Climate transition scenarios and financial risk

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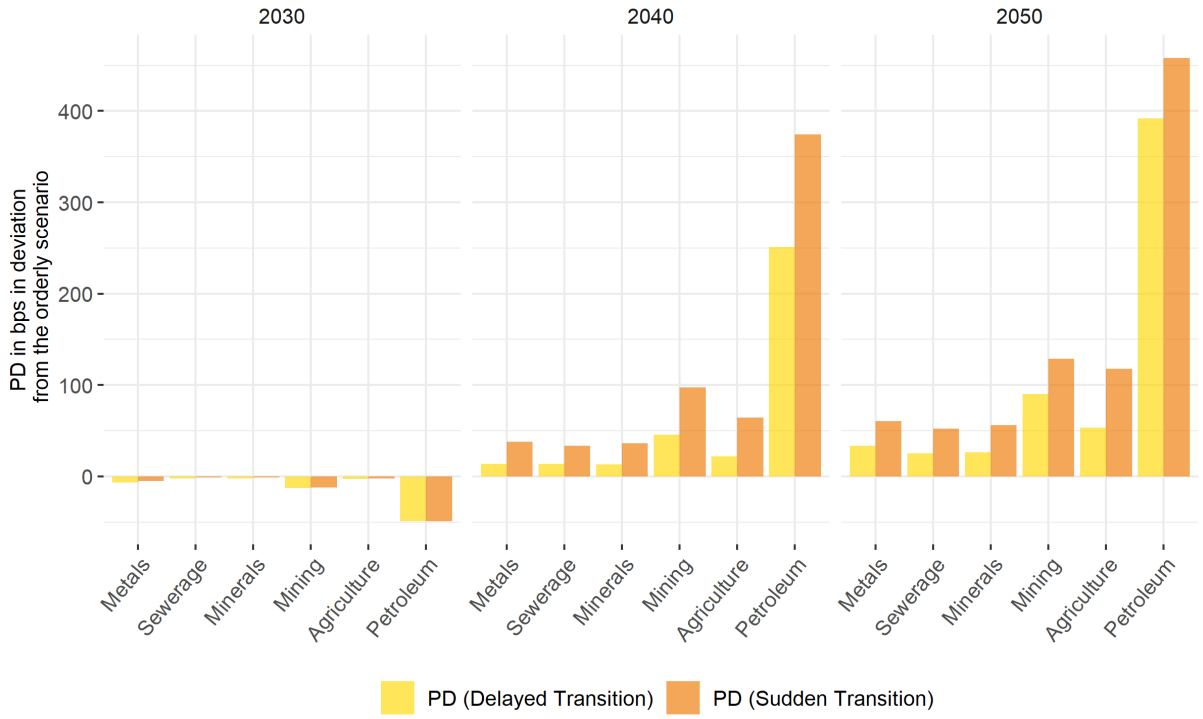
As part of the first climate pilot exercise, the Banque de France and the ACPR developed a series of models to quantify the financial risks associated with different climate transition scenarios. We present some of the results in this post. In some scenarios, the oil industry's probability of default is expected to increase by 400 bps, its credit spread by 30 bps and its stock market valuation is expected to decrease by 40-50% in 2050.

Chart 1: Changes in probabilities of default for the most affected sectors (PDs in bps in deviation from the orderly scenario)



Source: authors' calculations.

