



Bank of Russia



STRESS TESTING OF CLIMATE TRANSITION RISKS: PROVISIONAL VALUATION

Information and analytical review

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EXECUTIVE SUMMARY

The world is still far from greenhouse gas emissions pathways that align with the Paris Agreement goals. In 2022 – 2023, geopolitical and economic fragmentation increased, making the transition to a low-carbon economy more complex. [Meanwhile, 2023 was confirmed as the warmest year on record, according to the World Meteorological Organization](#). The annual mean global temperature has come close to 1.5°C above pre-industrial levels. The impacts of climate change are increasingly manifesting as natural hazards, thereby elevating the importance of climate transition measures for major countries. Russia's main trading partners from friendly countries, firstly China, a global leader in green technologies, are no exception.

The tightening of international climate regulations and the widespread adoption of low-carbon technologies will inevitably influence Russian exporters, whose products are mostly energy resources or have high carbon intensity. These processes seem to potentially pose systemic risks to the economy and the financial sector that funds these companies. This publication aims to highlight the importance of climate risks for the economy and the financial sector.

In December 2023, the Bank of Russia published recommendations¹ on climate risk management for banks and other financial institutions. According to these recommendations, stress testing is a crucial tool in assessing such risks. This review can be referenced by financial institutions when conducting stress testing of climate risks.

Two scenarios for Russian economy development up to 2040 were designed based on the climate scenarios of the Network for Greening the Financial System (NGFS):² 'Climate-1', with a domestic climate policy within the 2023 regulatory framework, and 'Climate-2', with a more ambitious domestic climate policy. The resilience of the non-financial and banking sectors of the Russian economy was assessed within these scenarios.

The realisation of transition risks impairs the financial condition of a third of the analysed companies in the real sector over the horizon of 2030 – 2040 in both climate scenarios, if companies do not proactively adjust to the energy transition. This primarily affects companies in the ferrous metallurgy and mining sectors (including coal mining), and fertiliser production. In 'Climate-2' scenario with a more ambitious domestic climate policy, companies begin to face challenges earlier and more intensely than in 'Climate-1' scenario.³

Banks could face significant risks if they find themselves incapable of restructuring their credit portfolios to favour green borrowers and reduce their exposure to vulnerable non-financial companies. Therefore, addressing customers from brown⁴ sectors to enhance their energy usage and reduce the carbon intensity of their products becomes important. Diversifying the business of brown companies and developing green sectors can greatly reduce transition risks. In both scenarios, banks remain resilient if their loan portfolios are diversified, although their capital reserves decrease compared to values without considering climate stress.

Calculations by the Bank of Russia indicate that credit institutions need to manage climate risks and collaborate with customers on potential measures to enhance their energy efficiency and reduce carbon intensity. This necessitates a gradual and consistent transformation of the loan

¹ Bank of Russia Information Letter No. IN018-35/60, dated 4 December 2023, ['On Recommendations on Climate Risk Management for Financial Institutions'](#).

² Stress testing is based on NGFS Phase III data. For more details, see <https://data.ece.iiasa.ac.at/ngfs-phase-3/>.

³ 'Climate-2' scenario assumes the introduction of an internal price for all greenhouse gas emissions from the industrial production as the stress test precondition. Under climate regulation charges are to be paid to the Russian Federation budget by both hydrocarbon producers (oil and gas, coal mining companies) and hydrocarbon consumers (metallurgists, fertiliser producers, and others).

⁴ Companies exposed to climate risks associated with transitioning to a low-carbon economy, that is with high carbon intensity of production or those producing hydrocarbons are referred to as 'brown' companies.

portfolio, both by altering the business model of current borrowers and by attracting new green customers.

Due to various limitations of the analysis, such as scenario and model assumptions, the duration of the forecast horizon, the lack of information about the strategies of brown companies up to 2040, and assumptions of a predominantly inertial response of test subjects, the results presented cannot be considered as precise or final evaluations. The bottom-up stress testing planned by the Bank of Russia for 2024, involving major financial institutions, will recalibrate assessments of systemic risks and the stability of the financial sector.

1. CLIMATE AGENDA GLOBALLY AND IN RUSSIA

The global climate agenda continues to progress. The 28th session of the Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change took place in November – December 2023 in Dubai, UAE, with over 97,000 delegates from nearly 200 countries in attendance. COP28 highlighted significant achievements in combating climate change. Despite the continued rise in global greenhouse gas emissions, countries acknowledged the progress made in slowing their growth under the Paris Agreement. A joint statement signalled the ‘beginning of the end’ of the fossil fuel era.

The parties agreed that by 2030 global greenhouse gas emissions must be cut by 43%, compared to 2019 levels, to limit global warming to 1.5°C above pre-industrial levels. The final decision called on parties to take actions towards creating energy systems with net zero emissions. Conference participants were encouraged to contribute, at a global scale, to a tripling of renewable energy capacity and doubling energy efficiency improvements by 2030. Additionally, the parties called for the phase-down of the unabated coal power, phasing out of inefficient fossil fuel subsidies that did not address energy poverty or a just transition. Finally, for the first time, COP28 recognised the need of transitioning away from fossil fuels in energy systems, in a just, orderly, and equitable manner, to achieve net zero emissions by 2050.

