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FINANCIAL SECTOR ASSESSMENT PROGRAM

April 2024

TECHNICAL NOTE ON CLIMATE-RELATED RISKS AND FINANCIAL STABILITY

This Technical Note on Climate-Related Risks and Financial Stability for the Republic of Kazakhstan Financial Sector Assessment Program was prepared by a staff team of the International Monetary Fund and the World Bank as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed in April 2024.

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REPUBLIC OF KAZAKHSTAN

FINANCIAL SECTOR ASSESSMENT PROGRAM

April 2024

TECHNICAL NOTE

CLIMATE-RELATED RISKS AND FINANCIAL STABILITY IN KAZAKHSTAN

Prepared By

Monetary and Capital Markets Department

This Technical Note was prepared by IMF staff in the context of a joint IMF-World Bank Financial Sector Assessment Program (FSAP) mission in Kazakhstan. The note contains the technical analysis and detailed information underpinning the FSAP findings and recommendations. Further information on the FSAP program can be found at http://www.imf.org/external/np/fsap/fssa.aspx.

CONTENTS

TABLES

APPENDICES

Glossary

ARDFM	Agency of the Republic of Kazakhstan for Regulation and Development of Financial Markets
ASPR	Agency for Strategic Planning and Reforms
CBAM	Carbon Border Adjustment Mechanism
CGE	Computable General Equilibrium
CO_2	Carbon Dioxide
COGS	Cost of Goods Sold
CR	Current Ratio
DSGE	Dynamic Stochastic General Equilibrium
EBIT	Earnings Before Interest and Taxes
EBT	Earnings Before Taxes
ETS	Emissions Trading System
EU	European Union
FSAP	Financial Sector Assessment Program
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GVA	Gross Value Added
ICR	Interest Coverage Ratio
IEA	International Energy Agency
IMF	International Monetary Fund
IPF	Integrated Policy Framework
IPCC	Intergovernmental Panel on Climate Change
KZT	Kazakhstani Tenge
LGD	Loss Given Default
LR	Leverage Ratio
MEGNR	Ministry of Ecology, Geology, and Natural Resources
MES	Ministry of Emergency Situations
MIID	Ministry of Industry and Infrastructural Development
MNE	Ministry of National Economy
MoA	Ministry of Agriculture
MoE	Ministry of Energy
MoF	Ministry of Finance
NBK	National Bank of Kazakhstan
NDC	Nationally Determined Contribution
NGFS	Network for Greening the Financial System
NZE	Net-Zero Emissions
PD	Probability of Default
P&L	Profit and Loss
US	United States
USD	United States Dollar

EXECUTIVE SUMMARY[1]

Kazakhstan is vulnerable to transition risk due to the importance of its energy- and emissions-intensive sectors. Kazakhstan's per capita carbon dioxide (CO_2) emissions are 3.5 times higher than the global average, making the country the 10th emitter in terms of per capita emissions. To mitigate climate change, Kazakhstan has pledged to reduce greenhouse gas emissions by 15–25 percent between 1990 and 2030 and reach carbon neutrality by 2060, which will require a significant transformation of its energy system. Kazakhstan's major trade partners have also announced net-zero targets, posing additional risks to Kazakhstan's energy and economic systems.

Two complementary modeling approaches are used to assess the impact of domestic and global climate mitigation actions on Kazakhstan's financial sector. The "micro" approach uses a combination of two models: a recursive dynamic computable general equilibrium model (IMF-ENV) to assess the macroeconomic and sectoral impact of climate-related transition risks, and a firm-level model in which the sectoral impacts are translated in shocks to relevant profit and loss and balance-sheet indicators and, ultimately, a company's financial health; the results are finally mapped into banks' corporate portfolio exposures. The "macro" approach also uses a combination of models: a dynamic stochastic general equilibrium model (IPF) and the same satellite models employed in the solvency stress test exercise to derive the evolution of probability of default and loss given default across all bank portfolios.[2] While the micro modeling approach focuses on the corporate portfolio and captures firm-, sector-, and bank-level heterogeneity, the macro modeling approach assesses the impact on banks' overall loan portfolios.

Domestic and global climate policies would negatively affect Kazakhstan's economy, its firms, industries, and banks, with heterogenous impacts across industries and banks. Using both micro and macro approaches, the climate risk analysis suggests that Kazakhstan is exposed to significant transition risk from domestic and, more importantly, global climate policies. The risk is especially higher for carbon intensive sectors, such as fossil fuel extraction, refining, and electricity generation. Banks with large exposure to emissions-intensive sectors experience up to 30 percent additional losses under a disorderly 1.5°C scenario over a 5-to-7-year horizon, compared to the baseline. Banks with a small share of portfolio exposed to emissions-intensive sectors may still experience losses, as climate change mitigation actions affect the economy at large (e.g., loss of GDP and currency depreciation) and the financial health of individual consumers, businesses, and industries.[3]

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[1] This Technical Note has been prepared by Sha Yu (climate risk analysis lead) and Sujan Lamichhane, under the FSAP mission leadership of Pierpaolo Grippa (mission chief) and Priscilla Toffano (deputy mission chief), all IMF. We thank Zoltan Jakab (MCM) and Hugo Rojas-Romagosa (RES) for their support in running macro-financial scenarios. The team is grateful to the ARDFM and NBK for their excellent collaboration in this exercise.

[2] For more information on the solvency stress test exercise, please see "Republic of Kazakhstan: Financial System Stability Assessment."

[3] The static balance sheet assumptions are applied in both micro and macro approaches.

The authorities are recommended to further assess the implications of climate change for the financial system. Joining the Network for Greening the Financial System, in particular the workstreams on Supervision, Scenario Design and Analysis, and Monetary Policy, would allow for a gradual engagement in the international debate in this area.

Given the cross-sectoral nature of climate-related issues, the authorities should strengthen coordination between financial regulators, ministries, and other stakeholders and develop an interagency working group on climate finance and climate risk analysis. Climate change mitigation and adaptation policies are developed and implemented by multiple ministries and agencies. On the one hand, policies developed by some line ministries—such as energy policies by the Ministry of Energy and emissions reduction targets by the Ministry of Ecology, Geology, and Natural Resources (MEGNR)—have broader economic impact and affect the financial system. On the other hand, understanding climate risk for the financial system requires data and modeling support from other line ministries. Enhancing interagency coordination could help address the data gap in climate risk analysis, improve the methodologies to assess climate risks, and support climate-related financial risk monitoring.

Improving and harmonizing data can be the first step to enhance interagency coordination and assess climate-related risks. Some data for climate risk analysis, such as firm-level energy consumption and emissions data, are currently collected by specific agencies and ministries and need to be shared across ministries and agencies to allow for the detailed assessment of climate-related impact on firms, banks, and the financial system. Other data that are critical to climate risk analysis but not available or collected at sufficient granularity, for example asset-level insurance coverage for hazards, need to be developed through new interagency initiatives (e.g., new data collection efforts that combine assets and insurance coverage data from financial authorities with climate and hazard projections data from MEGNR).

Given the potential for substantial risks associated with climate change and climate mitigation actions, the authorities should develop capacity to conduct climate stress testing. This includes: improving human capacity and potentially hiring climate experts; developing key risk indicators to assess climate-related risks; developing climate scenarios and climate-macro-financial models with suitable scope regarding country coverage, industry coverage, climate risk components, and macrofinancial variables; developing climate risk analysis training; and integrating climate risk into the stress testing framework.

While this analysis focuses on transition risk, Kazakhstan also faces physical risks, which require further assessment. The intensity and frequency of floods and droughts in Kazakhstan are expected to increase with climate change. Floods and droughts can affect crop yield and production, energy system operation, and major infrastructure and result in significant economic losses. Moreover, climate change, together with the onset of El Niño, will greatly increase the likelihood of extreme events in the next five years and increase physical risk in the near term (World Meteorological Organization, 2023).

Table 1. Kazakhstan: Main Recommendations		
Recommendations	**Authorities**	**Timeline***
Join the Network for Greening the Financial System, especially the workstreams on 'Supervision', 'Scenario Design and Analysis', and 'Monetary Policy'	ARDFM, NBK	I
Strengthen coordination between financial regulators and ministries and develop an interagency working group on climate finance and climate risk analysis	ARDFM, NBK, ASPR, MNE, MoF, MEGNR, MoE, MoA, MIID, MES, AIFC	ST
Improve and harmonize data (including energy, emissions, and environmental data) for assessing transition and physical risks	ARDFM, NBK, MEGNR, MoE, ASPR/Bureau of Statistics	MT
Develop capacity to conduct climate stress testing for the banking sector, including improving human capacity and developing climate-macro-financial models with suitable scope regarding country coverage, industry coverage, climate risk components, and macrofinancial variables	ARDFM, NBK	MT
* I = immediate (within 1 year), ST = short term (within 1-2 years), MT = medium term (within 3-5 years).		

INTRODUCTION

1. **Global climate change has caused widespread and substantial adverse impacts on human and natural systems and the impacts will continue to intensify.** Adverse impacts are unevenly distributed across regions, sectors, and systems. Climate-related economic losses and damages have been detected in several sectors, such as agriculture, energy, and tourism, and on individuals and households, such as loss of property and income. In addition, climate and non-climate risks can interact, creating compounding and potentially cascading risks that are more complex and difficult to manage (IPCC, 2023).

2. **Ambitious actions taken by countries and companies to address climate change, while necessary to counter the increase in extreme events and adverse impacts, can cause large and disruptive changes in existing economic and financial systems.** For example, in the transition to a low-carbon economy, assets may experience premature write-downs or devaluations, or become 'stranded', which poses a potential risk of an abrupt transition having destabilizing effects on the financial system. The potential adverse impacts of decarbonization—and, more generally, of reducing Greenhouse Gas (GHG) emissions—can be mitigated by integrating climate actions with macroeconomic policies and through fiscal, financial, institutional, and regulatory reforms (IPCC, 2023).

3. **Based on the different channels through which climate change and climate mitigation policies can affect the economy and the financial system, climate-related risks are usually classified into two categories: transition and physical risks.** Transition risks result from changes in policy, market, and technology when the economy moves away from fossil fuels and GHG-intensive activities and production processes; this transition can impact the value of financial assets and liabilities. Physical risks arise from the physical effects of climate change and environmental degradation and can be both chronic (e.g., sea level rise and temperature increase) and acute (e.g., floods, droughts, and storms). Shifts in climate patterns can cause damages to physical assets, markets, and productivity that in turn can affect the resilience of the financial system (Adrian et al., 2022).

4. **Climate risk analysis has been piloted in recent Financial Sector Assessment Programs (FSAPs).** For example, the FSAPs of Chile (International Monetary Fund, 2021), Colombia (Sever and Perez-Archila, 2021), Mexico (International Monetary Fund, 2022a), Norway (Grippa and Mann, 2020), and the United Kingdom (International Monetary Fund, 2022b) assessed transition risks posed by climate change mitigation and implications for the financial sector. The FSAPs of Mexico (International Monetary Fund, 2022a) and the Philippines (International Monetary Fund and World Bank, 2022) assessed country-specific physical risks, i.e., typhoons in the Philippines and tropical cyclones and floods in Mexico.

5. **The climate risk analysis in the Kazakhstan FSAP aims to assess potential transition risks to macroeconomic and financial stability posed by climate change.** While this analysis also discusses physical risks briefly, the main focus of the Kazakhstan FSAP climate risk analysis is on

assessing the exposure of the financial system in the transition to a low-carbon economy in the context of national and global climate actions.

CLIMATE-RELATED TRANSITION RISKS IN KAZAKHSTAN

6. **Limiting global warming to meet the Paris Agreement goal requires a significant transformation of the energy system and will result in unprecedented impacts on the economy and financial sector.** As the economy transitions from a carbon-intensive to a low-carbon growth path, banks could face costs from the decline of carbon-intensive industries and benefits from the rise of clean energy industries, depending on their exposures. Fossil-fuel exporting economies such as Kazakhstan are not only affected by changes in the domestic market, but also impacted by global climate actions as their trading partners transition to green, low-carbon economies.

7. **The energy sector is the major source of GHG emissions in Kazakhstan, accounting for 80 percent of the total.** Within the energy sector, 90 percent of GHG emissions come from fossil fuel combustion, and the remaining 10 percent are fugitive emissions from fossil fuel production and distribution (Figure 1a). In terms of scope 1 emissions,[4] energy industries, especially electricity and heat production, are responsible for more than half of energy sector emissions and the main driver of emissions growth in Kazakhstan (Figure 1c). Kazakhstan's emissions from energy industries more than doubled between 2000 and 2020, while its national total emissions only grew by 30 percent during the same period (Figure 1b).

8. **Kazakhstan's economy is highly carbon intensive.** As of 2020, coal, natural gas, and oil supply more than 98 percent of primary energy, compared to 70 percent in Europe and 80 percent globally. Renewable energy only accounts for less than 2 percent of total energy supply in Kazakhstan, whereas renewable accounts for 18 percent of the European energy mix and 15 percent of the global energy mix in 2020 (Figure 2a). Kazakhstan's electricity generation heavily relies on coal, which provided two thirds of electricity in 2020, while natural gas (22 percent), hydro (9 percent), and solar and wind (2 percent) provide the rest (Figure 2b). In contrast, coal only accounts for 15 percent of electricity generation in Europe (35 percent globally) and renewable resources (including hydro) provide more than 40 percent of European electricity (29 percent globally) (International Energy Agency, 2022a).