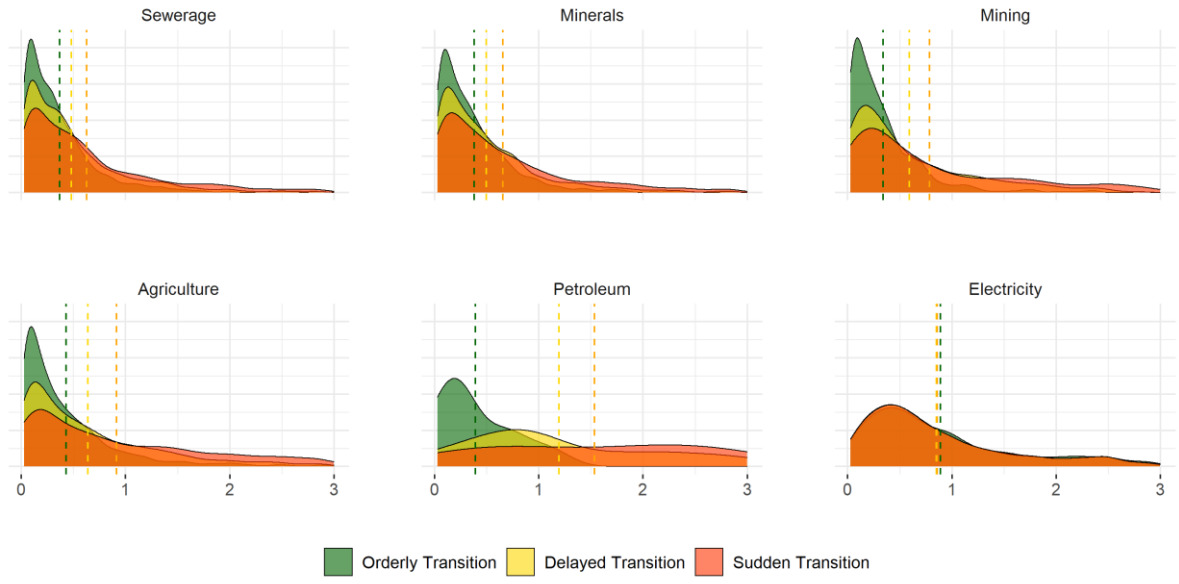
Note: Probability of default (PD) at 1 year in 2030, 2040, 2050 under the two adverse transition scenarios (delayed transition and sudden transition)

Probabilities of default of French non-financial corporations:

Blog post 255 presented the translation of transition scenarios toward a low-carbon economy into sectoral shocks on value added and turnover. Three scenarios were analysed: an orderly transition scenario and two disorderly transition scenarios, the first "delayed", the second "sudden", to reach the targets set by the Paris Agreement by 2050 (see Allen et al. for details).

These sectoral shocks on value added and turnover were applied to the balance sheets of French companies, available at end-2019, i.e. over 232,000 unconsolidated corporate balance sheets. Based on this vision of companies' financial situation, we projected these three scenarios in five-year steps between 2025 and 2050. These projections were carried out **company by company**, and resulted in an individual breakdown of sectoral shocks, consistent with a balance sheet equilibrium at end-2019. Thanks to this micro-simulation, it was possible to project, for each scenario, the financial ratios impacted by the shocks to value added and turnover, all other things being equal. The financial ratios thus obtained were then introduced into the Banque de France rating model. **This credit risk model was simulated at each five-year step and for each of the 232,000 companies, thus making it possible to obtain the probability of default (PD) for each company, period and scenario.**

Chart 2: Distribution of probabilities of default for companies in selected sectors projected to 2050 under 3 scenarios



Source: authors' calculations.

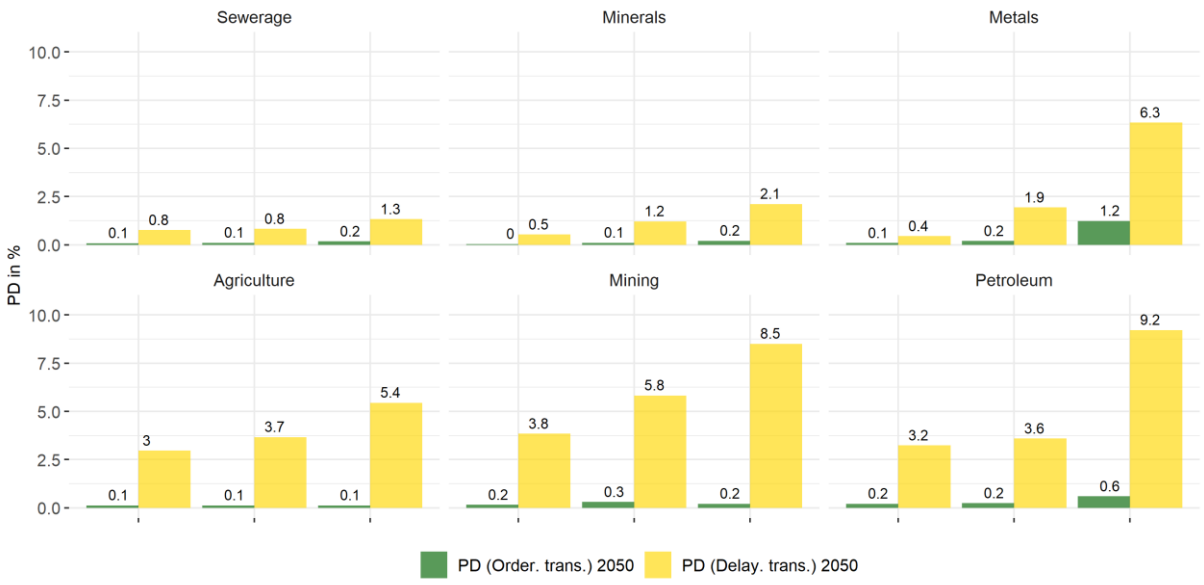
Note: The x-axis shows the PDs in percentage terms. The average sectoral PDs are shown as coloured vertical lines according to the scenario. The area under the curve, which is always equal to 1, represents the percentage of the population.