International arrangements are reflected in **the expansion of national mechanisms for carbon pricing**. In 2023, the share of global emissions covered by carbon pricing schemes was 23%, according to the World Bank. Further growth is expected: [plans are in place to introduce carbon pricing mechanisms in India](#), and Japan has begun the transition period for its emissions trading system. China plans that free emission allowances are to be gradually replaced with auctions. Moreover, in 2023, the European Union (EU) launched the first phase (monitoring of importers' emissions) of the Carbon Border Adjustment Mechanism (CBAM), and a number of Russian exporters are supposed to provide the required information from the end of 2023. In the long run, it aims to level the carbon pricing for European and foreign producers supplying carbon intensive goods to the EU market. Specifically, Russian exports of fertilisers and metallurgical products are directly subject to the CBAM.

The Russian climate agenda aligns with global trends. In October 2023, an updated Climate Doctrine was issued in Russia, establishing a goal of reaching carbon neutrality by 2060. The attainment of this objective will occur within the action plan for executing the Strategy for the Socio-economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050. Moreover, since 2022, the Sakhalin experiment to limit greenhouse gas emissions has been conducted, and a register of greenhouse gas emissions has been created.

The adoption of new technologies, backed by governments, results in a decrease in the proportion of fossil resources in the fuel energy balance. The NGFS scenarios suggest that upon achieving carbon neutrality globally by 2050, the share of carbon-based energy commodities will decrease 3–4 times compared to the 2020 levels. The International Energy Agency’s scenarios, built on different models and assumptions, also anticipate a significant reduction in primary consumption of energy commodities – slightly more than twice compared to the 2022 levels.

Basic technologies for replacing hydrocarbons and achieving carbon neutrality already exist. Some of them have held a substantial market share (solar, wind and nuclear power generation, electric vehicles, energy-efficient building technologies), while others are in the prototype and implementation phase (energy storage systems and green hydrogen, carbon capture, use and storage systems, technologies in ferrous and non-ferrous metallurgy, cement and chemical industries, etc.). Their deployment is aided by the extensive application of government programmes such as the European Green Deal (EU) or the Inflation Reduction Act (USA). In the meantime, China has achieved

the most significant progress globally due to state support within the framework of the 14th Five-Year Plan (2021 – 2025). Currently, its share in the global production of solar panel components exceeds 80%, wind turbines – 60%, and about 60% of new electric vehicles are registered in China.⁵ According to the International Energy Agency’s forecast, China will continue to be the main driver of the green agenda at least until 2028.

The aforementioned factors generate climate transition risks for Russian non-financial companies. Carbon border adjustment mechanisms and the decrease in hydrocarbon consumption will inevitably influence Russian exporters, whose products are primarily energy commodities or have high carbon intensity. If these companies do not undertake decarbonisation and business diversification measures, they may face a significant reduction in profits in the long term, which could negatively affect their creditworthiness. In this regard, it is advisable to examine existing trends and potential risks within the framework of stress testing.

⁵ [IEA. Global EV Outlook 2023 \(April 2023\).](#)
[IEA. Renewables 2023 \(January 2024\).](#)

2. ECONOMIC EFFECTS OF THE CLIMATE TRANSITION SCENARIOS

When designing climate scenarios, central banks and supervisors usually refer to the NGFS scenarios, which carry out extensive analytical and academic research in assessing the economic consequences of climate risks realisation.⁶

To assess the resilience of Russian non-financial companies and credit institutions to climate transition risks, the Bank of Russia conducted a top-down stress test using two stress scenarios that evaluate the resilience of the economy and credit institutions to the global climate transition.

The baseline scenario implies a moderately ambitious climate policy with a global commitment to limit the increase in the global average temperature to well below 2°C above pre-industrial levels. The stress scenarios were prepared in two options – with a persistent domestic climate policy ('Climate-1'), where it remains within the regulation adopted as of 2023, and with the introduction of a more ambitious domestic climate policy ('Climate-2'). The original scenarios pathways set by the NGFS were adjusted to more accurately reflect Russian specifics and major changes in the economy and markets that occurred after the NGFS scenarios were published.⁷

The stress-testing horizon was chosen to be 2040. On the one hand, major shifts in energy, transportation, and climate regulation will become evident by then. On the other hand, extending the period further would diminish the practical value of the analysis. Furthermore, this horizon is in line with the approach adopted by most of the global regulators.

The scenarios are based on several preconditions, the alteration of which could significantly influence the trajectory and structure of the Russian economy. The analysis was constrained by factors such as scenario and model assumptions, the length of the forecast horizon, the absence of information about the strategies of brown companies up to 2040, and the presumption of a predominantly inertial response of the test subjects to stress scenarios. Given these factors, the presented results should not be interpreted as evaluation of the future state of the business, but as pointers to trends and risks that require further analysis and consideration.

2.1. Stress scenario assumptions (based on the NGFS 'Below 2°C' scenario)

The global climate policy. Starting from 2025, countries implement coordinated climate policies. They commit to reduce emissions to cut the temperature rise within the limits of 2°C in 2100. Every country introduces carbon prices, through either a cap-and-trade system and/or a carbon tax. Within the cap-and-trade system, the government sets the quantity of emissions allowed, exceeding which incurs penalties. Furthermore, a carbon market is formed to trade emissions in tons of CO₂ equivalent: companies that have reduced their emissions below the allowances act as sellers, while those that have exceeded their caps act as buyers. A carbon tax can be levied on both hydrocarbon fuels at the point of production (or import) or consumption, and on finished products that use these fuels, primarily automobiles and motorcycles.

All countries adopt border adjustment mechanisms in line with the EU CBAM principles. When importing goods from abroad, the greenhouse gas emissions released as they were produced must be declared. The importing company pays for the declared emissions at the rate established in

⁶ For more details, see <https://www.ngfs.net/ngfs-scenarios-portal/>.