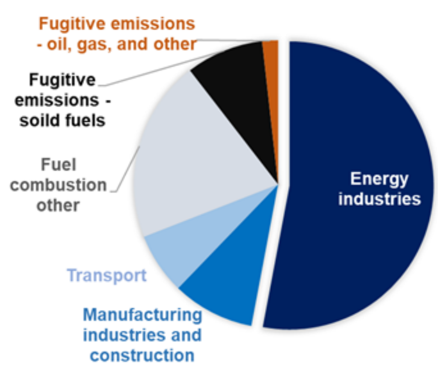
9. **Kazakhstan, as a fossil fuel export country, faces significant transition risks.** 93 countries have communicated a net-zero target, including some of Kazakhstan's major trade partners such as China, Italy, Netherlands, France, South Korea, and Turkey (Climate Watch, 2023).

[4] Scope 1 emissions are direct GHG emissions that are from sources owned or controlled by the reporting entity. Scope 2 emissions are indirect GHG emissions associated with the production of electricity, heat, or steam consumed by the reporting entity. Scope 3 emissions are all other indirect GHG emissions, for example, emissions associated with the extraction and production of purchased materials, fuels, and services (Allwood et al., 2014; World Business Council on Sustainable Development and World Resources Institute 2004).

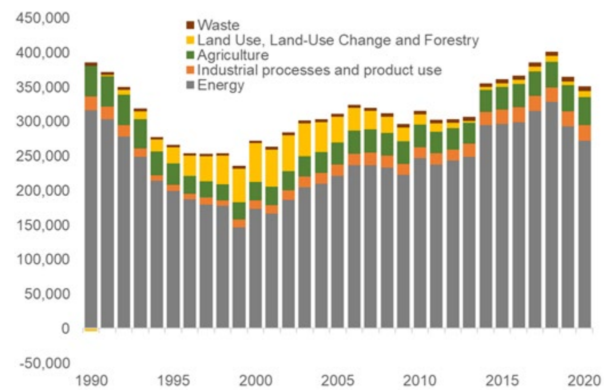
The demand for oil, natural gas, and other emissions-intensive products from Kazakhstan are expected to fall, driven by policies, technological development, and changing investor and consumer preferences. The International Energy Agency estimates that if all announced targets and net-zero goals are implemented, global oil and gas demand will be reduced by half by 2050 (International Energy Agency, 2022b). Similarly, the Network for Greening the Financial System (NGFS) estimates that global oil, gas, and coal demand will be reduced by 40–60 percent, 55-70 percent, and 85–98 percent by 2050, respectively, to meet the 1.5°C target (Figure 3). With hydrocarbon production in 2022 amounting to more than 20 percent of GDP and more than half of exports, and tax revenues from the oil sector representing more than 40 percent of the total, the financial system in Kazakhstan could be affected by the domestic implications of global climate mitigation policies, especially in case of a rapid and abrupt energy transition, which could severely impact the oil and gas industry; given the industry's relevance in the domestic economy, that could have major implications at macroeconomic level.

Figure 1. Kazakhstan's Greenhouse Gas Emissions by Source

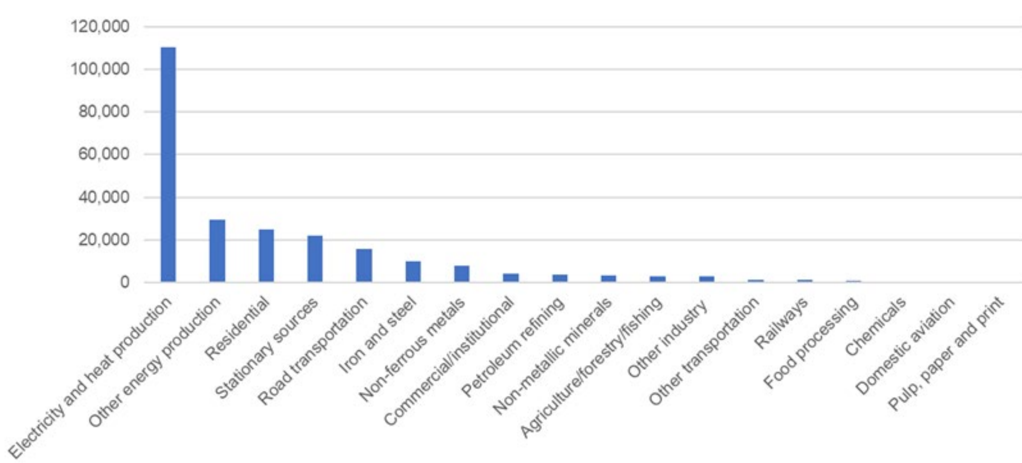
a) Energy Sector Emissions by Source, 2020 (In percent)



b) Historical Greenhouse Gas Emissions by Source, 1990-2020 (kt CO_2e)

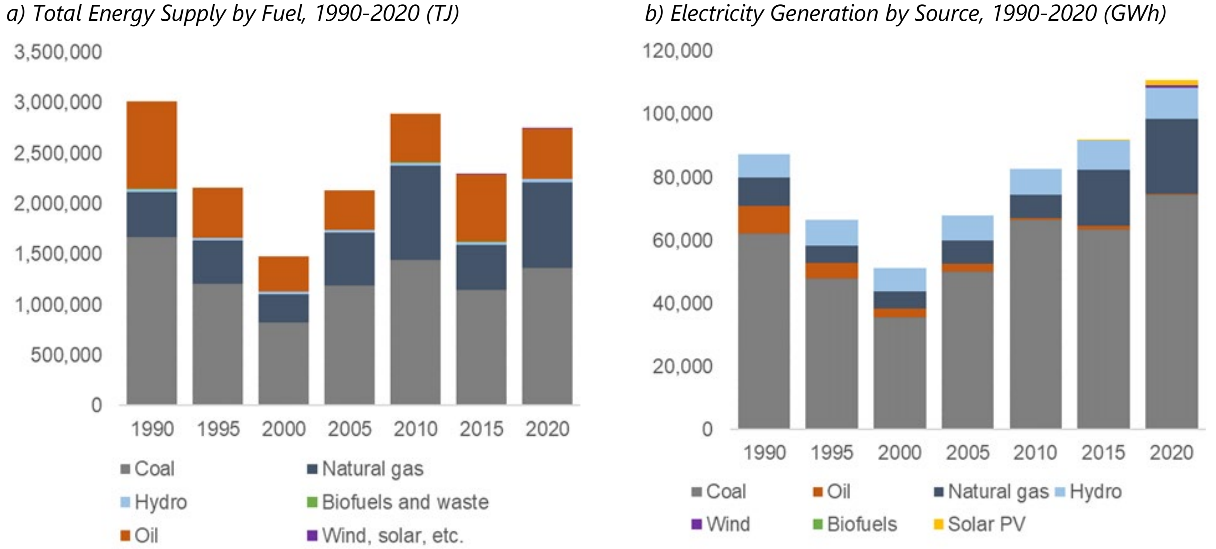


c) CO_2 Emissions from Energy Combustion by Sector, 2020 (kt CO_2)



Source: Government of Kazakhstan, 2022.

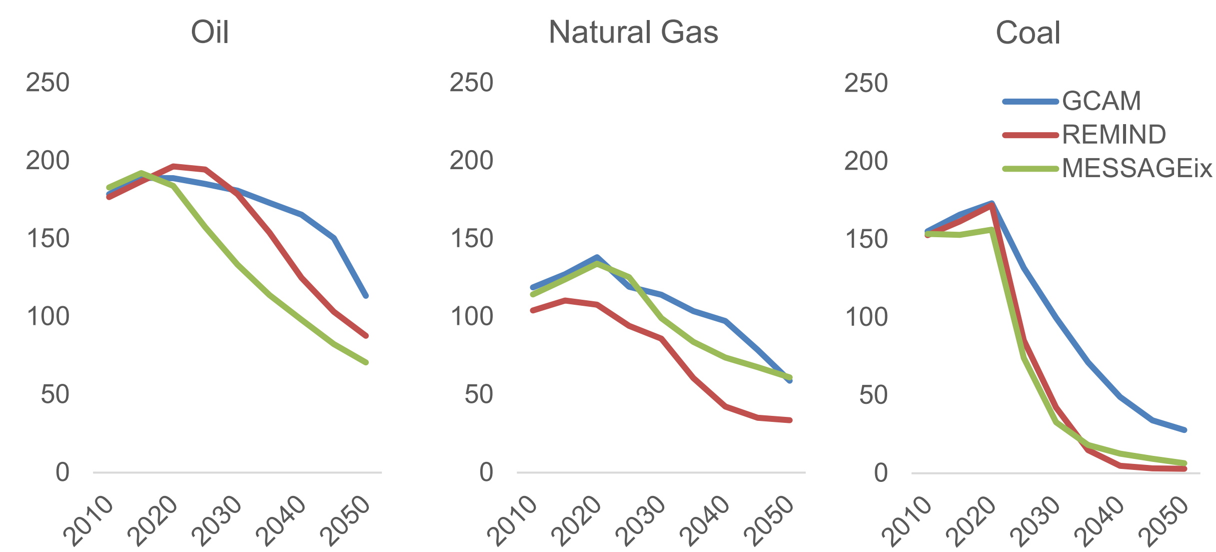
Figure 2. Energy Mix in Kazakhstan



Source: International Energy Agency, 2022a.

Figure 3. Global Fossil Fuel Demand in an Illustrative Orderly 1.5°C Scenario from NGFS

(EJ per year)



Source: Network for Greening the Financial System, 2022.

Notes: NGFS uses three integrated assessment models – GCAM, REMIND, and MESSAGEix, to produce transition pathways. Using different models allow users to obtain a range of results, which capture model uncertainty to some degree and allow users to draw robust insights across models.

10. Transition risks will extend beyond the oil and gas sector, given the importance of carbon intensive commodities in the country's export sectors and the potential reduction in demand for these commodities. Nearly 80 percent of Kazakhstan's export values are from carbon intensive sectors (e.g., minerals, chemicals, metals, stone) (Figure 4). Demand for carbon-intensive goods (produced with significant use of fossil fuel energy) is likely to face increasing barriers, as global climate actions accelerate. For example, to limit carbon leakage and enhance global mitigation efforts, the European Union (EU) passed the Carbon Border Adjustment Mechanism (CBAM), which is set to level import duties based on the emissions intensity of products. The EU CBAM currently covers six product types (aluminum, cement, electricity, fertilizer, hydrogen, and iron and steel), and is expected to extend to plastics and chemicals by 2026 and all sectors covered by the EU Emissions Trading System (ETS) by 2030. Export to EU accounts for 32 percent of Kazakhstan's total export values in 2020. Modeling suggests that Kazakhstan could lose over $250 million per year in export to the EU due to the CBAM by 2035 (against a gross export value of $12 billion in 2020), with the iron and steel sector most at risk; the losses could reach $1.5 billion per year if the CBAM is expanded to more sectors in future (World Bank, 2022b).

Figure 4. Kazakhstan's Gross Export Value by Product and Country in 2020

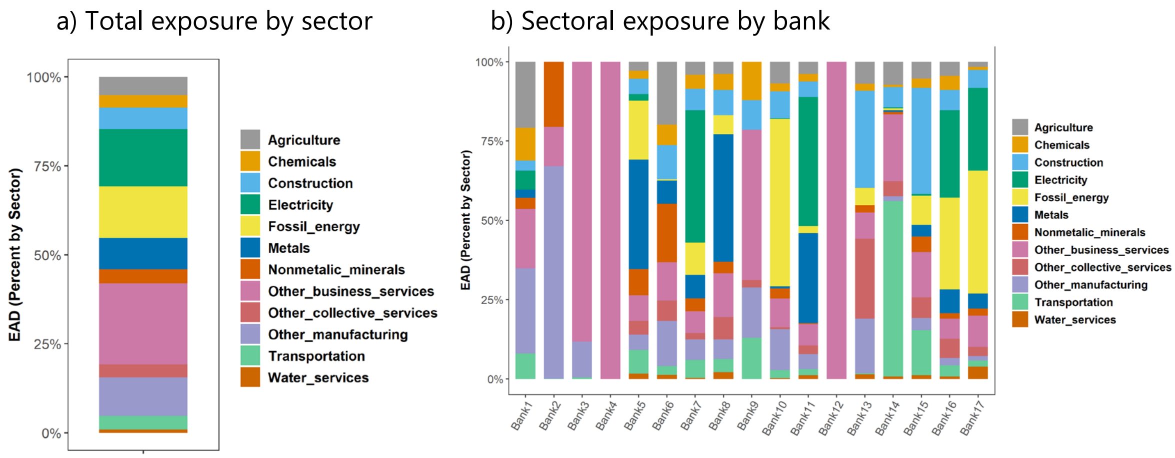
Source: WITS-UNSD COMTRADE, 2023. http://wits.worldbank.org.