Our results show that, compared to the orderly transition, the delayed and sudden transition scenarios have an **upward impact on probabilities of default (PDs) for all sectors**, except for the electricity sector.

The PDs of the most impacted sectors increase sharply over time. In the oil industry, for example, they rose by up to 400 bps in 2050 (Chart 1). By way of comparison, a similar deterioration in PDs has been estimated for the sectors most impacted by the Covid-19 health crisis in 2020. However, the deterioration in the PDs is gradual in the medium and long term due to the trend nature of the scenarios used.

The distribution of impacts across scenarios shows, as expected, that **the structural increases in PDs are greater when the transition is more adverse**, as shown in Chart 2. It is interesting to note that, depending on the scenario, the distribution of PDs changes significantly for some sectors: a larger share of the sample is in the tail of the distribution (extreme risks) when the transition becomes more disorderly. This is the case for the oil industry, which counts a significant number of companies with PDs above 3%, while they barely exceed 1.5% in the orderly scenario.

Chart 3: Probabilities of default in 2050 for the most impacted sectors (Top 3 impacted companies)



Source: authors' calculations.

Note: From left to right the value of the PDs under an orderly and a delayed transition, for the first, second and third most affected company (with the largest difference between the PDs in the two transition scenarios in 2050).

Looking more specifically at some individual companies (the three most impacted companies for each sector), Chart 3 shows **that some companies may reach an unsustainable level of PD in 2050**, rising from 0.6% in an orderly transition scenario to over 9% in a delayed transition scenario. Among the very adverse consequences of this deterioration in credit quality for companies and credit institutions, it is worth pointing out that credit claims that are eligible as collateral for refinancing operations must have a PD below 0.4% in the permanent monetary policy framework and a PD below 1.5% if they are additional credit claims (ACC). A credit claim with a PD over 1.5% is considered ineligible for monetary policy operations, and PDs over 5% correspond to the worst level of credit quality.

Corporate credit spreads and financial asset prices:

Climate change is a phenomenon that may have very significant effects on economic sectors, financial institutions and financial stability (NGFS). For these reasons, we focus here on the impact of transition scenarios on key financial variables such as corporate credit spreads and financial asset prices. The credit spreads of French non-financial corporations, and their projections, were determined from the probabilities of default provided by the Risk Management Institute of the National University of Singapore and the projections calculated, for each relevant scenario, by the Banque de France rating model. Based on the PDs over each relevant horizon and economic sector, the associated credit spreads were determined using the formula of Merton (1974) and Black and Cox (1976). **Once the database of spreads had been compiled, projections were made, for each transition scenario, using a Gaussian VAR model** with the following variables: corporate credit spreads, two macroeconomic variables (GDP growth rate and inflation rate) and the risk-free yield curve.