⁷ Specifically, prices and quantitative restrictions for Russian exports were based on both NGFS data (2022, Phase III) and the Bank of Russia's macroeconomic models. Scenario calculations at the industry level and the calculation of the carbon price in Russia were conducted using a computable general equilibrium model (Burova et al., 2023). The scenario forecast of macroeconomic variables was based on a quarterly model (Orlov, 2021, in Russian).

the importing country. If the exporting and importing countries have an agreement to mutually recognise carbon pricing systems, the importer is credited with the payments made by the exporter in their home country.

In this scenario, the median temperature increase will reach 1.6°C.

The climate policy in Russia. Two variations were assessed for Russia: in one, Russia aligns with the global climate policy and gains recognition from its main trading partners (with the assumption that exports are redirected to friendly countries). In the other scenario, the domestic climate policy remains persistent. In the first scenario, companies pay tax on the entire volume of production, which is directed to the Russian budget. In the second scenario, companies pay a tax that is only applied to exports, but it replenishes the budgets of Russia's trading partner countries.

Technology and energy balance. The climate policy encourages the development of new technologies that increase the share of renewable energy sources (RES) and the use of new materials in production, such as wear-resistant composites, which reduce the demand for ferrous metals. As new technologies develop, interest in industrial non-ferrous and precious metals increases, which is reflected in their prices.

As the carbon price increases, global demand for carbon-intensive energy commodities and goods with high carbon footprints decreases. By 2040, global coal consumption falls by 90% of current levels.⁸ The main load in the energy balance turns to gas and RES. The oil share goes down moderately, yet it continues to be a primary energy source. This results in a decrease in the export prices for coal, oil, and oil products.

Global economy. The implementation of a carbon tax in the global economy escalates energy expenses, causing a simultaneous inflation rise and production drop. As the carbon price continues to grow, inflation remains above the target for a prolonged period due to a persistent negative output gap during the business and population adjustment period.

In response to inflation growth, central banks increase rates, mitigating the secondary effects of escalating inflation expectations. They subsequently start to lower rates, however, due to the consistent inflationary pressure; it takes several years to return to a neutral level. Moreover, the neutral rate itself also appears to be higher due to persistently elevated economic costs and increased demand for investment.

Russian economy. Like all other oil-exporting countries, Russia experiences a deterioration in trade terms as the global climate policy reduces the prices of hydrocarbons and other Russian exports with large carbon footprints. In the initial stress period, inflation and inflation expectations significantly increase due to (1) rising foreign inflation due to the carbon tax implemented in other countries, (2) the depreciation of the exchange rate as a result of worsening external conditions, and (3) the introduction of domestic climate regulation (in a scenario with the active domestic policy). The Bank of Russia, along with other central banks, is compelled to increase the policy rate. Output decreases in the first year of stress, after which the economy starts to recover. Subsequently, the growth rate decelerates and stabilises at a new equilibrium level.

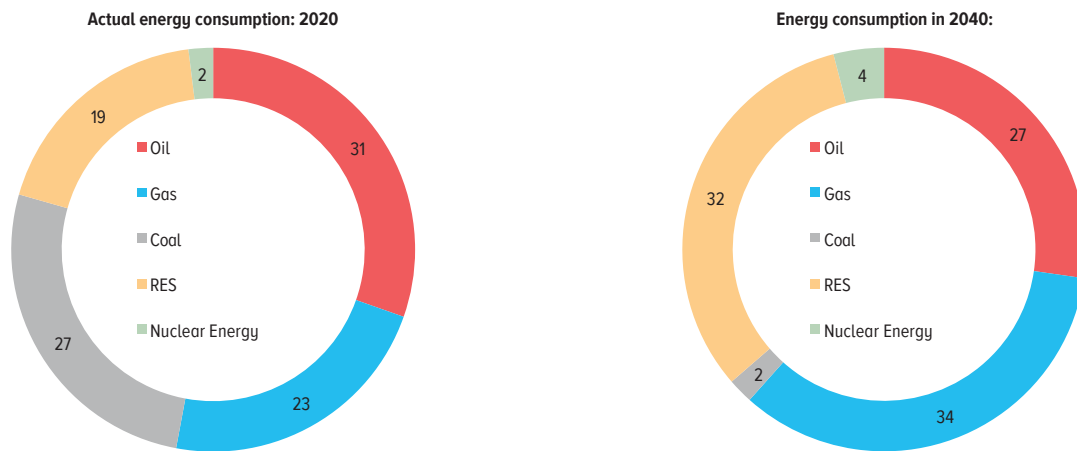
Already implemented external restrictions continue to impact Russian energy product exports. Oil exports slow, while gas exports mount due to the growing need for gas as a transition fuel. Exports of industrial non-ferrous metals and platinum group metals are bolstered by the growing demand from car manufacturers and the development of hydrogen energy (particularly at the far end of the forecast horizon).

A comparison of climate scenarios is provided in Table 1. In 'Climate-1' scenario, which assumes a persistent climate policy within the country, GDP growth rates for most of the forecast horizon may be higher than in 'Climate-2' scenario with an ambitious climate policy. However, in this scenario, economic agents lack additional incentives to decrease their carbon intensity and enhance their energy usage. As a result, new green industries will develop persistently, while brown companies will

⁸ However, it is important to note that coal consumption trends vary among individual countries.

GLOBAL ENERGY CONSUMPTION (%)

Chart 1



Note. The total sum deviating from 100% is due to data rounding.
Source: NGFS.