11. Kazakhstan has made meaningful climate change commitments but there is room to further enhance climate actions. The country signed the Paris Agreement to limit the global temperature rise to well below 2°C above pre-industrial levels, submitted its first Nationally Determined Contribution (NDC) in 2016, and updated it in 2023. Kazakhstan also committed to achieve carbon neutrality by 2060 but is yet to submit its long-term strategies to specify the pathway to reach carbon neutrality. In its initial and updated NDC submission, Kazakhstan pledges to reduce emissions by 15–25 percent by 2030, compared to 1990 levels.[5] Considering the relative high level of emissions in 1990 (on the eve of the post-soviet economic slump, which led to almost 20 percent emissions reduction in ten years), there is still room for Kazakhstan to enhance its climate ambition. For example, Kazakhstan has set a target of 15 percent renewable electricity generation by 2030, but that target is much lower than the current global average level of renewable electricity generation (29 percent). In addition, modeling studies estimate that to be consistent with 1.5°C pathways, Kazakhstan needs to reduce emissions by 31–43 percent below 1990 levels by 2030 (Climate Action Tracker, 2022). Kazakhstan also has an ETS in place, covering 43 percent of national emissions, but the carbon price is low (slightly more than \$1/tCO_2) as a result of low emissions caps and generous allocations of quotas (World Bank, 2022b). The Government of Kazakhstan is considering introducing carbon pricing for the unregulated sectors that are not covered in the ETS (Ministry of Ecology and Natural Resources, 2023).

12. The banking system's corporate portfolio is exposed to carbon intensive sectors and the sectoral exposures are heterogenous across banks. For the 17 banks with corporate exposures, their loans to electricity, fossil energy, and heavy industry (i.e., iron and steel, metals, chemicals, and nonmetallic minerals) sectors represent roughly half of the corporate loan books (Figure 5a). At the aggregate level, the largest exposure shares pertain to electricity and fossil energy sectors (e.g., coal, oil, and gas production, coke production, and petroleum refining). The sectoral exposures are heterogenous across banks (Figure 5b). While some banks have more than 50 percent exposures to carbon intensive sectors, a few banks focus exclusively on services and light manufacturing sectors.

[5] NDCs include both unconditional and conditional commitments. Unconditional NDCs assume that countries meet these climate pledges based on their own resources and capabilities, and conditional NDCs assume that countries meet these climate pledges if international support is provided, or other conditions are met. Kazakhstan's unconditional NDC is 15 percent GHG emissions reduction between 1990 and 2030 and conditional NDC is 25 percent GHG emissions reduction between 1990 and 2030.

Figure 5. Corporate Portfolio Exposure in the Banking System in 2021



Sources: ARDFM and IMF staff calculations.

13. While the width, breadth, and pace of implementation of domestic climate mitigation policies will affect transitions risks, global policies could become significantly more relevant for a fossil fuel exporter as Kazakhstan. Countries accounting for more than 87 percent of Kazakhstan gross export values in 2020 have announced net-zero targets, signaling policy and technology transition towards low-carbon development paths. With the bulk of exports coming from carbon intensive sectors, changes in global climate policies pose significant risks to the economy and financial sector in Kazakhstan. In the transition risk analysis, we primarily focus on the impact of global climate policies on Kazakhstan's financial sector.

SCENARIOS AND MODELING FRAMEWORK FOR TRANSITION RISK ANALYSIS

14. Two complementary analytical approaches are used to assess the impact of climate mitigation policies on the financial sector. A micro approach based on detailed firm- and bank-level analysis is used to analyze the impact on the corporate portfolio. A macro approach using the solvency stress test framework is used to examine transition risks across all loan portfolios. While the micro modeling approach focuses on corporate portfolio and captures firm-, sector-, and bank-level heterogeneity, the macro modeling approach assesses the impact on banks' overall loan portfolios.

A. Micro Simulation Model to Assess Transition Risk Impact on the Corporate Portfolio

15. The analysis of impacts on the corporate portfolio is conducted in four steps. First, temperature and emissions targets in the baseline and adverse scenarios are defined. Second, these temperature/emissions targets are translated into different domestic and global carbon price paths that are simulated in a macroeconomic model.[6] Several factors are considered in this process, including: country-specific climate policies and targets, global climate pledges, policies, and mitigation actions, domestic and/or global carbon prices, and carbon revenue recycling mechanisms (e.g., lump sum transfer vs. income tax). Third, based on macroeconomic trajectories generated in the second step, we assess impacts at the firm and sector levels. Finally, these are translated into bank-level impacts, based on each bank's exposures through loans. The micro approach includes 17 banks with corporate portfolios.

16. Four scenarios, considering both Kazakhstan's domestic policies and international conditions, are used in assessing transition risks in Kazakhstan. These include:

- Baseline scenario: All countries, including Kazakhstan, follow their current policies, and no further climate action is taken.
- NDC scenario: Countries with NDC commitments, including Kazakhstan, implement unconditional NDC by 2030. No further global climate action is taken.
- Orderly 1.5°C scenario: All countries, including Kazakhstan, pursue an immediate, economy-wide orderly transition to 1.5°C. Countries with net-zero or carbon neutrality commitments, including Kazakhstan, achieve their individual climate pledges. This aligns with the NGFS Phase III Net-Zero 2050 scenario.
- Disorderly 1.5°C scenario: All countries, including Kazakhstan, pursue an immediate transition to 1.5°C, but with more ambitious policies to reduce emissions from certain sectors. This aligns with the NGFS Phase III Divergent Net-Zero scenario.

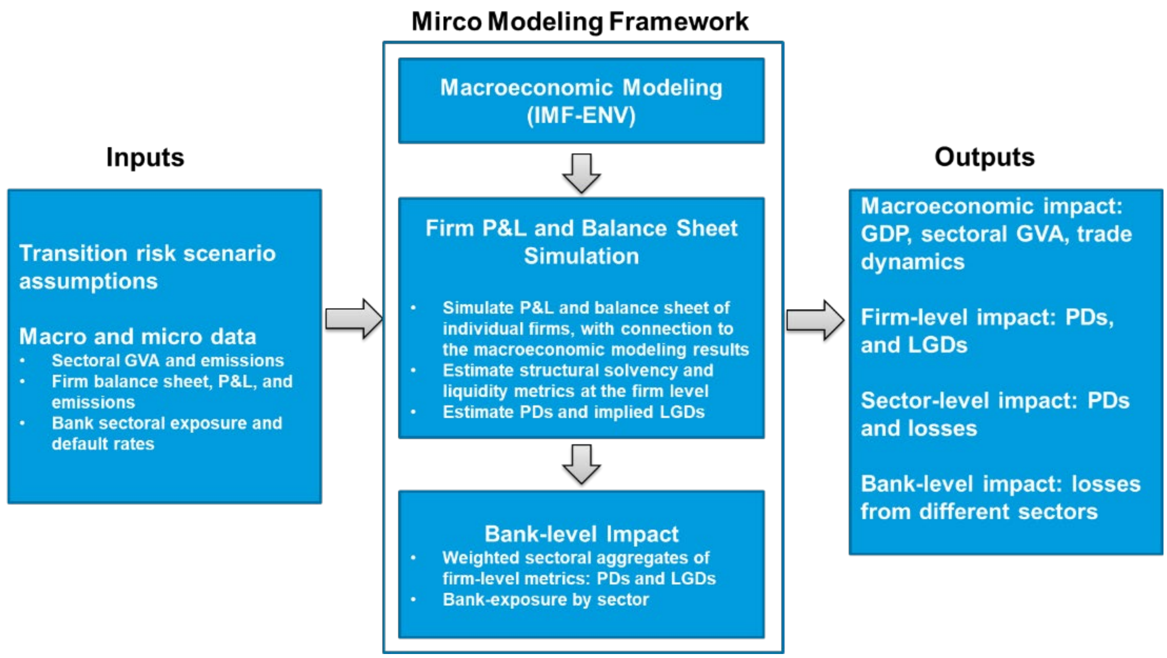
17. These four scenarios are simulated through an integrated modeling framework that connects a multi-country, multi-sector computable general equilibrium (CGE) model with a detailed firm- and bank-level simulation model[7] (Figure 6). The CGE model, IMF-ENV, is a global recursive-dynamic computable general equilibrium model that captures the interactions between economic agents (e.g., households, firms, governments, and external sector) in a simplified way. Links from economy to environment are straightforward and explicit: each source of emissions is directly associated to the corresponding economic activity. The version used in this analysis aggregates the GTAP data to 36 production activities, 28 commodities, and 26 countries/regions (Kazakhstan, G20 countries, and 5 regional aggregations) (see Appendix I for more information on

[6] While policies supporting a transition to a low-carbon economy can take different forms (e.g., subsidies to renewable energy production, caps on fossil-fuel-based power generation, etc.), the assumed shock is represented by a (sharp) increase in carbon prices. This is a convenient, powerful, and relatively tractable assumption that allows to characterize and model a decarbonization scenario effectively and parsimoniously. It is also extensively used in the scenario design for transition risk by central banks. Finally, it is justified by recognizing that, even in the absence of 'explicit' carbon prices, alternative decarbonization policies would produce effects corresponding to the adoption of an 'implicit' carbon price.

[7] Similar approaches have been used by Gross et al. (forthcoming) and in the Mexico FASP (International Monetary Fund (2022a).

IMF-ENV). Key output variables from the IMF-ENV model include the impact on GDP growth, sectoral gross value added, and trade dynamics.

Figure 6. Modeling Framework to Assess Transition Risk Impact on the Corporate Portfolio

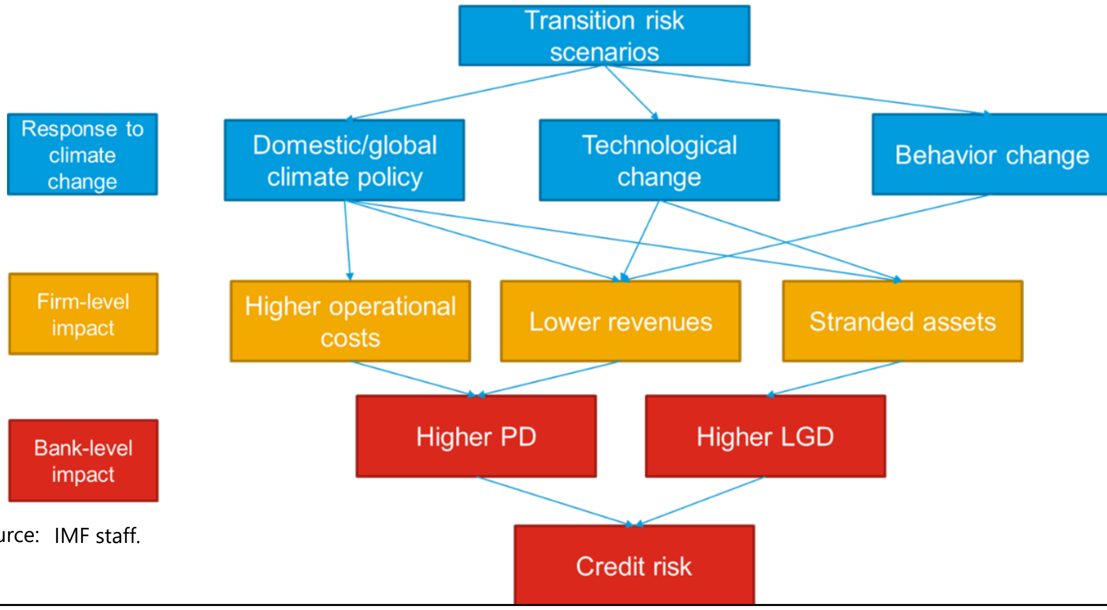


Source: IMF staff.

18. **IMF-ENV results are used as the input to firm-level simulation, which are then aggregated to the sector- and bank-level.** We use balance sheet and profit and loss (P&L) data of 963 individual borrowers from ARDFM. Each firm's revenues and costs are scenario-specific and explicitly linked to the IMF-ENV model output. The specific firm-level simulation is described in detail in the following paragraphs. Using firm-level P&L and balance sheet simulation, we estimate individual firm's probability of default (PD) and loss given default (LGD) through 2030, and then calculate weighted average sectoral PDs and losses as well as bank losses.

19. **Transition risk is transmitted across the corporate portfolio through multiple microeconomic channels.** This includes the impact of domestic and global climate policies, technological change, and behavior change on the corporate sector due to higher operational cost, and lower revenue, which in turn may increase firms' PDs and pose risks to banks through their exposure to these firms. Climate policies and technological change could also result in stranded assets that may impact firms' LGDs, and then affect banks if such assets have been used as collateral for loans. These factors together could increase credit risk, especially for banks with high exposures to carbon intensive sectors (Figure 7).

Figure 7. Transmission Channels of Transition Risk in the Corporate Sector



Source: IMF staff.

