1\, leverage_{i,t} + \beta_2\, profitability_{i,t} + \beta_3\, REV_{i,t} + \beta_4\, controls_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $leverage = \frac{debt_{i,t}}{assets_{i,t}}$ is the company's financial leverage, $profitability = \frac{EBITDA_{i,t}}{assets_{i,t}}$ and *REV* its revenue.[2] Lastly, *controls* correspond to the bond characteristics (size, maturity, coupon, seniority, early redemption).

The NGFS scenarios provide revenue projections, but not direct projections of leverage or profitability. Two additional empirical relationships are therefore estimated:

$$\frac{\Delta\, leverage_{i,t:t+h}}{leverage_{i,t}} = \alpha_{i,t} + \gamma_1 \frac{\Delta REV_{i,t:t+h}}{REV_{i,t}} + \varepsilon_{i,t} \qquad (2)$$

$$\frac{\Delta\, profitability_{i,t:t+h}}{profitability_{i,t}} = \alpha_{i,t} + \gamma_2 \frac{\Delta REV_{i,t:t+h}}{REV_{i,t}} + \varepsilon_{i,t} \qquad (3)$$

The growth in financial leverage depends negatively on revenue growth, whereby y_1 = -0.2, and the growth in profitability is positively correlated with revenue growth, so that y_2 = 0.7.

2 EBITDA: earnings before interest, taxes, depreciation and amortisation.

For each company i and each climate scenario s, the variation in the spread relative to the baseline scenario is estimated:

$$\Delta\, spread^{s}_{i,t+h} = (1+\delta)\,(spread^{s}_{i,t+h} - spread^{ref}_{i,t+h}) = (1+\delta)\,[\beta_1(leverage^{s}_{i,t+h} - leverage^{ref}_{i,t+h}) + \beta_2(profitability^{s}_{i,t+h} - profitability^{ref}_{i,t+h}) + \beta_3(REV^{s}_{i,t+h} - REV^{ref}_{i,t+h})] \quad (4)$$

Parameter δ captures an additional effect linked to changes in investors' environmental preferences, a loss of confidence in brown assets, or portfolio reallocation effects leading to an additional downgrading of the risk premium by investors. In accordance with the European Fit-for-55 stress test, this parameter is set at 0.58.[3]

The change in the price of corporate bonds is then estimated using the adjustment formula linked to the duration and convexity of the financial asset in question (from Refinitiv Eikon and the Centralised Securities Database – CSDB):

$$\frac{\Delta P^{s}_{i,t+h}}{P^{ref}_{i,t+h}} = -MD_{i,t}\,\Delta YTM^{s}_{i,t+h} + \frac{1}{2}C_{i,t}(\Delta YTM^{s}_{i,t+h})^2 \quad (5)$$

where $\Delta P^{s}_{i,t+h} = P^{s}_{i,t+h} - P^{ref}_{i,t+h}$ corresponds to the change in price between the transition scenario ("below 2°C" or "delayed transition") and the baseline scenario, and $\Delta YTM^{s}_{i,t+h} = \Delta\, spread^{s}_{i,t+h} + \Delta RF^{s}_{i,t+h}$ represents the change in the bond's yield to maturity. MD is the modified duration of the bond, and C is its convexity. In this exercise, the horizon considered is 2045. However, asset prices may correct before this timeframe if investors factor the future deterioration in the economic and financial conditions of companies exposed to transition risk into prices.

Modelling the risk of equity repricing

Stock market valuations are estimated using the *H-Model* developed by Fuller and Hsia (1984), an extension of the method developed by Gordon and Shapiro (1956), which introduces a gradual convergence of the dividend growth rate towards its long-term value.

$$P^{s}_{i,t+h} = \frac{D_{i,t}[(1+g^{s}_{LT,i}) + H(g^{s}_{ST,i} - g^{s}_{LT,i})]}{r^{s}_{i,t+h} - g^{s}_{LT,i}} \quad (6)$$

where P^s is the value of the security in each period, D is the dividend paid calculated on a year-on-year basis[4], and g^{s}_{ST} and g^{s}_{LT} are the short-and long-term growth rates of dividends, estimated from projected earnings:

$$g^{s}_{ST,i} = \left(\frac{REV^{s}_{i,2030}}{REV^{s}_{i,2023}}\right)^{1/7} - 1\,;\; g^{s}_{LT,i} = \left(\frac{REV^{s}_{i,2045}}{REV^{s}_{i,2030}}\right)^{1/15} - 1 \quad (7)$$

3 Expressed as a simple multiplier, fire sales increase first-round losses by a factor of 0.58. Although modelling second-round effects is complex and the multiplier is unlikely to be linear, it gives an idea of the relative magnitude of the amplification due to forced selling.

4 Company earnings (earnings per share [EPS]) are used instead of dividends because some companies do not pay dividends and we have better data coverage for this variable. Prices and EPS are downloaded from Refinitiv Eikon.

Parameter *H* in equation (6) corresponds to half the period of convergence to the long-term growth rate (in years). We use a value of *H = 3.5* in this exercise. Lastly, r_i^s is the discount rate (cost of equity), which can be broken down into a risk-free rate and a risk premium:

$$r_{i,t+h}^{s} = r_{i,t}^{ref} + RP_{i,t+h}^{s} \quad (8)$$

where $RP_{i,t+h}^{s}$ is the additional risk premium for scenario *s* approximated in this exercise by $RP_{i,t+h}^{s} = \Delta\, spread_{i,t+h}^{s} + \Delta RF_{i,t+h}^{s}$.[5]

$r_{i,t}^{ref}$ represents the baseline discount rate, which is deduced from the current price by inverting the *H-Model*, assuming that investor expectations are currently anchored in the baseline scenario:

$$r_{i,t}^{ref} = \frac{D_{i,t}}{P_{i,t}}\left[\left(1 + g_{LT,i}^{ref}\right) + H\left(g_{ST,i}^{ref} - g_{LT,i}^{ref}\right)\right] + g_{LT,i}^{ref} \quad (9)$$

Lastly, the correction of a share price between transition scenario *s* ("below 2°C" or "delayed transition") and the baseline scenario is calculated by $\frac{\Delta P_{i,t+h}^{s}}{P_{i,t+h}^{ref}}$, where $\Delta P_{i,t+h}^{s} = P_{i,t+h}^{s} - P_{i,t+h}^{ref}$.

5 This approach is inspired by the work of Allen et al. (2024).

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