CLIMATE SCENARIOS COMPARISON

Table 1

	'Climate-1', unchanged domestic climate policy	'Climate-2', more ambitious domestic climate policy
Based on	NGFS Scenario 'Below 2°C'	NGFS Scenario 'Below 2°C'
Russia's climate policy	Within current trends	Elevating to global standards
Change in global GHG emissions, excluding Russia (2040 / 2020)	-50%	-50%
Change in Russia's GHG emissions (2040 / 2020)*	-10%	-36%
Average growth rate of real GDP in Russia**	1.8%	1.4%***
The cost of climate regulation is paid by	Exporters based on export volume	All domestic energy consumers
Carbon price per ton of CO ₂ -eq. by 2035****	USD20	USD20
Carbon payments go to the budget of	Other nations	Russia*****

* Assuming the net absorption of greenhouse gases in the Land Use, Land-Use Change and Forestry (LULUCF) sector remains constant.

** The average real GDP growth rate is calculated as the mean GDP growth rate from 2024 to 2040.

*** Higher growth rates can be achieved beyond the stress test period.

**** Based on a computable general equilibrium model (Burova et al., 2023).

***** Assuming that Russia's climate policy is acknowledged by its main trading partners.

lose their significance, reduce their investment programme, and consequently, their technological level. The pace of reducing greenhouse gas emissions domestically will significantly lag behind the global pace. Russian exporters will pay for their emissions to the budgets of other countries, and over time, access for their products to foreign markets may be significantly limited. Consequently, the potential economic growth rate will significantly decelerate beyond the stress-testing horizon, and the accumulated technological gap will be even more challenging to bridge.

An active climate policy will stimulate business process transformation, decrease the carbon footprint of the economy, and generate necessary funds for investment in green sectors or for subsidies to households and firms. This will collectively create conditions for enhancing the economy's competitiveness in the long run.

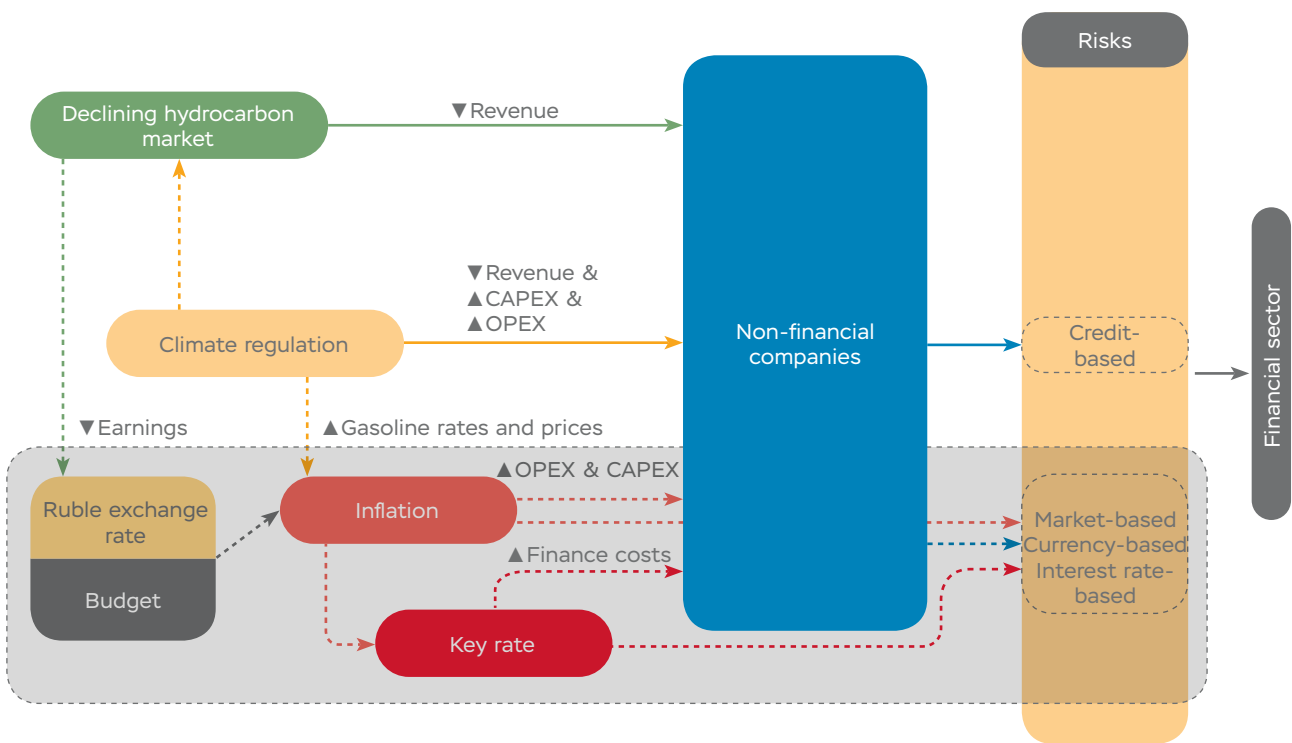
To align with the NGFS 'Below 2°C' scenario, according to the Bank of Russia calculations, the carbon price in Russia would need to reach USD20 per tonne by 2035.

2.2. Transmission channels

Based on these scenarios, we assessed the resilience of the Russian economy and banking sector to global economic changes, specifically, the decrease in global hydrocarbon consumption and the implementation of climate regulation globally and in Russia. The primary impact of these factors is manifested through non-financial companies and the credit risk of banks. Market, currency, and interest rate risks will also emerge, but due to existing regulations, such as restrictions on open currency positions, they will play a less significant role compared to credit risk. They are omitted in the analysis.