20. The impact of climate actions on the financial sector is heterogenous and driven by multiple factors. These include (1) changes in sectoral output, (2) changes in firm- and sectoral-emissions intensities, (3) starting point of individual firms and sectors, and (4) different exposures to economic sectors by banks. The first two factors are captured in the IMF-ENV modeling, whereas the last two factors are captured in the firm-bank simulation.

21. The corporate data used in this analysis include key balance sheet and P&L items as well as emissions. Specifically, these include sales revenue, cost of goods sold, earnings before interest and taxes (EBIT), interest expense, total debt, total assets, current liabilities, current assets, and emissions. These financial variables are often used to construct various solvency and liquidity indicators to assess the financial health of individual firms. Firm-level emissions are estimated thorough sectoral- and scenario-specific emissions intensities and firm revenue.

22. The P&L flow model includes various structural and econometric components. EBIT of firm *f* at time *t* under each scenario *s*, $EBIT_{f,t,s}$, is estimated based on firm's revenue and cost, which change across scenarios (Table 2). Firm's revenue at time *t* under each scenario *s*, $REV_{f,t,s}$, changes with sectoral output and is directly affected by climate policies. There are three components of firm's cost: cost of goods sold ($COGS_{f,t,s}$), operating cost (OC_f), and emissions cost ($EC_{f,t,s}$)[8]. Each firm's cost of goods sold and emissions cost change over time and across scenarios, while operating cost is held constant. Appendix II includes detailed information on the P&L modeling.

$$EBIT_{f,t,s} = REV_{f,t,s} - COGS_{f,t,s} - OC_f - EC_{f,t,s}$$

[8] The emissions cost is estimated using the shadow price of carbon, which indicates the economic impact of the low-carbon transition.

Table 2. Kazakhstan: Firm Profit and Loss Modeling[1/]

P&L Component	Modeling Approach
Sales Revenue	Directly affected by climate policies and scenario specific; aligned with sectoral gross value added (GVA) from IMF-ENV results
Cost of goods sold	Linked to sales revenue based on fixed effects panel regression
Operating cost	Constant
Emissions cost	Directly affected by climate policies and scenario specific; estimated based on firm-level GHG emissions and shadow price of carbon; aligned with IMF-ENV results
Financial income	Changing proportionally with sales revenue
Financial expense	Constant interest/debt ratio
Corporate tax expense	Constant tax/EBT ratio

[1/] The approach used in the firm P&L modeling is similar to the one used in Gross et al. (forthcoming). More information on the P&L modeling is available in Appendix II.

23. The key linkages between firm-level P&L simulation and the IMF-ENV model are sales revenue and emissions cost to transition to a low carbon economy. Sales revenue is more volatile than sectoral value added. Sales-to-GVA elasticities are estimated based on log level firm-fixed effects panel regression, using historical firm-level data (963 firms) with annual frequency (2020-2021).

$$\log(REV_{f,t}) = \alpha_f + \beta \log(GVA_{f,t}) + \epsilon_{f,t}$$

Where $REV_{f,t}$ is the revenue of firm *f* at time *t* and $GVA_{f,t}$ is gross value added of the sector that firm *f* is in at time *t*. β is the sales-to-GVA elasticity and estimated separately for business services sectors (β = 2.0) and other sectors (β = 1.13). Emissions cost is estimated based on the shadow price of carbon from IMF-ENV and scenario- and time-specific firm-level emissions. Firm-level emissions are estimated based on emissions intensity and firm's revenue. Emissions intensity changes with climate policies and technological changes and is sector specific. Emissions intensity in the sector with low abatement cost, such as the electricity sector, decreases faster than that of hard-to-abate sector (e.g., heavy industries and freight transportation).

24. Firm's cost of goods sold (COGS) is linked to sales revenue and changes with scenarios. COGS-to-sales elasticities are estimated using log difference-based industry-level i cost of goods sold, $COGS_{i,t}$, and sales revenue, $REV_{i,t}$, operating with industry-fixed effects panel regression, using historical data at the industry-level (NACE 4-digit code) with annual frequency (2014-2021).[9]

$$\Delta \log(COGS_{i,t}) = \alpha_i + \beta \Delta \log(REV_{i,t}) + \epsilon_{i,t}$$

[9] COGS-to-Sales elasticities are estimated at the industry level, because firm-level time series data on COGS are not available.

where β refers to the COGS-to-Sales elasticity and is used to estimate firm's COGS based on firm's revenue. The estimated β across industries is 0.99, similar to the elasticities used by Gross et al. (forthcoming) and in the Mexico FASP (International Monetary Fund (2022a).

25. Firm's periodic profit $P_{f,t,s}$ is estimated by accounting for all income and expenses.

$$P_{f,t,s} = EBIT_{f,t,s} + FI_{f,t,s} - FE_{f,t,s} - Tax_{f,t,s}$$

Where $FI_{f,t,s}$ is firm's financial income which changes proportionally with sales revenue; $FE_{f,t,s}$ is financial expense, calculated based on constant interest/debt ratio (Figure 8); $Tax_{f,t,s}$ is corporate tax expense, calculated based on constant tax/EBT ratio. This modeling approach assumes implicitly that the value of nonfinancial assets remains constant throughout the simulation period. In this context, the total profit can also be referred to as net cash flow, because there are no non-cash types of net income nor other revaluation effects.

26. The firms' balance sheet dynamics are driven by their net cash flows. Total assets and current assets of a firm change by the net profit at an annual frequency. In the case that the firm's cash stock would turn negative during the simulation, a debt top-up process is applied. Explicit repayment of principal debt is not considered, assuming that outstanding debt is rolled over continuously (see Appendix II for the details of the firm balance sheet module).

27. The PD model links various structurally evolving solvency and liquidity metrics and suggests a quantitatively prominent role for leverage. The PD model has a sector fixed effects panel structure, with a logit-transformed sector-level PDs on the left hand side. As firm-level data are not available, sectoral data are used in the PD model. The left hand side PD data are weighted average sectoral PDs of borrowers at the annual frequency (2014-2021). The right hand side data are weighted average sectoral solvency and liquidity metrics (Figure 8) from the corporate database at the annual frequency (2014-2021) that attempt to capture the relationship between financial health condition and implied default risks. The modeling results show that PDs are most sensitive to leverage ratio (LR), followed by interest coverage ratio (ICR) and current ratio (CR) (see Appendix II for the summary of the estimation).

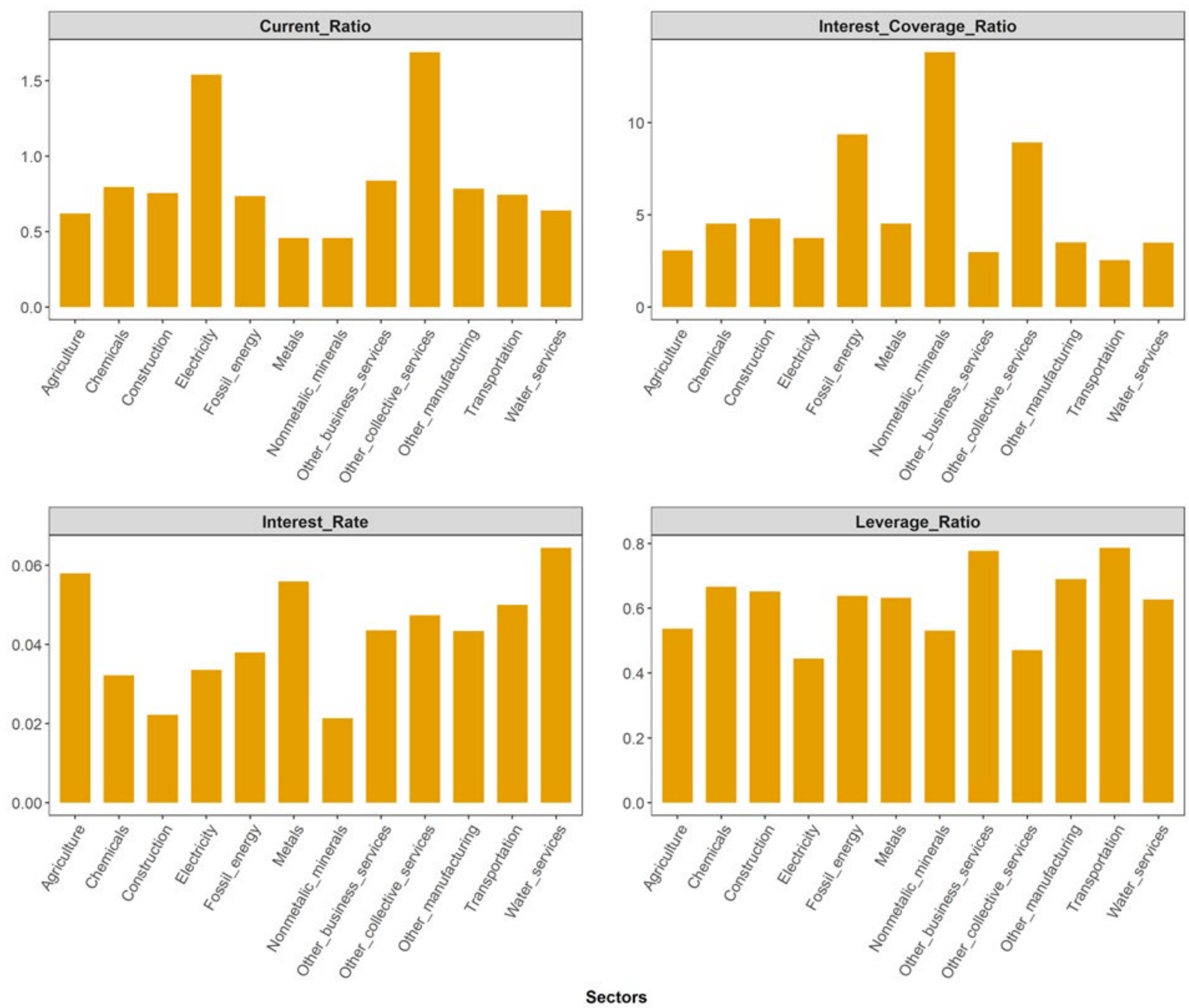
$$Logit(PD_{i,t}) = \alpha_i + \beta_1 ICR_{i,t} + \beta_2 LR_{i,t} + \beta_3 CR_{i,t} + \epsilon_{i,t}$$

Where $PD_{i,t}$ is weighted average probability of default for sector *i* at time *t*. $ICR_{i,t}$ is weighted average interest coverage ratio for sector *i* at time *t*. $LR_{i,t}$ is weighted average leverage ratio for sector *i* at time *t*. $CR_{i,t}$ is weighted average current ratio for sector *i* at time *t*. The right hand side of the equation do not contain any macrofinancial variables on purpose, as the risk metrics used are already affected by macrofinancial conditions. For example, changes in sectoral output and GDP feed through sales revenue to net profit, and thereby the numerator of ICR. All net cash flows affect financial assets and total assets, and thereby the denominator of LR.

28. Using the PD model, we generate scenario specific PD paths for individual firms, which are then aggregated to weighted average sectoral PD paths used to compute scenario specific

delta PDs and losses for each bank. Given the limited data, the exposure of banks cannot be mapped to individual firms and only sectoral credit exposures are available. Therefore, we estimate exposure-weighted sectoral PDs for each scenario. For each bank, the changes in PDs from the baseline, weighted by their sectoral exposures, are then estimated for each scenario, with the assumption that sectoral credit exposures of each bank remain constant over time and across scenarios. We use empirical relationship from literature to estimate LGD[10] (Altman, 2010) and then compute expected losses for each bank.

Figure 8. Corporate Risk Characteristics
(End of 2021, median per industry)



Sources: ARDFM, NBK, and IMF staff calculations.

[10] Using weighted average default rates and recovery rates over the period of 1982-2009, Altman (2010) applied four bi-variate regressions (linear, quadratic, log-linear, and power function) to estimate the relationship between these two variables. We use the log-linear model (y = -0.1069 Ln(x) + 0.0297), the one with high explanatory power (R^2 = 0.63), to estimate recovery rates and LGDs in this analysis. In addition, we test other regressions in Altman (2010) and obtain similar results.

B. Macrofinancial Modeling to Assess the Impact on All Portfolios

29. A dynamic stochastic general equilibrium (DSGE) model, Integrated Policy Framework (IPF), is used to estimate the impact of transition policy on all portfolios. IPF is an empirically oriented New Keynesian model to analyze monetary policy and financial stability issues in open economies. As a typical New Keynesian setup, it has the following features: incomplete financial markets, imperfect exchange rate pass-through local currency pricing, micro-founded private and sovereign borrowing spreads, sticky wages, and integrated policy analysis with both interest rate and exchange rate policies (Adrian et al., 2021).

