

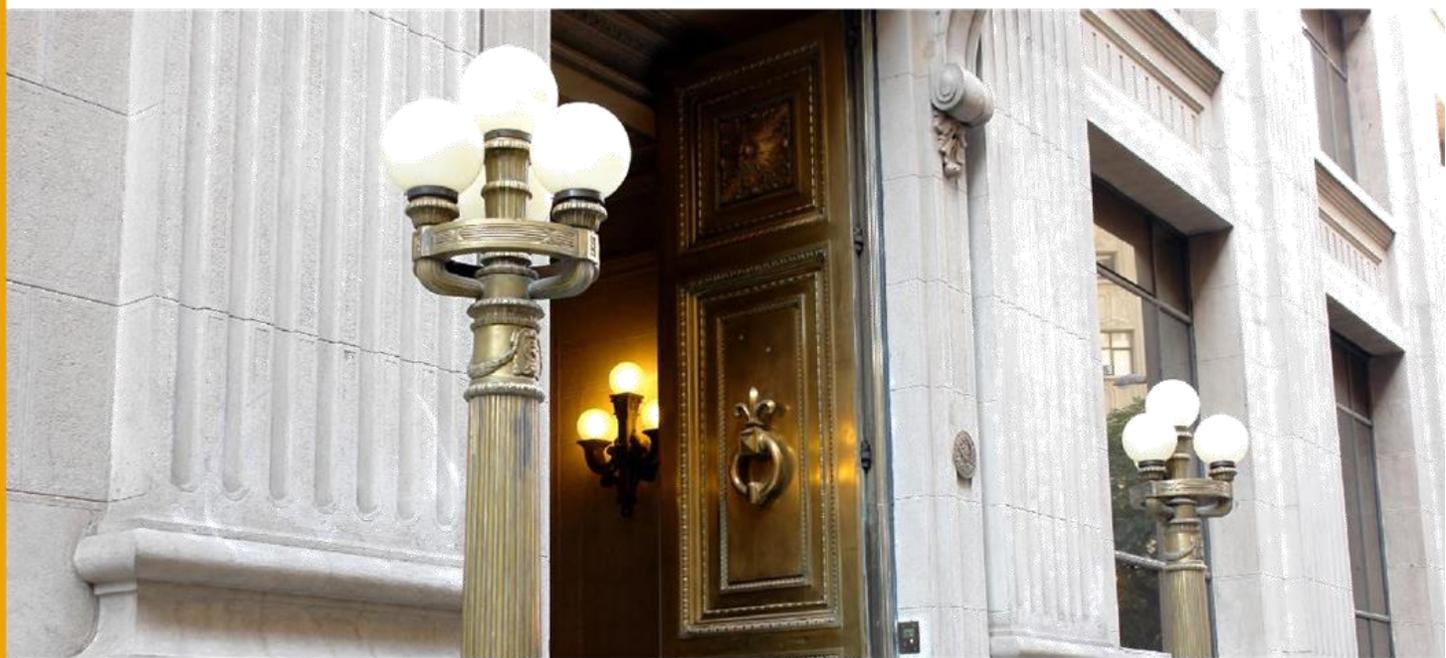
# DOCUMENTOS DE TRABAJO

## Climate Transition Risks in Chile's Banking Industry: A Loan-Level Stress Test

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## Climate Transition Risks in Chile's Banking Industry: A Loan-Level Stress Test\*

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### Resumen

Este estudio presenta la primera prueba de tensión considerando riesgos de transición climática para el sector bancario chileno. Combinamos datos granulares del registro de crédito con los escenarios de corto plazo del NGFS derivados de un marco de equilibrio general. Estimamos las pérdidas de los bancos por riesgo de crédito bajo dos trayectorias de transición, una ordenada y otra desordenada, integrando shocks sectoriales con probabilidades de incumplimiento a nivel de empresa y abordando la incertidumbre mediante técnicas de remuestreo. Los resultados muestran que, a pesar de una disminución gradual en la exposición del crédito a sectores ligados a industrias más contaminantes, los bancos siguen siendo vulnerables: las pérdidas bajo una transición desordenada podrían casi duplicarse y acercarse rápidamente a los niveles observados durante la Crisis Financiera Global, observando una heterogeneidad significativa entre instituciones. Estos hallazgos destacan la naturaleza sistémica y específica por institución de los riesgos de transición y subrayan la necesidad de incorporar riesgos climáticos en las pruebas de tensión supervisoras y en la adecuación de capital para salvaguardar la estabilidad financiera.