PRIMARY TRANSMISSION CHANNELS

Chart 2



3. RESILIENCE ASSESSMENT OF RUSSIAN NON-FINANCIAL COMPANIES

To carry out stress testing of the non-financial sector we chose 31 firms from the main sectors of the Russian economy.⁹ These firms prepare their financial reports in accordance with the International Financial Reporting Standards (IFRS), and either have a substantial portion of export earnings or lead in the industry. Specifically, their combined earnings made up a third of Russia's nominal GDP for 2022, and their export earnings accounted for about 80% of Russia's export volume for the same period. The share of these companies' greenhouse gas emissions in 2021 in Scope 1¹⁰ made up about 30% of Russia's total emissions.¹¹

During stress testing, the existing business model of firms was assumed to remain constant throughout the stress testing period,¹² without any significant transformations due to their adaptation to climate transition risks and structural economic changes (which would occur during the implementation of stress scenarios). The reorientation of companies to new businesses or segments was also disregarded. However, the calculations did consider additional investment costs for firms to reduce greenhouse gas emissions, which partially mitigate the negative impact of implementing climate regulation. The cost estimation was based on the expense of implementing advanced technologies that make it possible to achieve climate targets.

The aggregated stress test results of individual non-financial companies were extrapolated to represent the results for the entire brown industries. A probability of default (PD) prediction model, built on the financial indicators of legal entities and macro indicators, was used to estimate the default probability of borrowers from other sectors.

As a consequence of transitioning to a low-carbon economy, major non-financial companies face a decrease in global consumption and hydrocarbon prices. The implementation of cross-border climate regulation leads to an increase in operating costs and a decrease in sales profitability of companies. Consequently, without active adaptation to the energy transition, a third of the largest firms in the sample show a significant deterioration in their financial health over the 2030 – 2040 horizon. However, if a more ambitious domestic climate policy ('Climate-2') is implemented, these firms will start facing difficulties somewhat earlier over this horizon, and their financial indicators will be worse than under 'Climate-1' scenario. This is partly due to the implementation of domestic climate regulation, where a fee is charged for the entire volume of emissions from firms' production activities (not just the volume intended for exports, as under 'Climate-1' scenario). The domestic fee is paid to the Russian Federation budget by both producers (oil and gas, coal-mining firms) and consumers of hydrocarbons (metal companies, fertilizer manufacturers, and others).

⁹ Oil and gas sector, metal industry, mining and quarrying, transportation sector, fertiliser and chemical manufacturers.

¹⁰ Scope 1 emissions are direct emissions of greenhouse gases from sources owned or controlled by the reporting economic agent. For instance, emissions from the production process and the company's own vehicles.

¹¹ Excluding the Land Use, Land-Use Change and Forestry (LULUCF) sector.

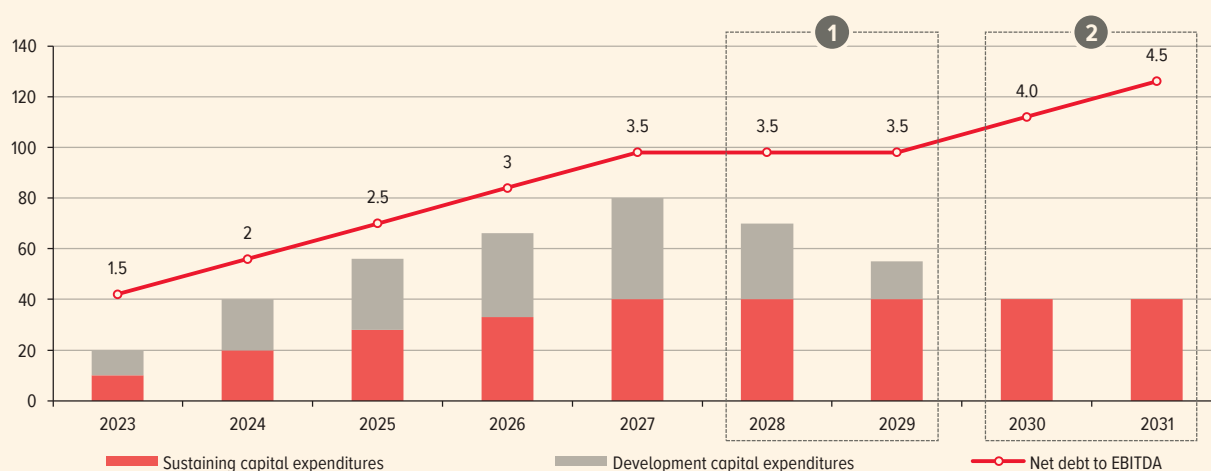
¹² For instance, the scenarios did not assume a waiver of the key oil and gas taxes (mineral extraction tax (MET) and additional income tax (AIT) by oil and gas companies, even though their tax burden may increase under certain scenarios.

Box 1. Assumption of reducing the investment programme of companies in case of their financial position deterioration

The scenarios assumed that firms would reduce their investment programme if their financial situation worsened. For this, two categories of capital expenditure were identified for each firm: development investment and investment to support core business. Sustaining capital expenditures were modeled as the average percentage of depreciation deductions from revenue for the period from 2018 to 2022 and were considered non-reducible (i.e. made by the firms annually). Meanwhile, development investments were reduced as firms reached a net debt-to-EBITDA ratio of 3.5 (it was assumed that firms would strive to maintain financial soundness and refrain from new investment projects).