30. Both oil price shock and endowment shock are applied to simulate the impact of climate policies. The oil price and endowment shocks are generated based on the Net-Zero Emissions by 2050 (NZE) scenario from the International Energy Agency (IEA), in which, the global GHG emissions reach net-zero by 2050 and the global temperature rise is maintained within the 1.5°C. The IEA-NZE scenario is compatible with the IMF-ENV Disorderly 1.5°C scenario in terms of the rate of global emissions reduction between 2020 and 2030. Both scenarios have approximately 35 percent of emissions reduction between 2020 and 2030.[11] The IEA-NZE scenario is used as it runs through 2050 and allows us to calculate the potential risk of stranded assets. The oil price shock is based on oil price projection in the IEA-NZE scenario, and the endowment shock is generated through the assessment of stranded assets in the energy infrastructure[12]

31. These shocks are then simulated in the solvency stress test framework to estimate bank losses. The solvency stress test includes 12 banks, covering about 90 percent of the banking system assets. A combination of econometric and accounting models is used to project the major components of the banks' balance sheets and income statements and assess credit risk. Using macrofinancial data from the IPF model, the solvency stress test framework is used to estimate losses of individual banks under the baseline and IEA-NZE scenario.

32. The macro modeling approach using the IPF model is complementary to the micro modeling using the IMF-ENV model and dynamic recursive firm/bank simulation in two ways. First, the IPF modeling together with the solvency stress test framework assess bank losses across all portfolios, whereas the IMF-ENV modeling and firm-level simulation focus on the corporate portfolio with more firm- and sectoral-level granularity. Second, the IPF-Solvency framework captures transition risk through the macroeconomic channels (GDP, inflation, interest rate, commodities, and foreign exchange rate), while the IMF-ENV-firm analysis captures the transition risk through the microeconomic channels (firms' operating cost, revenue, and stranded assets).

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[11] The rate of emissions reduction applies to emission sources that are explicitly modeled or reported. IEA reports CO_2 emissions from energy and industrial processes, and IMF-ENV models GHG emissions from energy and industrial processes.

[12] Using detailed sectoral data from Rystad and Global Energy Monitor, we estimate potential stranded assets of coal mines, oil and gas fields, and fossil fuel power plants. Approximately 50 percent of current assets in these sectors in Kazakhstan will be stranded in the NZE scenario.

TRANSITION RISK IMPACT ON THE FINANCIAL SYSTEM

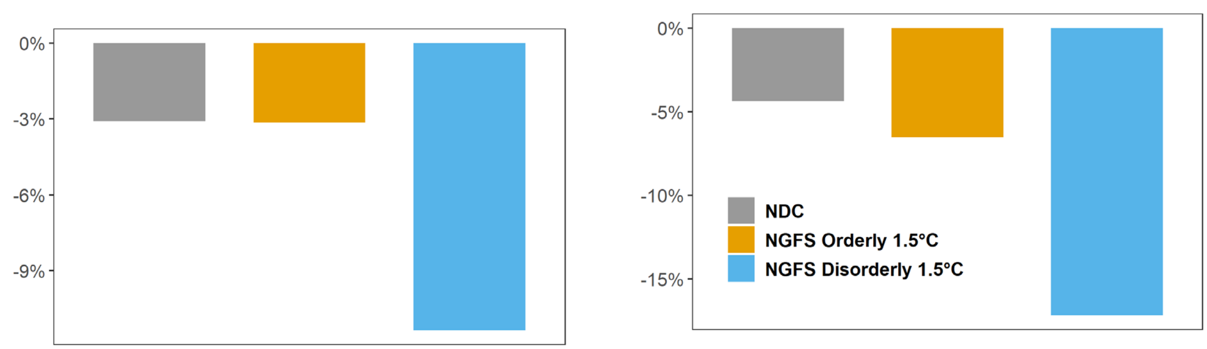
A. Impact on the Economy and the Financial System from the Micro Modeling Approach

33. Kazakhstan is affected by a decrease in global oil demand more severely than other regions. Global oil demand decreases by 11 percent in 2030 from baseline in the disorderly 1.5°C scenario, while Kazakhstan's oil export decreases by 17 percent. (Figure 9). Transition scenarios with more ambitious decarbonization paths could lead to more severe drops in global oil demand, which would result in even more severe decrease in the Kazakhstani oil sector export and revenue. For example, in the IEA-NZE scenario, global oil demand drops by 26 percent from baseline in 2030, which could lead to more severe impact on Kazakhstan's oil export and oil revenue.

Figure 9. Changes in Global Oil Demand and Kazakhstan's Oil Export

a) Impact on Global Oil Demand (in percent, deviation from baseline in 2030)

b) Impact on Kazakhstan's Oil Export (in percent, deviation from baseline in 2030)



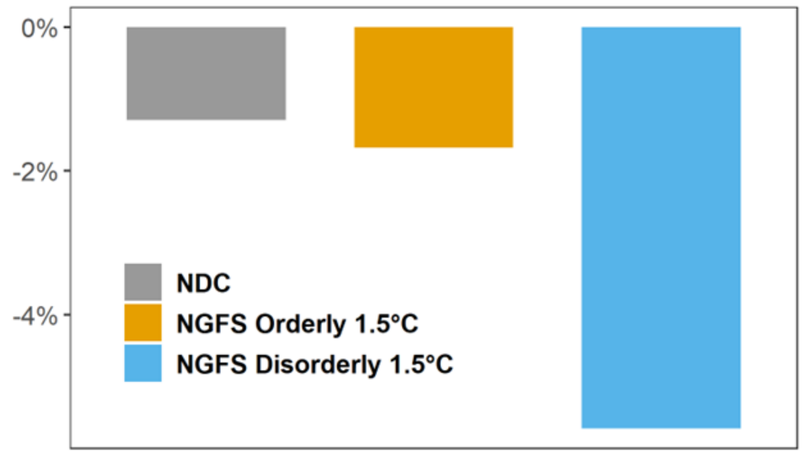
Source: IMF staff calculations.

34. National and global climate policies could result in up to 5.5 percent additional GDP losses in Kazakhstan by 2030, relative to the baseline (Figure 10). The additional GDP losses are primarily driven by reduction in consumption and investment. Iron and steel, electricity generation, coke and petroleum production, and fossil fuel mining record more losses than other sectors, with 20 to 35 percent more losses in sectoral gross value added in the disorderly 1.5°C scenario than in the baseline scenario. The gross value added of the chemicals sectors, on the other hand, increases in the transition scenarios, relative to the baseline: chemicals production uses a large amount of oil feedstock; as oil price lowers in the transition scenarios, the cost of chemicals production lowers.

35. The shadow prices of carbon in Kazakhstan increase with more ambitious climate policies but are still lower than carbon prices in most regions and potential prices imposed by EU CBAM (Figure 11). The shadow price of carbon for implementing the NDC reaches \$6/tCO2 in 2025 and \$24/tCO2 in 2030. Carbon prices increase further under the 1.5°C scenarios, reaching

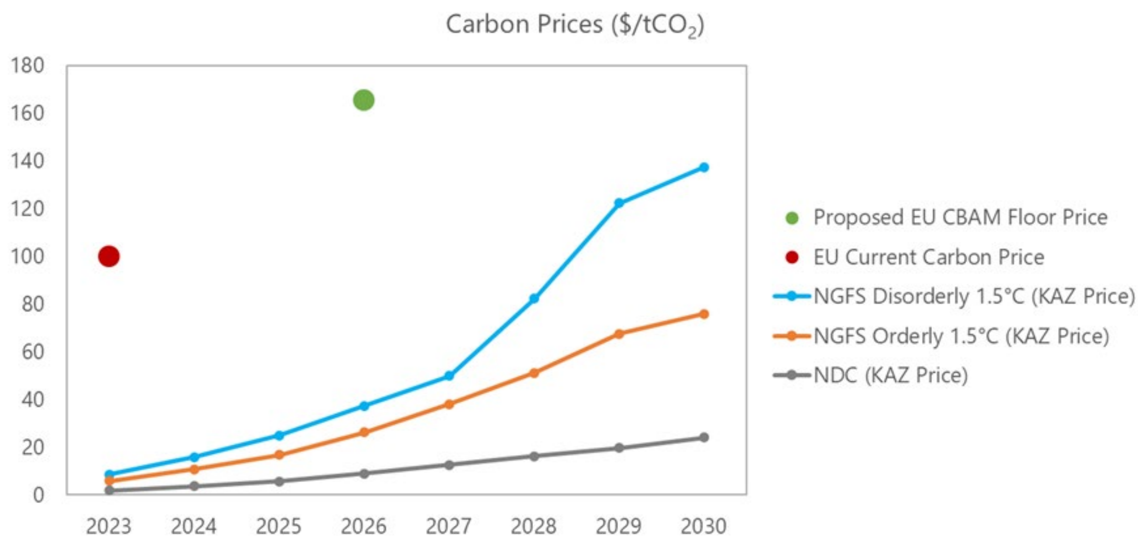
$17/tCO2 in 2025 and $76/tCO2 in 2030 in the orderly 1.5°C transition and $25/tCO2 in 2025 and $137/tCO2 in 2030 in the disorderly 1.5°C transition. In comparison, the current EU carbon price is around $100/tCO2 and the European Council foresees a minimum threshold of €150/ tCO2 for products covered by CBAM (Simões, 2023).

Figure 10. Impact on Kazakhstan's Real GDP
(In percent, deviation from baseline in 2030)



Source: IMF staff calculations.

Figure 11. EU Carbon Prices and Shadow Price of Carbon Across Scenarios

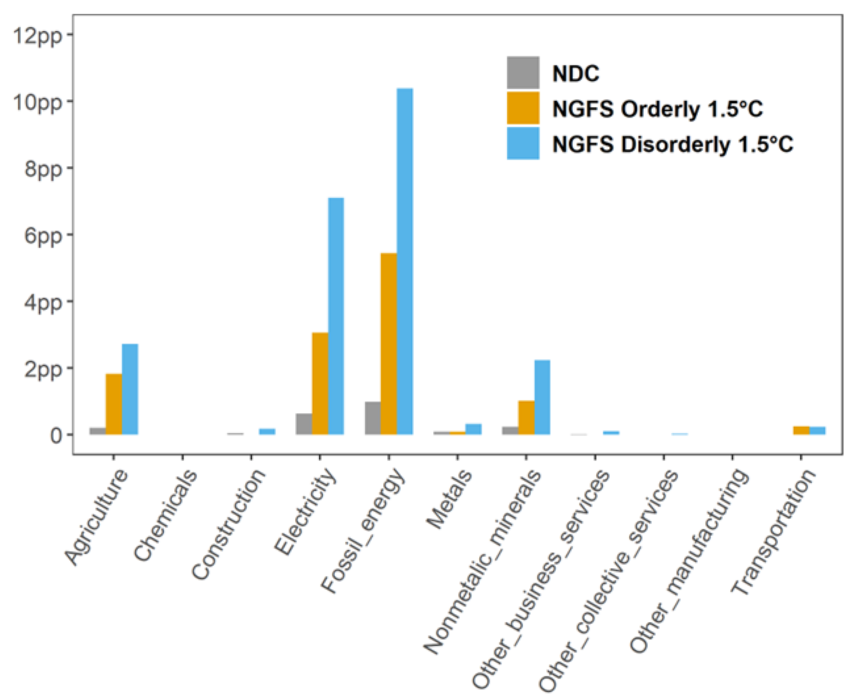


Sources: Simões, 2023 and IMF staff calculations.

36. All sectors' risk parameters are affected by the low-emissions transition, with more severe impact under the disorderly transition scenario than the orderly transition and NDC scenarios (Figure 12). The impact of NDC scenario is limited across sectors, with most sectors unaffected. Under the orderly 1.5°C scenario, fossil energy, electricity, agriculture, and nonmetallic minerals are affected, with the maximum PDs increase over the baseline reaching 5 percentage points. Under the disorderly 1.5°C scenario, PDs for electricity and fossil energy sectors are material, as the differences between the PDs in the disorderly 1.5°C and baseline scenarios reach more than 10 percentage points for fossil energy and 7 percentage points for electricity. This is largely driven by the negative impact on sectoral output, in combination with high abatement cost.

37. The impact on risk parameters is non-linear and sectoral specific. PDs under climate scenarios are particularly impacted for firms in the electricity generation and fossil energy production sectors. The electricity sector in Kazakhstan is dominated by fossil fuel generation and carbon intensive. With the high shadow prices of carbon in climate scenarios, especially in the disorderly 1.5°C scenario, the cost of production for electricity sector firms increases rapidly, leading to higher risks. In addition to the high abatement cost, the fossil energy sector faces significant reduction in sectoral output, as the economy transitions from fossil fuels to clean energy in the decarbonization scenarios. Agriculture, metals, and nonmetallic minerals sectors, with their high emissions intensities, are also affected in the low-carbon transition.