### Abstract

This study provides the first loan-level climate transition risk stress test for Chile's banking sector, combining granular credit data with NGFS short-term scenarios stem-ming from a general equilibrium framework. We estimate credit losses under orderly and disorderly transition pathways, integrating sectoral shocks with firm-level probabilities of default and addressing uncertainty through resampling. Results show that despite a gradual decline in exposure to carbon-intensive sectors, banks remain vulnerable: losses under a disorderly transition could nearly double and rapidly approach levels seen during the Global Financial Crisis, with significant heterogeneity across institutions. These findings highlight the systemic and institution-specific nature of transition risks and underscore the need to embed climate risk into supervisory stress testing and capital planning to safeguard financial stability.

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# 1 Introduction

Despite Chile’s leadership in Latin America’s energy transition and its commitment to carbon neutrality by 2050, the implications of climate transition risks for the Chilean banking sector remain largely unexplored. This paper provides the first comprehensive assessment of these risks using granular loan-level data combined with firm-specific credit ratings and forward-looking stress scenarios. Our approach integrates this unique dataset with industry-specific transition pathways derived from a general equilibrium framework that captures sectoral interlinkages. Leveraging the recently released Phase 5 Short-Term Climate Scenarios, developed by the Network for Greening the Financial System (NGFS) and documented in Battiston *et al.* (2025), we evaluate banks’ exposure to transition risks across both the past decade and a range of alternative future narratives. Unlike traditional models that rely solely on carbon tax shocks, these scenarios incorporate dynamic adjustments across interconnected sectors, mapping macroeconomic and policy shocks into firm-level probabilities of default. We focus on two contrasting transition pathways: an orderly scenario aligned with a gradual decarbonization process and a disorderly scenario characterized by abrupt policy shifts. Our analysis reveals that, while system-wide exposure to transition-sensitive sectors declined from 73% of commercial loans in 2011 to about 60% in 2025, this adjustment has been highly heterogeneous across institutions. Stress test results, based on a bootstrap resampling framework, confirm that these differences are statistically significant and strongly conditional on initial portfolio composition. Under a disorderly transition, banks’ losses could nearly double relative to current levels, with the upper range of estimated outcomes approaching those observed during the Global Financial Crisis. These findings underscore the need for forward-looking risk management and capital planning tailored to banks’ starting positions and portfolio structures.

Although the macroeconomic consequences of climate change in Chile have been widely explored<sup>1</sup>, the financial system, and banks in particular, has received far less attention. This gap is striking given the relevance of the banking industry in Chile, where outstanding loans amount to approximately 80% of GDP in 2024. For the rest of the world, there has been growing focus on the implications for financial stability of climate risks and the need for regulatory and supervisory responses (European Systemic Risk Board, 2016; Financial Stability Board, 2025).

The mechanism we explore throughout this paper is that climate transition risks, especially those arising from carbon pricing and other mitigation policies, have the potential

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<sup>1</sup>Antosiewicz *et al.* (2020) investigates the macroeconomic dynamics in Chile following the implementation of key climate change mitigation policies aligned with the Paris Agreement. Madeira (2022) provides a comprehensive review of the impact of physical climate risk on Chile’s macroeconomic aggregates, including an international comparison with other relevant countries. Beltrán *et al.* (2024) offer a synthesis of recent studies examining the effects of physical and transition climate risks on Chile’s macroeconomic performance and sectoral economy. Hernandez and Madeira (2022) analyze the influence of physical climate risk in various economic sectors in Chile. Similarly, Cortina and Madeira (2023) explore the implications of physical climate risk in the Chilean real estate market. Cordova *et al.* (2024) assess physical climate risk in Chile using a novel dataset of firm-level invoice transactions and firm-level debt information. By combining granular administrative data with municipal-level physical risk scenarios, it reveals concentrated exposure in high-risk areas vulnerable to extreme heat and urban fires. Another examination of the economic impact of climate change on the Chilean economy is presented by Bañados *et al.* (2023), offering a more general perspective that complements the sector-specific and risk-focused analyses found in the aforementioned studies.

to impair firms' repayment capacity, weaken banks' balance sheets, and trigger systemic vulnerabilities under specific scenarios. These risks are increasingly shaping central banks' agendas, prompting the inclusion of this type of shocks into the banking stress test toolbox.<sup>2</sup> Our study contributes to this global effort by providing an empirical assessment of climate transition risk exposure of Chile's banking sector using rich loan-level data. This unique dataset permits not only looking into the current exposure of banks to this type of risk, but also looking into its evolution over the past decade and posing hypothetical future scenarios with different narratives, such as orderly and disorderly pathways, that maintain internal consistency within a general equilibrium framework.