ILLUSTRATIVE CALCULATION OF A FIRM'S INVESTMENT PROGRAMME WHEN ITS FINANCIAL SITUATION DETERIORATES

Chart B-1-1



- ❶ The firm manages to limit the growth of its debt burden by reducing development investment costs
- ❷ Due to a decrease in operating performance, the firm is forced to completely abandon development investments. Subsequent growth in the firm's debt burden is associated with the need to finance investments to maintain core activities, as well as to service existing debt

However, the impact varies across industries. Iron ore producers and miners (including coal mining), as well as fertilizer producers, may become most exposed to climate transition risks. They face a decrease in export earnings due to the high carbon intensity of their products.

Companies in oil and gas industry may also face negative pressure from global consumption volumes and hydrocarbon prices. However, the largest companies maintain financial resilience under stress scenarios over the forecast horizon. Producers of liquefied natural gas might even enhance their financial status due to the anticipated rise in demand.

The financial standing of certain transport companies may also worsen due to a decrease in transportation demand.

Companies in non-ferrous metallurgy benefit from the accelerated energy transition, as the demand for non-ferrous metals will increase. Most types of non-ferrous metals are utilised in low-carbon technologies. For instance, solar energy heavily depends on copper, aluminum, and chromium, wind energy depends on copper and zinc, and geothermal energy depends on nickel and chromium. The production of electric cars and batteries demands copper, cobalt, nickel, lithium, and aluminum, while hydrogen energy requires nickel and platinum. Consequently, these companies improve their financial status under stress scenarios.

Box 2. Non-financial sector stress testing tools

To evaluate the impact of climate transition risks and structural changes in the economy on the financial status of Russia's largest non-financial companies, the regulator has developed a comprehensive financial model to assess the credit soundness of Russia's major businesses. It allows forecasting the main IFRS financial statements of companies at the consolidated level (statement of financial position, statement of financial performance, statement of cash flows), analysing the sufficiency of cash flow for servicing and repayment of debt obligations (including consideration of data from reporting form 0409303 'Information on Loans to Legal Entities'), estimating the amount of additional funding required by the company in case of cash gaps, and considering the impact of various development scenarios of the Russian and global economy as a whole, including commodity and capital market dynamics, sanctions pressure and other constraints.

The impact of structural changes in the economy is reflected in the calculations through changes in revenue, operating expenses, investment programme, net working capital, as well as considering the forecast of raising, repayment, and servicing of debt obligations.

The comprehensive financial model calculates financial ratios at both individual and aggregate (industry) levels, and analyses the dynamics of the main items of the companies' financial statements. The transformation of these indicators provides an assessment of the impact of climate transition risks on the selected companies and the industries as a whole. Changes in the financial status of companies affect the financial resilience of credit institutions that invest in the assets of non-financial companies.

Therefore, even though that under current business models, without proactive adaptation, most brown companies remain resilient for the next 10–15 years, the impact of climate transition risks on the brown non-financial sector could be substantial. The deterioration of these companies' financial status could potentially create systemic risks in the financial sector. The probability and timeline for these risks realisation will depend on the actual dynamics of the energy transition and the ability of non-financial companies to adapt to changes in the climate policy. Business diversification measures and the green transformation, which can be implemented by brown companies, can improve their financial status in the long term, leading to outcomes that are more positive.

4. ASSESSMENT OF BANKING SECTOR RESILIENCE

Stress testing of the banking sector was conducted for systemically important credit institutions (SICI) on an individual basis, as well as collectively for a group of remaining banks. The dynamic stress test was calculated for the following periods: 2023 to 2025, 2025 to 2030, 2030 to 2035, and 2035 to 2040.

Based on the results of this test, the final indicators of financial resilience are the capital adequacy ratio N1. i and the corresponding value of capital surplus / capital deficit. The capital deficit includes three capital adequacy ratios¹³ and is defined as the largest amount of required bank recapitalisation until the minimum capital adequacy requirements are met. In contrast, the capital surplus was assessed as the minimum value of the capital reserve for each of the three ratios (N1.1, N1.2, N1.0), with the bank complying with all adequacy ratios.

The results of stress testing indicate that under both scenarios, climate stress will have a downward effect on the actual values of credit institutions' ratio N1.0. The extent of this impact will also depend on the degree of economic adaptation to climate transition risks and, consequently, the ability of banks to reallocate the structure of their loan portfolios in favour of green borrowers.

'Climate-1' scenario is more lenient in terms of the dynamics of macroeconomic and sectoral indicators. Simultaneously, the absence of incentives could negatively influence the pace of economic structural changes. In these circumstances, the capacity of banks to diversify their loan portfolios towards sectors resilient to transition risks might be restricted. By 2040, the climate stress is expected to decrease the actual values of ratio N1.0 across the sector. On average, this effect is estimated at 0.7 pp, assuming the loan portfolio structure remains constant throughout the entire forecast horizon. If credit institutions do manage to diversify their loan portfolio towards the green economy, ratio N1.0 could decrease by 0.2 pp.

An ambitious domestic climate policy under 'Climate-2' scenario could significantly green the economy and introduce new sectors immune to transition risks. Banks will have more opportunities to alter their lending structure by reducing exposure to brown companies. Our estimates suggest that their share will decrease from 34% in 2022 to 6.7% of the loan portfolio by 2040, assuming banks implement an active adaptation policy (Chart B-3-1). However, the introduction of carbon pricing mechanisms will present more significant challenges for brown companies compared to 'Climate-1' scenario. As a result, the climate stress will exert more substantial pressure on the capital of credit institutions. Collectively, this will result in a 0.7 pp decrease in the actual ratio N1.0 across the banking sector.