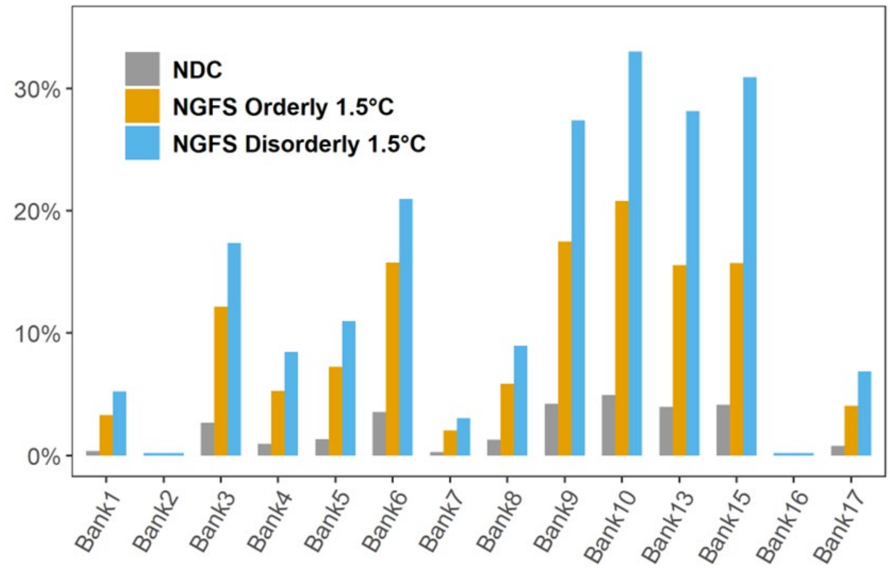
Figure 12. PDs Across Sectors and Scenarios
(In percentage points, deviation from baseline in 2030)



Source: IMF staff calculations.

38. Bank additional losses (in excess of those incurred in the baseline) vary across banks and scenarios, due to different sectoral exposures at the outset. Cumulative corporate portfolio losses over the simulation time horizon are 11 percent more in the disorderly 1.5°C scenario than in the baseline scenario. The impact is heterogenous across banks, with some banks facing nearly 30 percent more losses compared to the baseline (Figure 13).

Figure 13. Corporate Portfolio Losses Across Banks and Scenarios (In percent, deviation from baseline for 2023-2030)



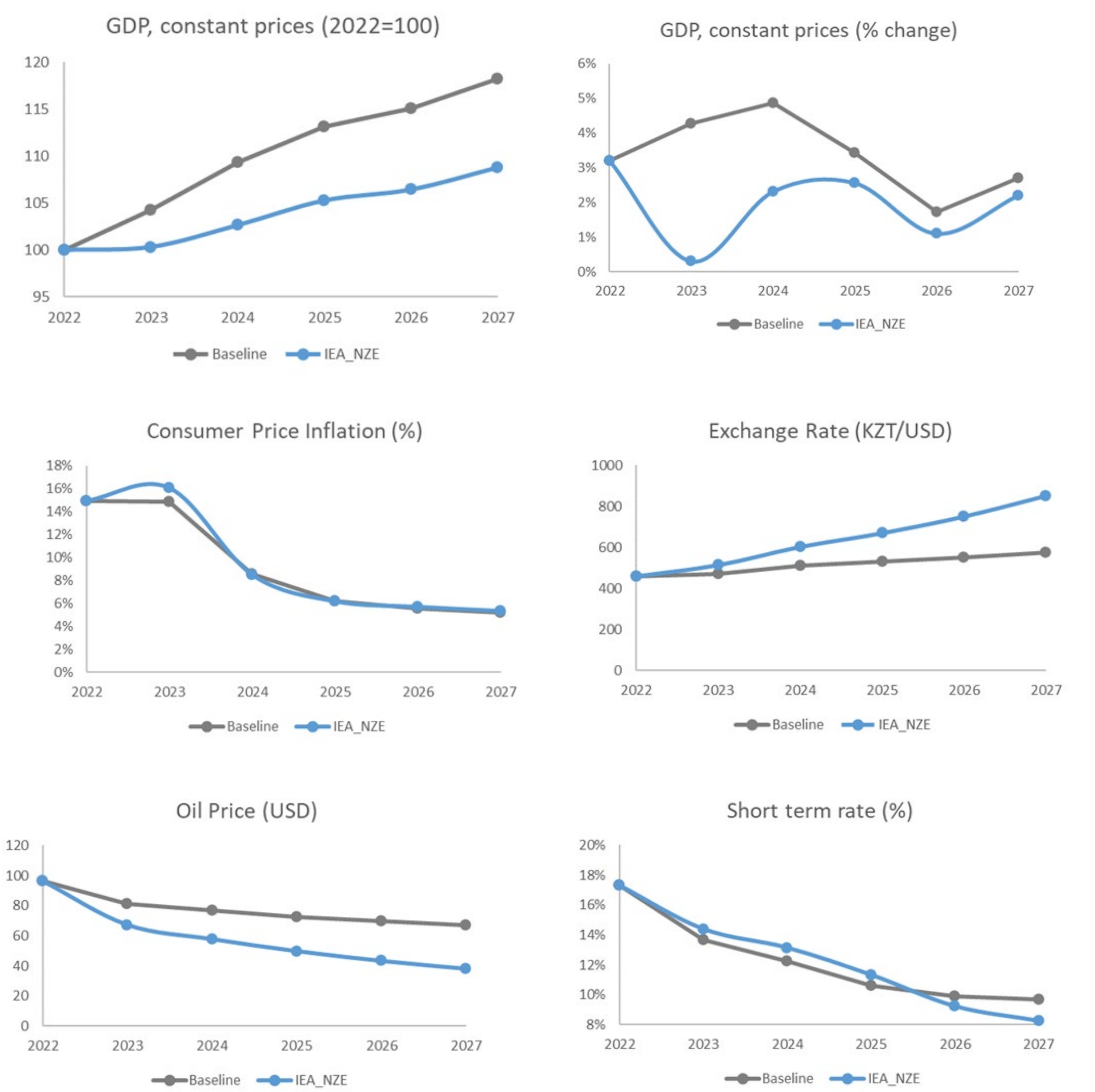
Source: IMF staff calculations.

39. Transition risks may be underestimated due to modeling restrictions in the IMF-ENV framework and they could be higher if more ambitious global policies and the associated domestic responses were considered. First, the impact of climate policies on Kazakhstan's trade could be worse than the model estimates. The resurgent popularity of green industrial policy is also associated with protectionist provisions, for example, domestic sourcing in the U.S. Inflation Reduction Act and CBAM in EU's Fit-for-55 packages (Kaufman et al., 2023; Juhász et al., 2023). These protectionist provisions would make it harder to divert trade from one country to the other, and therefore, the impact on Kazakhstan's export could be worse than estimated by the model (which might over-estimate the ease in rerouting exports). That, in turn would lead to even larger GDP losses. Second, the IMF-ENV model runs through 2030, which limits the ability to assess the long-term impact of climate policies. For example, the newly planned and built fossil fuel infrastructure in Kazakhstan could be stranded in future when Kazakhstan transitions to a low-carbon economy and achieves its carbon neutrality target. This could impact agents' expectation and firms' valuation in the near term. Finally, the current modeling framework is not fully capturing second-round effects and potential climate non-linearities, which if considered, would further increase transition risk. Meanwhile, it is worth noting that the static balance sheet assumption is applied in this analysis. Potential changes in firms' and banks' investment strategies and portfolios could affect the analysis results.

B. Impact on the Financial System from the Macro Modeling Approach

40. Transition risk can also affect other loan portfolios, through macro channels. In the process of transitioning towards net-zero emissions by 2050, there will be significant drops in oil price and production, which in turn would lead to GDP losses and currency depreciation. In the "macro" analysis, the net-zero transition could result in 8 percent additional GDP losses in 2027, relative to the baseline, and the tenge would lose nearly 50 percent of its value against the USD (Figure 14).

Figure 14. Macrofinancial Shocks from the IPF Model

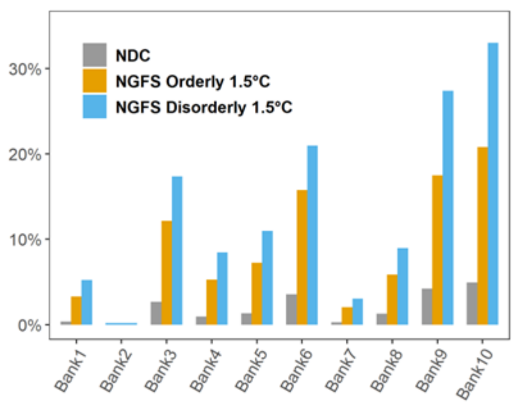


Source: IMF staff calculations.

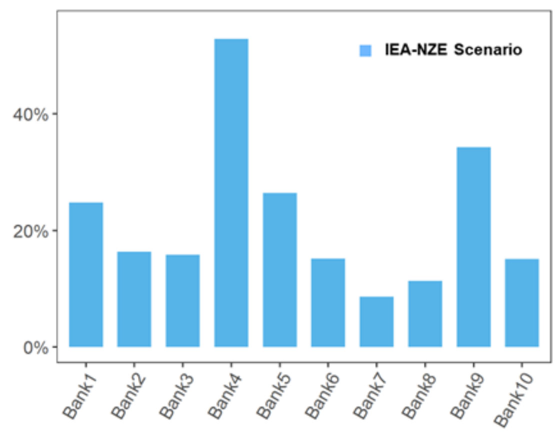
41. Considering all loan portfolios, cumulative bank loan losses over a five-year time horizon (2023–2027) are 18 percent larger in the net-zero transition than in the baseline, with a heterogenous impact across banks. Banks with a larger exposure to emissions-intensive sectors show a similar magnitude of losses as in the "micro" analysis.[13] Banks with larger exposures to low-emissions sectors and non-corporate portfolios have more losses in the "macro" analysis than in the "micro" analysis. Even banks with no corporate exposures show 7-10 percent additional losses in the IEA-NZE scenario, compared to the baseline (Figure 15). Over the same 3-year time horizon of the solvency stress test (2023-2025), cumulative bank loan losses would be approximately 600 billion KZT larger than under the baseline, roughly half of the additional losses (with respect to the baseline) estimated in the solvency stress test over the same time span. However, the comparison is affected by the short time horizon: the solvency stress test simulates a cyclical downturn, followed by a recovery, while the impact from transition risk scenarios is expected to persist and potentially worsen over time.

Figure 15. Bank Losses in Transition Scenarios

a) Bank Losses on the Corporate Portfolio
(In percent, deviation from baseline, 2023-2030)



b) Bank Losses across All Portfolios
(In percent, deviation from baseline, 2023-2027)



Source: IMF staff calculations.

C. Additional Transition Risks

42. In addition to climate policies assessed in the above scenarios, CBAM could pose additional transition risk to Kazakhstan. The European Union adopted CBAM on May 10, 2023, which went into force on May 17, 2023 and entered into application in its transitional phase on October 1, 2023, with the first reporting period for importers ending January 31, 2024. Once the permanent system enters into force on 1 January 2026, importers will need to declare each year the quantity of goods imported into the EU in the preceding year and their embedded GHG emissions. The European Union is also considering to further expand the production category and emissions

[13] Bank 10, due to its large exposure to the fossil energy sector in the corporate portfolio, has more additional losses (with respect to the baseline) in the "micro" analysis than in the "macro" analysis.

scope covered in the CBAM (European Commission, 2023). In addition, other countries, including the United Kingdom, the United States of America, Canada, and Japan, are considering developing policies similar to the CBAM.

43. CBAM has both direct and indirect impact on Kazakhstan's economy and financial sector. CBAM can directly impact Kazakhstan export of covered sectors. Moreover, it can also impact fossil fuel export to countries that do not have CBAM, as producers in these countries can move away from high-emissions energy commodities to reduce their own risks associated with CBAM.

44. Emissions-intensive sectors, extensively financed in offshore markets, may face large refinancing risks. According to the World Bank analysis, 76 percent of Kazakhstan's "brown" (i.e., emissions-intensive) sector assets are financed by offshore bonds and loans,[14] and may face refinancing risks as the international financial institutions are moving away from fossil fuel finance. Currently, over 200 globally significant financial institutions have established coal exclusion policies, which include both policies stopping new coal finance and policies phasing out existing coal finance. In addition, the momentum of divesting coal has accelerated in the last two years, despite record profits by coal companies in the backdrop of the energy crisis and high coal prices. The number of financial institutions engaged in divesting oil and gas, although not as substantial as the ones divesting coal, is also increasing. The divestment momentum away from fossil fuels is expected to continue rising, as countries start to develop more ambitious climate policies and transition towards net-zero emissions.