Although other jurisdictions have implemented climate-related stress tests, monetary authorities and regulators in Chile have yet to formally adopt such measures. This study provides the first climate stress test applied to the Chilean banking sector using risk scenarios that take into account sectoral linkages and the general equilibrium responses of firms under different transition paths towards a greener economy. By doing so, we are addressing a critical gap in the local financial stability literature.

We examine two relatively unexplored dimensions of climate change in the local banking industry. First, we focus on the temporal evolution of banks' exposure to transition risks: past, present, and future. Secondly, we assess the impact of climate transition shocks on loan portfolios under several prospective scenarios, which incorporate sectoral interdependencies and general equilibrium responses of firms. The former aims to uncover the vulnerability of banks' loan portfolios to climate distress by categorizing loans into industries exhibiting a heterogeneous sensitivity to climate change. The latter quantifies the impact of climate shocks on banks losses via credit risk in a scenario where borrowers may default on their loans given episodes of climate distress under different transition paths towards a greener economy. This work offers novel evidence on how climate shocks may affect banks' loan portfolios and generate potential losses and also on how banks have shifted their portfolios over the past decade and changed their exposure to certain industries. These insights are particularly relevant for central banks and financial regulators, as they contribute to the development of forward-looking risk assessment frameworks. By enhancing the understanding of climate-related vulnerabilities in the financial system, the findings support the design of more robust macroprudential policies and inform the calibration of supervisory tools aimed at safeguarding financial stability in the face of climate change.

In this paper, we utilize three main sources of information. The first is a proprietary dataset from the Chilean financial supervisor, which includes a credit registry data covering about 30 thousand firms and 15 banks operating in Chile over the period from January 2011 through May 2025. This dataset provides loan-level transaction records for all Chilean firms that fund themselves with banks, including loan characteristics such as amount, interest rate and term. For about 80% of total commercial debt, it is also available the risk classification assigned by commercial banks to each loan of each firm, the level of guarantees required and the loan-loss provision associated to the specific loan. These credit ratings enable us to infer firm-level probabilities of default (PD) and loss given default (LGD). The second source of information corresponds to a separate proprietary dataset maintained by the Chilean Tax Authority, which contains information on the productive sectors where the borrowers operate.

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<sup>2</sup>Further information can be found in Bank of England (2021), European Central Bank (2022), and Federal Reserve System (2024).

The third source of information is the NGFS Phase 5 Short Term Scenarios developed by Battiston *et al.* (2025), hereafter the NGFS scenarios, which offer plausible trajectories for financial variables under different narratives of climate stress.<sup>3</sup> Our analysis focuses specifically on the NGFS transition risk scenarios, which project future PDs for firms across fifty productive sectors. By integrating these datasets, we can apply the NGFS climate shocks to estimate potential bank losses resulting from the materialization of transition risks by 2030 and the entire path between now and then. This exercise focuses on credit risk, assessing how increased PDs under climate-distressed scenarios can translate into economic losses for banks. The methodology is further elaborated in Section 3.

The NGFS short-term scenarios are derived from a coupled modeling framework that integrates the interactions among three distinct yet interrelated models with general equilibrium internal consistency and rich sectoral linkages. In this study, we focus on transition risk scenarios, which are critical for understanding the financial implications of climate policy shifts. The risks of transitioning to a low-carbon economy affect the asset side of firms' balance sheets through the stranding of carbon-intensive assets. This further leads to a decline in output, reducing the projected cash flows of firms and, consequently, their financing capacity. We specifically employ two transition risk scenarios: the Highway to Paris (HW2P), representing an orderly transition, and the Sudden Wake-Up Call (SWUC), representing a disorderly transition. Section 2 provides a detailed discussion of the two transition risk scenarios under analysis.

Our research is situated within the growing field of climate stress testing, which seeks to evaluate the resilience of financial systems under climate-related scenarios. Within this context, one of the most recent and influential contributions is the work of Battiston *et al.* (2017) who introduce a network-based climate stress-testing method to assess how climate policy risks spread through the financial system. They find that financial actors, especially banks and investment funds, hold significant exposures to climate-policy-relevant sectors. The study emphasizes that early, credible climate policies can reduce systemic risk, while delayed action may trigger abrupt losses. Acharya *et al.* (2023) review climate stress testing as a tool for managing systemic financial risks, highlighting limitations in current frameworks and advocating for improved scenario design, dynamic modeling of transition risks, and market-based approaches. They emphasize the need to better capture short-run credit risks and investor expectations to enhance financial stability assessments. Following the relevance of climate shocks on the banking industry, an increasing number of articles have contributed to improve the understanding of this matter. The survey in Reinders *et al.* (2020) provides an updated review of existing methods, classifying scenarios and approaches, analyzing underlying models and results, and critically discussing the temporal, technical, and conceptual limitations of climate risk stress testing frameworks. While there is no previous research examining climate shocks in a banking stress test context in Chile, Gonzales and Rojas (2024) shed light on the exposure of the Chilean banking sector to both transition and physical climate-related risks utilizing a number of specific productive sectors. Their findings indicate that approximately 11% of the banking sector's loan portfolio is exposed to severe physical climate conditions, while 20% is susceptible to the financial impacts of a substantial carbon tax. Two recent studies offer relevant comparisons to our work. One