Meanwhile, if banks maintain the current credit portfolio structure throughout the entire forecast horizon under 'Climate-2' scenario, the climate stress could downgrade the ratio N1.0 to 3 pp. In this case, due to the uneven distribution of capital and risks across the banking sector, some SICIs may experience a capital deficit, indicating potential risks to financial stability.

Therefore, the resilience of the banking sector will largely hinge on the ability to diversify the loan portfolio towards the green economy. Considering this, credit institutions (and the financial sector as a whole) need to manage climate risks and work with customers to enhance their energy efficiency and reduce the carbon intensity of their products. This will facilitate a gradual and consistent transformation of investments and the loan portfolio, increasing the proportion of customers resilient to transition risks.

Although it is easier for credit institutions to adapt to climate risks by diversifying their portfolios, it does not imply they should prohibit financing certain sectors. Conversely, the most forward-

¹³ Core Tier I capital – N1.1, Tier I capital – N1.2, total capital – N1.0.

looking policy appears to be the one where banks assist the corporate sector in restructuring business models amid the energy transition, support emission reduction projects, and accelerate the growth rate of lending to alternative industries. The Bank of Russia developed Recommendations on Climate Risk Management for Financial Institutions with more details on the issue.¹⁴

Given that conclusions heavily rely on model assumptions, it is advisable to conduct a bottom-up stress test to enhance the analysis. The Bank of Russia has scheduled for 2024 a survey of major banks, non-financial companies, and federal authorities about the key channels through which climate transition risks influence their resilience, potential adaptation mechanisms for the Russian economy, and the impact of stress scenarios on market participants' performance.

Box 3. Stress testing toolkit for the banking sector

The stress testing of the banking sector is based on the following assumptions:

- Dynamic simulation of balance sheets and financial results based on the current business models of banks;
- Gradual adaptation to climate transition risks and structural economic changes, reflected in the decreasing proportion of loans provided to brown companies in the loan portfolio structure.

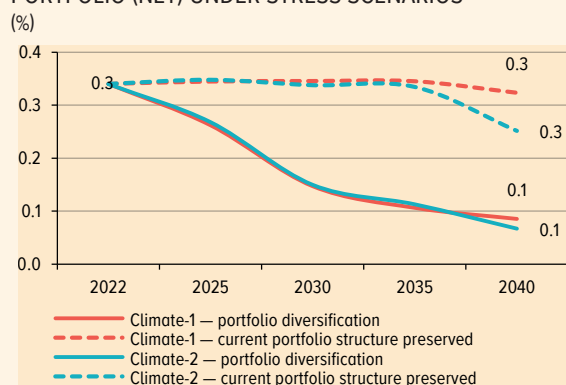
The first stage involves forecasting the performance of the loan portfolio, securities portfolio, and net assets of the banking sector, as well as risk-weighted assets (RWAs). The ratio of the corporate loan portfolio to GDP in Russia is still lower than in many countries used for comparison. Hence, the calculations anticipate a catch-up growth in the ratio of the corporate portfolio to GDP in the long run, in line with the evolution of capital markets. Considering the constraints on firms to incur external debt, it is projected that bank lending will increase by 15 pp relative to GDP by 2040.

It is presumed that the structure of the portfolio distribution among the largest borrowers according to their obligations will remain constant. The sectoral dynamics of corporate debt mirrors that of the largest sectoral companies evaluated individually; the growth rates of other sectors are derived from the overall forecast of the loan portfolio growth.

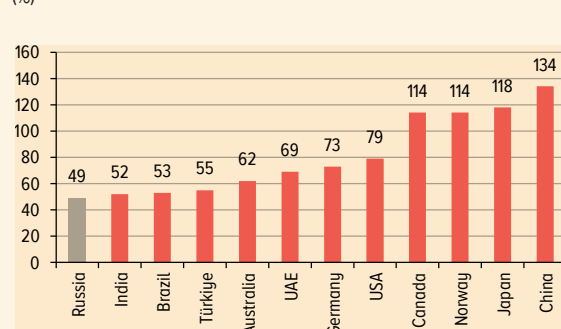
A model predicting the likelihood of default for the largest non-financial companies and individual sectors was employed to estimate the loan loss provisions (LLP), with expert adjustments applied in certain instances.

In the second phase, a financial outcome forecast was computed based on historical profitability ratios and projected net asset values, which was then adjusted for the anticipated amount of additionally created provisions and the revaluation of the securities portfolio. The ultimate financial result, inclusive of tax and dividend payments, was incorporated into the capital. RWAs associated with market risk were adjusted in line with the growth of the securities portfolio, while those linked to operational risk were adjusted in accordance with the growth of the financial result. In the end, the capital adequacy ratio N1. i as a result of the stress and the corresponding amount of the banks' capital deficit were computed.

PROPORTION OF LOANS GRANTED TO BROWN COMPANIES IN THE CORPORATE LOAN PORTFOLIO (NET) UNDER STRESS SCENARIOS *Chart B-3-1*