CLIMATE-RELATED PHYSICAL RISK IN KAZAKHSTAN

45. The temperature rise in Kazakhstan is projected to be higher than that of the global average, with potential warming of 6.2°C by the end of the century, compared with the 1995-2014 baseline, under a high emissions pathway scenario. Warming is expected to be even stronger for maximum and minimum temperatures and in winter. Historical climate observations show an average annual temperature increase in Kazakhstan of 0.14°C per decade (against a global average of 0.11°C per decade) between 1961 and 1990, and an even higher increase in recent years, i.e., 0.43°C per decade (global average of 0.21°C per decade) in the period of 1991-2016. The rapid temperature change has led to accelerated glacial melting, with a loss of nearly 30 percent of Tien Shan glacier since 1950 (Chepelianskaia and Sarkar-Swaisgood, 2022). With increasing temperature, there is a risk of losing half of the current Tien Shan glacier (USAID, 2017)

46. Droughts are expected to occur at higher frequency and intensity under high emissions pathway scenarios. Reductions in precipitation during summer months, in combination with rising surface air temperature, can increase the risk of water scarcity and droughts, especially in the western and southern regions that are already vulnerable (Figure 16). More frequent and intense drought and water scarcity could reduce agricultural productivity. Kazakhstan is a major wheat producer and the agricultural sector accounts for 5 percent of GDP and employs 25 percent of

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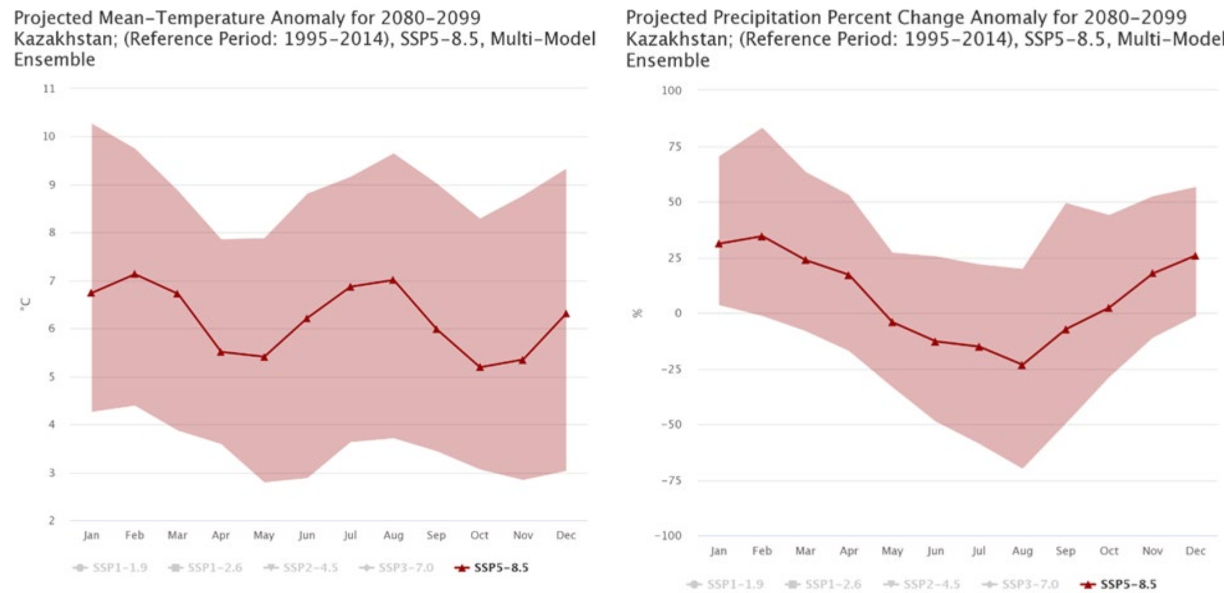
[14] For more information, see https://blogs.worldbank.org/europeandcentralasia/just-transition-advances-hidden-challenge-emerges-kazakhstans-financial-sector

population (USAID, 2017). If no adaptation measures are taken, spring wheat yields in Kazakhstan are projected to decline by up to 50 percent by mid-century due to increased droughts (World Bank and Asian Development Bank, 2021).

Figure 16. Projected Monthly Temperature and Precipitation Change

(The value shown represents the median of the model ensemble with the shaded areas showing the 10th-90th percentiles)



Source: World Bank Climate Change Knowledge Portal, 2022

47. The risk of river floods, mudflows, and landslides is also expected to increase with climate change. Under high emissions scenarios, Kazakhstan's annual average precipitation is expected to increase by 9 percent by the end of the century, with greatest increases happening in winter and spring (World Bank, 2022a). Precipitation intensity and storm severity are also expected to increase. In addition, rising temperature will accelerate glacier melting in Kazakhstan, resulting in an increase in river flow and flood risks, as well as mudflows and landslides.

48. Without ambitious global action to reduce greenhouse gas emissions, climate change is expected to have a harmful impact on Kazakhstan, with increasing risks of heatwaves, droughts, floods, and glacier melting. These climate hazards can affect agriculture yield and pasture productivity, energy supply and demand, built environment, and human health (Table 2).

49. Although on average Kazakhstan is less vulnerable to physical risks than other countries, it faces high risks of droughts and floods. The greatest economic damages over the past three decades were caused by droughts and floods, with cumulative monetary damages of KZT 245 billion and KZT 100 billion, respectively (Figure 17). The INFORM Risk Index ranks Kazakhstan 25th out of 191 countries in terms of the current exposure to drought risk and 59th out of 191 countries in terms of the exposure to flood risk (INFORM, 2022).[15] Climate change could further exacerbate this situation. In a moderate emissions scenario, 62 percent of agricultural land could be

[15] A higher ranking indicates a higher risk.

exposed to water stress (Munday et al., 2022). The INFORM Climate Change Risk Indicator estimates that there will be 305,000 (2 percent of population) and 5.5 million (30 percent of population) people exposed to floods and extreme droughts, respectively, in 2050, even in an optimistic climate change scenario[16] (Thow et al., 2022).

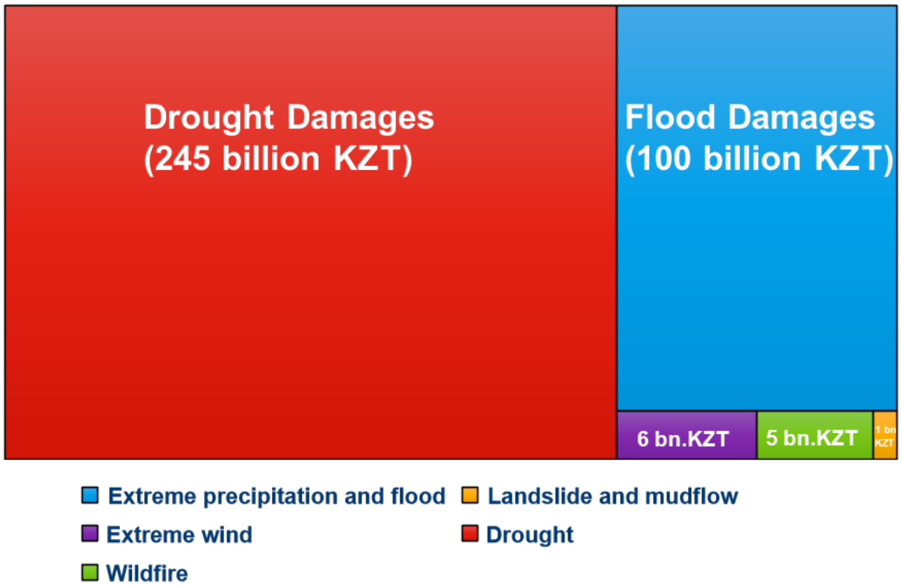
Table 3. Kazakhstan: Potential Climate Change Impacts on Economic Sectors

Climate Projections	Agriculture	Energy	Human Health	Infrastructure
Increased average and extreme temperature; increased heatwaves	land degradation due to heat stress; crop yield reduction; pasture productivity reduction	Reduced thermal power generation due to insufficient cooling water; reduced hydro power generation; increased cooling demand in summer and reduced heating demand in winter; reduced power system efficiency	Increased mortality and morbidity due to heatwaves, particularly in urban areas	Impaired shipping; damage to road and rail infrastructure due to melting of seasonal ground frost; expansion of bridge joints
Increased droughts	Crop land degradation and increased variability of crop production due to drought	Reduced hydro power generation	Expansion of infectious disease vectors such as ticks and mites	Impaired shipping
Increased incidence of heavy precipitation events, resulting in floods, mudflows, and landslides	Increased variability of crop production; reduced pasture productivity related to increased flood and mudflow; increased incidence of pests and diseases	Disruption of energy services due to damages to the physical infrastructure; economic losses due to power outages	Increased mortality and morbidity related to extreme weather events, especially mudflows; increased gastrointestinal disease due to degraded water quality	Impaired shipping; damage to rail, road, and energy infrastructure (e.g., transmission lines, coal mines, and power plants)

Sources: USAID, 2017; UNESCAP, 2021; Großmann et al., 2022.

[16] The INFORM Climate Change Risk scenarios consider a combination of climate and socioeconomic projections. The climate projections are based on representative concentration pathways (RCPs), which describe the evolution of future atmospheric greenhouse gas concentrations and other radiative forcings. The socioeconomic projections are based on shared socioeconomic pathways (SSPs), which depict the evolution of the society under different mitigation and adaptation challenges. The optimistic climate change scenario (SSP1-RCP4.5) indicates moderate emissions and low challenges for both mitigation and adaptation, including lower population growth.

Figure 17. Cumulative Reported Monetary Damages by Extreme Events in Kazakhstan, 1991–2020 (in billion KZT)



Sources: Großmann et al., 2022, based on data compilation by Kazhydromet, Aibat Muzbay, GWS.

CONCLUSIONS AND RECOMMENDATIONS

50. **Kazakhstan is vulnerable to transition risk due to the importance of its energy- and emissions-intensive sectors.** Kazakhstan's per capita CO_2 emissions are 3.5 times higher than the global average, making the country the 10th emitter in terms of per capita emissions. To mitigate climate change, Kazakhstan has pledged to reduce GHG emissions by 15-25 percent between 1990 and 2030 and reach carbon neutrality by 2060, which will require a significant transformation of its energy system. Kazakhstan's major trade partners have also announced net-zero targets, posing additional risks to Kazakhstan's energy and economic systems.

51. **Domestic and global climate policies would negatively affect Kazakhstan's economy, its firms, industries, and banks, with heterogenous impacts across industries and banks.** Using both micro and macro approaches, the climate risk analysis suggests that Kazakhstan is exposed to significant transition risk from domestic and, more importantly, global climate policies. The risk is especially higher for carbon intensive sectors, such as fossil fuel extraction, refining, and electricity generation. Banks with large exposures to emissions-intensive sectors experience up to 30 percent additional losses under a disorderly 1.5°C scenario over a 5-to-7-year horizon, compared to the baseline. Banks with a small share of portfolio exposed to emissions-intensives sectors may still experience losses, as climate change mitigation actions affect the economy at large (e.g., loss of GDP and currency depreciation) and the financial health of individual consumers, businesses, and industries.

52. While this analysis focuses on transition risk, Kazakhstan also faces physical risks, which require further assessment. Floods and droughts caused nearly KZT 350 billion losses in the past three decades and the intensity and frequency of floods and droughts are expected to increase with climate change. Floods and droughts can affect crop yield and production, energy system operation, and major infrastructure and result in significant economic losses. Moreover, climate change, together with the onset of El Niño, will greatly increase the likelihood of extreme events in the next five years and increase physical risk in the near term (World Meteorological Organization, 2023).

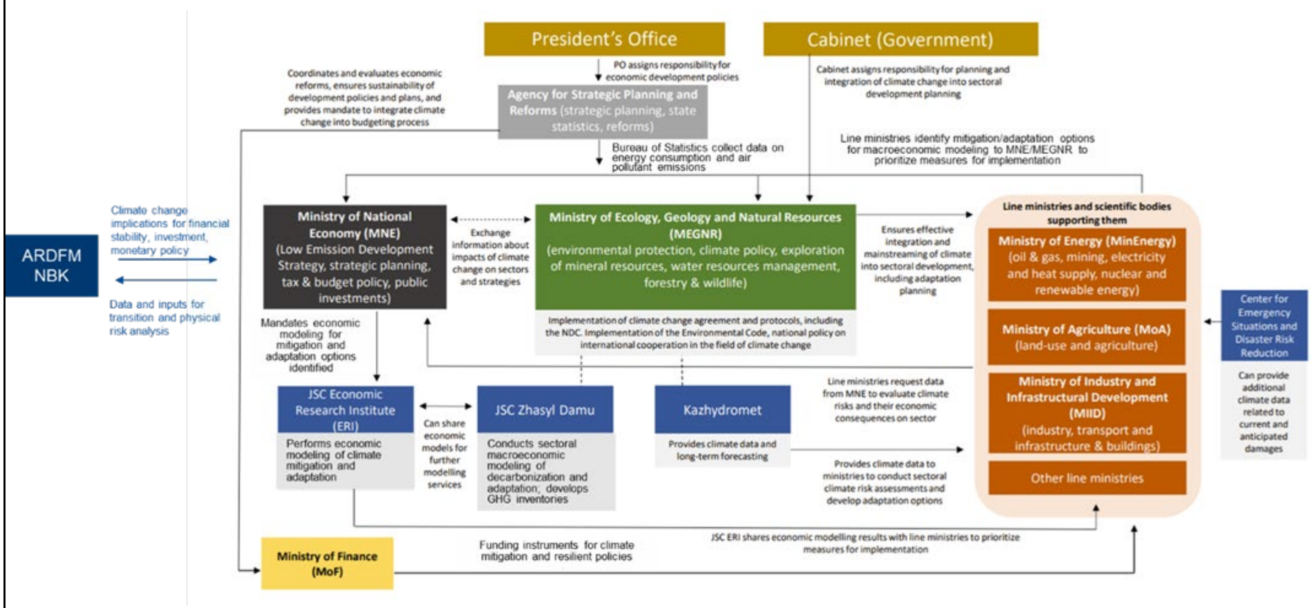
53. The authorities should assess the implications of climate change for the financial system. Joining the Network for Greening the Financial System, in particular the workstreams on Supervision, Scenario Design and Analysis, and Monetary Policy, would allow for a gradual engagement in the international debate in this area.