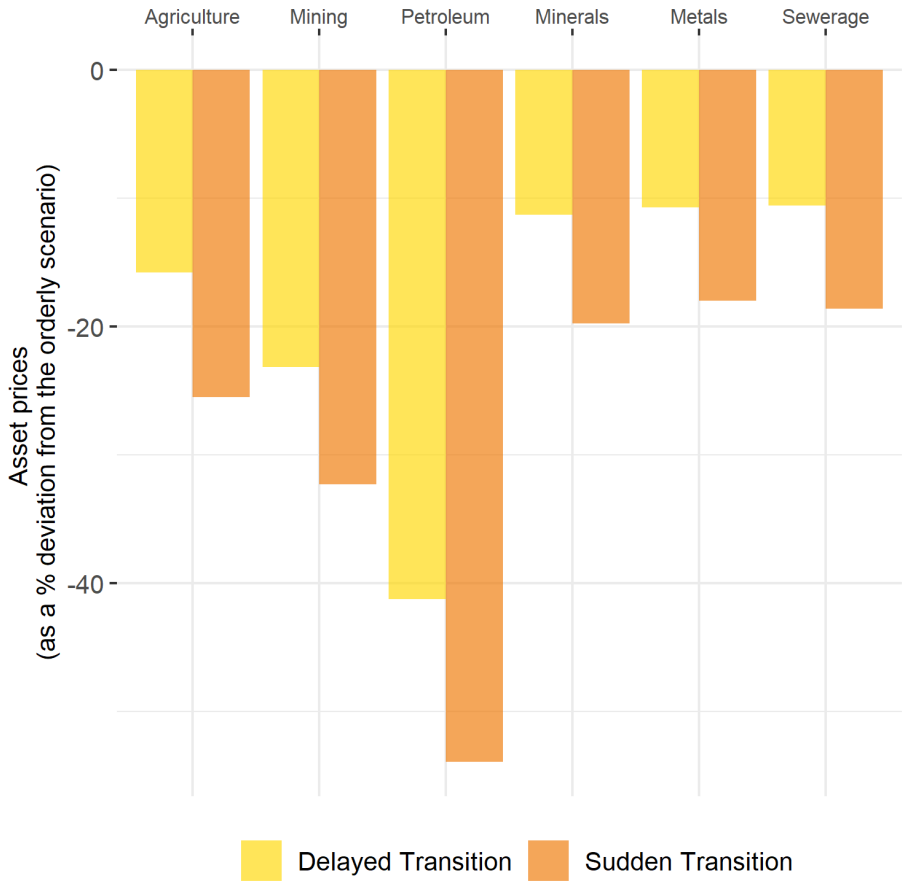
In order to study the impact of each alternative scenario, compared to an orderly transition scenario, two economic sectors can be compared: the **non-cyclical consumption sector** (NCC; agriculture, food, beverage and tobacco manufacturing, pharmaceutical industry and human health activities) and the **fossil energy sector** (FE; mining and quarrying, coking and refining).

In deviation from the baseline scenario, and in line with the projections of the PDs presented in Chart 1, we observe that: a) **the fossil energy sector exhibits larger expected changes in credit spreads than the NCC** sector for each alternative scenario; b) the expected changes in the NCC sector are marginally affected by the two alternative scenarios (10bps and 15bps, respectively); c) **in the delayed transition scenario, the expected changes in the credit spreads of the FE sector are slightly negative until 2035** and then become positive and reach values close to 25bps in 2050; d) in the sudden transition scenario, the expected changes in the spreads of the FE sector are negligible until 2030 and then reach almost 30bps in 2050.

Stock market asset prices are determined using a model based on the sum of discounted flows of expected future dividends (Dividend Discount Model). These dividends are derived from the projections of value added (VA) determined according to the methodology mentioned in blog post 255. The discount rate is determined using the stock market index of the country under consideration, incremented by a risk premium component, identified, for each sector and scenario, by the associated corporate credit spread. Given an asset price for each sector and scenario, **the relative change (in percentage terms) of the price in an alternative scenario compared to the baseline scenario determines the elasticity of the relevant asset**. Chart 4 shows that if investors were to suddenly discover in 2020 that the

future values of oil sector dividends were not those of the baseline scenario but those of a disorderly transition scenario (delayed or sudden), then the stock prices of this sector would appear to be overvalued - compared to the baseline scenario - by around 41% in the former case and 54% in the latter.

Chart 4: Asset price elasticities in France by economic sector and transition scenario



Source: authors' calculations.