RATIO OF THE CORPORATE SECTOR'S DEBT FINANCING TO GDP IN 2022 *Chart B-3-2*

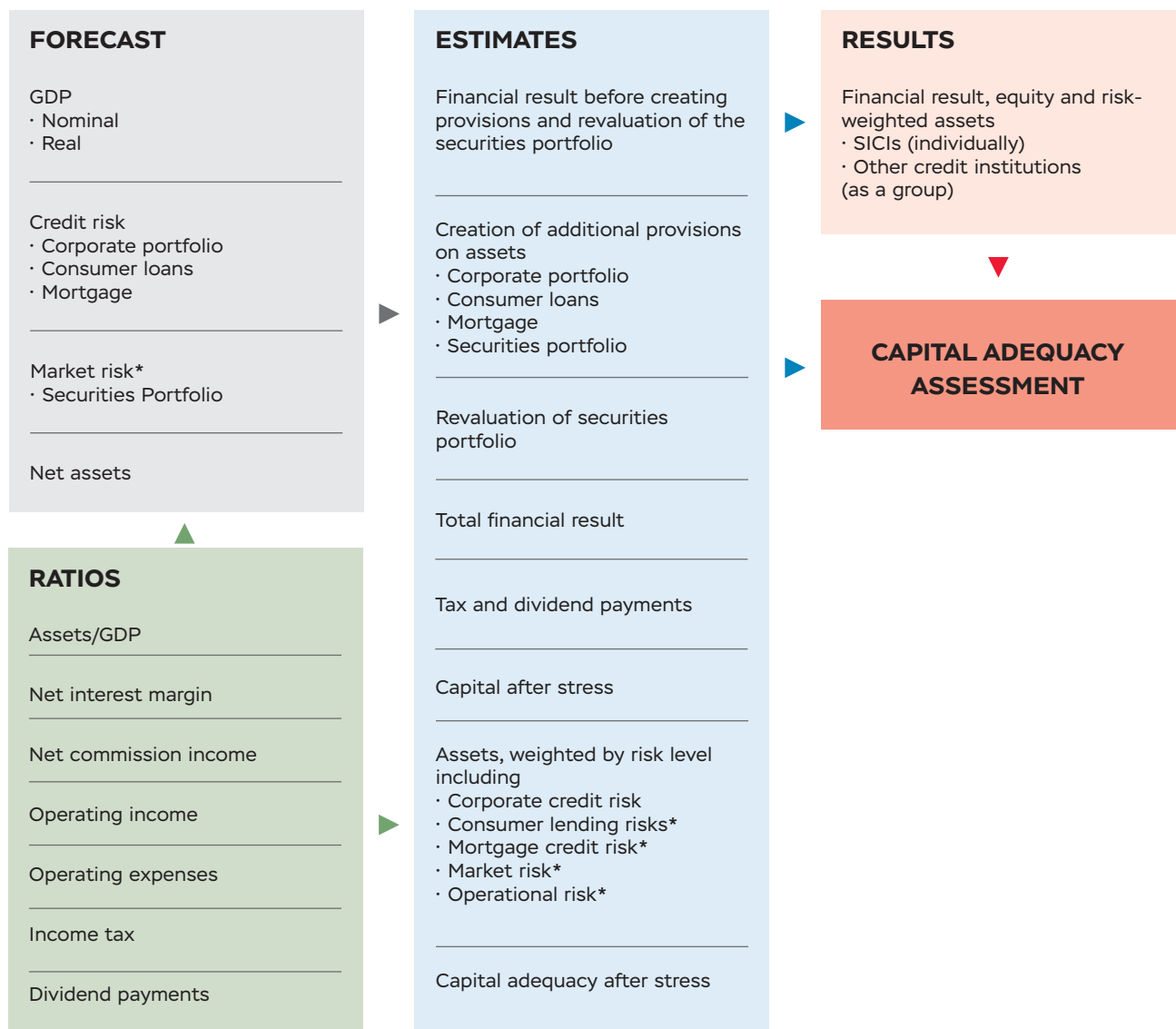


Sources: IMF, Bank of Russia.

¹⁴ Bank of Russia Information Letter No. IN018-35/60, dated 4 December 2023, '[On Recommendations on Climate Risk Management for Financial Institutions](#)'.

STRESS TESTING CHART FOR BANKING SECTOR

Chart 3



* Market, currency, interest rate, and operational risks will have a significantly lesser impact than credit risk. They are not considered in the analysis.

CONCLUSIONS AND NEXT STEPS

The stress test results indicate that, should climate transition risks realise, some of the largest non-financial companies from brown sectors could experience a significant financial downturn. In this situation, if the economy fails to adapt and the share of brown companies remains unchanged, the risks to the banking sector could be substantial. The calculations, on one hand, may overstate the potential losses of the banking sector due to assumptions about the absence of extensive adaptation by non-financial companies. On the other hand, the NGFS 'Below 2°C' scenario is relatively moderate, and there is a possibility that the pace of the global energy transition will proceed faster.

Considering this, financial institutions, especially banks, should manage climate risks in line with the Bank of Russia Recommendations on Climate Risk Management for Financial Institutions. Unlike non-financial companies, it is considerably easier for them to diversify their portfolio structure. However, this does not imply that it is advisable for them to impose restrictions on financing certain sectors. Contrarily, a strategy where banks assist the corporate sector in restructuring business models amidst the energy transition seems optimal. Therefore, it is crucial to work with brown sector to enhance their energy efficiency and reduce the carbon intensity of their products. As the stress testing results demonstrate, such measures will not only help prevent significant losses in the banking sector but also promote the growth of banking business.

The Bank of Russia intends to continue assessing the potential impact of climate transition risks and the capacity of the real sector and banks to adapt to the corresponding economic changes. Specifically, in 2024 we plan to do the following in order to refine on the preliminary estimates presented in this publication and on the timeframe within which non-financial companies and the financial sector may face the biggest challenges:

- conduct bottom-up stress testing of climate risks (including scenario updates) in collaboration with major financial and non-financial companies and relevant authorities;
- launch a regular survey of financial institutions regarding their exposure to climate risks and management thereof, in line with the Bank of Russia's recommendations on climate risk management for financial institutions.