- The Supervision workstream aims to help NGFS members incorporate climate-related risks within their supervisory frameworks and practices. It currently (1) conducts deep dives into prudential supervision of climate-related and environmental financial risks, including litigation risks, reputational risks, and credit risks, (2) analyzes the needs and roles of supervisions in addressing transition risks, and (3) helps integrate climate-related risks into microprudential supervision.

- The Scenario Design and Analysis workstream helps countries improve awareness and capabilities of climate scenario analysis. It develops and improves the climate scenarios, and models both transition and (acute and chronic) physical risks. NGFS Phase III has six long-term climate scenarios, ranging from current policies (3.3°C) to 1.5°C scenario and NGFS Phase IV expands to seven long-term scenarios, with the introduction of Fragmented World and Low Demand scenarios. In addition, the Scenario workstream is developing short-term scenarios, addressing the needs of climate risk stress testing.

- The Monetary Policy workstream considers both the framework and implementation of monetary policy. It analyzes macroeconomic impacts from climate change and net-zero transition, for example, the impact of low-carbon transition on inflation, price adjustment, and interest rate and implications for monetary policy. It also assesses adjustments that need to be made to operational frameworks of monetary policy to account for climate-related risks, such as adjusting pricing to reflect counterparties' climate-related lending or to reflect the composition of pledged collateral, aligning collateral pools with climate-related objectives, and skewing asset purchases according to climate-related criteria applied at the issuer or asset level (NGFS, 2021).

Figure 18. Improving Coordination between Financial Regulators and Ministries in Kazakhstan on Climate Risk Analysis



Source: adapted from Terton et al. (2022).

54. **Given the cross-sectoral nature of climate-related issues, the authorities should strengthen coordination between financial regulators, ministries, and other stakeholders and develop an interagency working group on climate finance and climate risk analysis.** Climate change mitigation and adaptation policies are developed and implemented by multiple ministries and agencies (Figure 18). On the one hand, policies developed by other line ministries – such as energy policies by the Ministry of Energy and emissions reduction targets by the Ministry of Ecology, Geology, and Natural Resources (MEGNR) – have broader economic impact and affect the financial system. On the other hand, understanding climate risk for the financial system requires data and modeling support from other line ministries. Enhancing interagency coordination could help address the data gap in climate risk analysis, improve the methodologies to assess climate risks, and support climate-related financial risk monitoring.

55. **Different government agencies should also coordinate to improve data granularity for assessing transition and physical risks.** Measuring climate-related financial risks requires additional data and methodologies that may be new to regulators and financial institutions. To conduct climate risk analysis, the authorities need to improve data and knowledge sharing across ministries and develop efforts to collect new data. In some cases, data are available but cannot be easily accessed by financial regulators. For example, transition risk analysis often requires detailed emissions data at the company or household level. The MEGNR collects detailed energy consumption and GHG emissions data of large companies under the emissions trading system; the Ministry of Industry tracks energy use data of large energy consumers; the Bureau of Statistics

conducts consumption surveys at the household and company level. These data, if shared with the financial regulators, could be used to assess transition risk. In other cases, data do not exist or are not available at a sufficiently granular level. For example, data related to asset-level insurance coverage for hazards are critical for assessing the exposure of financial institutions to physical risks but currently not available. In this case, new or enhanced data collections are needed to improve climate-related financial risk analysis.

56. Given the potential for substantial risks associated with climate change and climate mitigation actions, the authorities should develop capacity to conduct climate stress testing. This includes: improving human capacity and potentially hiring climate experts; developing key risk indicators to assess climate-related risks; developing climate scenarios and climate-macro-financial models with suitable scope regarding country coverage, industry coverage, climate risk components, and macrofinancial variables; developing climate risk analysis training; and integrating climate risk into the stress testing framework.

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Appendix I. IMF-ENV Model

The IMF-ENV model is a global, dynamic recursive, sectoral CGE model. It is built on the ENVISAGE model (van der Mensbrugghe 2019) and the OECD ENV-Linkages Model (Chateau et al., 2014). The model can be used to simulate the impact of climate mitigation policies on emissions, sectoral output, trade, and macroeconomic variables. It is developed based on a neo-classical framework and solves in real values and with almost perfect markets for commodities and production factors (see Figure A1 for the commodities modeled in the IMF-ENV model). Capital investment in IMF-ENV is vintaged, allowing the model to differentiate between new capital investment and existing capital stock. The model does not have heterogenous households and is not able to capture distributional effects within a country. Technology assumptions are also exogenous in IMF-ENV, so it cannot capture technology learning and spillover effects (Chateau et al., 2022a & b).

Appendix I. Figure 1. Commodities modeled in IMF-ENV

1	**All Crops (cro)**	Paddy Rice (pdr), Wheat (wht), Other Grains (gro), Vegetables and fruits (v_f), Oil Seeds (osd), Sugar cane and sugar beet (c_b), Plant Fibres (cotton and other fibersused in textiles) (pfb), Other Crops (ocr)
2	**Livestock (lvs)**	Bovine cattle, sheep and goats, horses (ctl), Animal products n.e.s. (oap), Raw milk (rmk), Wool, silk-worm cocoons (wol)
3	**Forestry (frs)**	Forestry (frs)
4	**Fisheries (fsh)**	Fishing (fsh)
5	**Construction (cns)**	Construction (cns)
6	**Minerals n.e.s. (OMN)**	Minerals n.e.s. (oxt)
7	**Water services (wts)**	Water supply; sewerage, waste management and remediation activities (wtr)
8	**Coal extraction (coa)**	Coal (coa)
9	**Crude Oil extraction (oil)**	Oil (oil)
10	**Petroleum and coal products (p_c)**	Manufacture of coke and refined petroleum products (p_c)
11	**Natural gas (gas)**	Natural gas extraction (gas), Gas manufacture and distribution (gdt)
12	**Electricity (ELY)**	Coal power baseload (CoalBL), Coal-based CCS (colccs), Oil power baseload (OilBL), Oil power peakload (OilP), Gas power baseload (GasBL), Gas power peakload (GasP), Gas-based CCS (gasccs), Nuclear power (NuclearBL), Advanced nuclear (advnuc), Hydro power baseload (HydroBL), Hydro power peakload (HydroP), Wind power (WindBL), Solar power (SolarP), Other baseload includes biofuels, waste, geothermal, and tidal technologies (OtherBL), Electricity transmission and distribution (TnD)
13	**Paper & Paper Products (ppp)**	Paper products, publishing (ppp)
14	**Non-metallic minerals (nmm)**	Mineral products n.e.s. (nmm)
15	**Iron and Steel (i_s)**	Iron and steel (i_s)
16	**Chemical products (crp)**	Chemical products (chm)
17	**Non-ferrous metals (nfm)**	Non-ferrous Metals (nfm)
18	**Electronics (ele)**	Electronic equipment (ele)
19	**Food Products (fdp)**	Bovine cattle meat products (cmt), Meat products n.e.s. (omt), Vegetable oils and fats (vol), Dairy products (mil), Processed rice (pcr), Sugar (sgr), Food products n.e.s. (ofd), Beverages and tobacco products (b_t)
20	**Textiles (txt)**	Textiles (tex), Wearing apparel (wap), Leather products (lea)
21	**Transport Equipment (mvh)**	Motor vehicles and parts (mvh), Transport equipment n.e.s. (otn)
22	**Fabricated metal products (fmp)**	Metal products (fmp)
23	**Other manufacturing (oma)**	Wood products (lum), Machinery and equipment n.e.s. (ome), Electrical equipment (eeq), Basic pharmaceuticals (bph), Rubber and plastic products (rpp), Manufactures n.e.s. (omf)
24	**Water Transport (wtp)**	Sea transport (wtp)
25	**Air Transport (atp)**	Air transport (atp)
26	**Land transport (otp)**	Transport n.e.s.: Land transport and transport via pipelines (otp)
27	**Other collective services (osg)**	Public administration and defense (osg), Education (edu), Human health and social work (hht)
28	**Other Business services (osc)**	Communication (cmn), Financial services n.e.s. (ofi), Insurance (ins), Recreation and other services (ros), Dwellings (dwe), Trade (trd), Accomodation and food service activities (afs), Warehousing and support activities (whs), Business services n.e.s. (obs), Real estate activities (rsa)
		n.e.s. = not elsewhere specified.

Appendix II. Firm Profit and Loss and Balance Sheet Simulation

Appendix II. Figure 1. Firm Profit and Loss Modeling

$$EBIT_{f,t,s} = REV_{f,t,s} - COGS_{f,t,s} - OC_f - EC_{f,t,s}$$

Where $EBIT_{f,t,s}$ is earnings before income and tax for firm *f* at time *t* under scenario *s*. $REV_{f,t,s}$ is sales revenue, which is linked with sectoral GVA from IMF-ENV. Sales-to-GVA elasticities are estimated based on log level firm-fixed effects panel regression.

$$\log(REV_{f,t}) = \alpha_f + \beta \log(GVA_{f,t}) + \epsilon_{f,t}$$

$COGS_{f,t,s}$ is cost of goods sold for firm *f* at time *t* under scenario *s* and linked to sales revenue. COGS-to-sales elasticities are estimated based on log difference-based fixed effects panel regression. OC_f is other operating cost and held constant for each firm.

$$\Delta \log(COGS_{i,t}) = \alpha_i + \beta \Delta \log(REV_{i,t}) + \epsilon_{i,t}$$

$EC_{f,t,s}$ is scenario- and time-specific firm-level emissions cost and estimated based on the shadow price of carbon from IMF-ENV $Cprice_{t,s}$ and firm-level emissions. Firm-level emissions are calculated based on emissions intensity for the industry *i* that the firm belongs to at time *t* under scenario *s*, $EI_{i,t,s}$; and firm's revenue. Sectoral emissions intensity is affected by climate mitigation policies and technological change, and therefore, changes across scenarios and time.

$$EC_{f,t,s} = Cprice_{t,s} \times EI_{i,t,s} \times REV_{f,t,s}$$

Firm's profit $P_{f,t,s}$ is estimated by accounting for all income and expenses.

$$P_{f,t,s} = EBIT_{f,t,s} + FI_{f,t,s} - FE_{f,t,s} - Tax_{f,t,s}$$

$$Tax_{f,t,s} = \gamma \times (EBIT_{f,t,s} + FI_{f,t,s} - FE_{f,t,s})$$

Where $FI_{f,t,s}$ is firm's financial income which changes proportionally with sales revenue; $FE_{f,t,s}$ is financial expense, calculated based on constant interest/debt ratio; $Tax_{f,t,s}$ is corporate tax expense, calculated based on constant corporate tax rate γ.

Appendix II. Figure 2. Firm Balance Sheet Module

$$CCE_{f,t+1,s} = \max\ (0,\ CCE_{f,t,s} + \ P_{f,t+1,s})$$

$$TA_{f,t+1,s} = \ \max\ (0, TA_{f,t,s} + \ P_{f,t+1,s})$$

$$TD_{f,t+1,s} = TD_{f,t,s} - \ \min\ (0,\ CCE_{f,t,s} + \ P_{f,t+1,s})$$

$$CA_{f,t+1,s} = \max\ (0,\ CA_{f,t,s} + \ P_{f,t+1,s})$$

$$CL_{f,t+1,s} = CL_{f,t,s} - \ \min\ (0,\ CCE_{f,t,s} + \ P_{f,t+1,s}) \times \frac{1}{2}$$

Where $CCE_{f,t+1,s}$ is cash and cash equivalents; $TA_{f,t+1,s}$ is total assets; $TD_{f,t+1,s}$ is total debt; $CA_{f,t+1,s}$ is current assets; $CL_{f,t+1,s}$ is current liabilities for firm *f* at time *t* under scenario *s*.

Risk Metrics

Interest coverage ratio $ICR_{f,t,s}$, leverage ratio $LR_{f,t,s}$, and current ratio $CR_{f,t,s}$ from the firm balance sheet module are used in fixed effects panel regression to estimate probability of default for 2023-2030.

$$ICR_{f,t,s} = \frac{EBIT_{f,t,s}}{FE_{f,t,s}}$$

$$LR_{f,t,s} = \frac{TD_{f,t,s}}{TA_{f,t,s}}$$

$$CR_{f,t,s} = \frac{CA_{f,t,s}}{CL_{f,t,s}}$$

Appendix II. Figure 3. Fixed Effects Panel Regression Estimation in the PD Model

	Logit (PD)
ICR	-0.019
	(0.071)
LR	2.064
	(0.012)
CR	-0.006
	(0.512)
Sector Level Fixed Effect	Yes
Sample	2014-2021
Sector	16
Observations	128

The p-values are reported in parenthesis. Intercept is set equal to the average fixed effects across sectors.

Sources: ARDFM, NBK, and IMF staff calculations.