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<sup>3</sup>The NGFS short-term scenarios were released in May 2025. Both the accompanying documentation and dataset are publicly available for download from the NGFS website in the following [link](#).

conducts a stress testing exercise within the Colombian banking system, contributing to the broader Latin American context. The other examines the German banking sector, employing the framework developed by the NGFS. Bebczuk *et al.* (2025) present a sectoral disaggregated climate stress testing framework to assess the long-term impact of climate change on bank solvency in Colombia. Their methodology focuses on estimating the dynamics of bank capital and non-performing loans under a number of climate-distressed GDP scenarios. The study finds that while systemic solvency risks remain limited in most scenarios, certain banks with low initial capital ratios may face significant vulnerabilities, particularly under extreme climate conditions. Similar to our work, Gross *et al.* (2025) quantify climate transition risks for German banks by integrating the NGFS macroeconomic scenarios with firm-level data. The approach captures heterogeneous impacts and models uncertainty through multiple probability-of-default estimates. Results show significant sectoral variation, with emissions-intensive firms facing losses up to one percent of their loan portfolio.

The remaining of this paper is as follows, Section 2 presents the data and climate scenarios. Section 3 introduces the climate stress-test methodology, Section 4 discusses the results and Section 6 concludes with a discussion of our findings and their implications for policy. It also revisits the main limitations of the study and outlines potential avenues for future research aimed at addressing them.

## 2 Data and climate scenarios

In this study, we utilize three data sources. The first one is a credit registry, a proprietary source managed by the Financial Market Commission, the financial supervisor in Chile. It provides comprehensive information on the stock of all commercial loans and their evolution over time. Each observation corresponds to a loan and includes identifiers for both the lending bank and the recipient firm, capturing the bilateral lending relationships between banks and borrowing firms. Key variables include the amount of credit, firm credit score, credit risk rating from the point of view of the lender (e.g., A1, A2, and so on, performing, non-performing), provisioning levels, and details of credit delinquency, including the number of days past due and the outstanding delinquent amount. This granular structure allows for the analysis of credit allocation patterns, risk exposure, and inter-institutional dependencies within the financial system. The second source comprises proprietary data on the sectoral classification of firms by economic activity, provided by the Chilean Tax Authority. This dataset contains the sectoral classification of all firms operating in Chile. The information is initially self-reported by the firms and subsequently verified by the Tax Authority using VAT receipt records. Table 1 presents the classification of firms according to the ISIC 2-digit code. It also provides the correspondence between the domestic categorization based on the ISIC 2-digit classification and the NGFS sectoral framework.

### 2.1 NGFS transition risk scenarios

In addition to the two proprietary data sources used in this study, a third source comprises the forecasts included in the NGFS short-term scenarios, which consider 42 countries and 11 regions over a five-year horizon, extending to 2030. These scenarios offer predictions of financial indicators under stress simulations, they are not necessarily depictions of the most

likely future path.

The NGFS short-term climate scenarios are constructed using an integrated modelling framework that combines three complementary models: GEM-E3, CLIMACRED and EIRIN<sup>4</sup>. GEM-E3 is a global, multi-sectoral computable general equilibrium model that captures linkages across 50 sectors and 46 regions through endogenous bilateral trade flows and market-clearing mechanisms. It represents production and consumption decisions based on microeconomic optimization, incorporating dynamic capital accumulation, technological change via learning-by-doing, R&D investment, and international spillovers. CLIMACRED complements this by translating sectoral dynamics into financial outcomes, including probabilities of default, cost of capital, and asset valuations. EIRIN, a stock-flow consistent macro-financial model, simulates feedback loops between real and financial sectors, accounting for monetary policy responses, credit constraints, and heterogeneous agent behavior. These models are iteratively coupled: GEM-E3 provides sectoral output and carbon price paths, EIRIN returns macro-financial variables such as policy rates, and CLIMACRED adjusts sectoral costs of capital, which feed back into GEM-E3. This iterative process ensures general equilibrium consistency while capturing sectoral linkages through trade, technology diffusion, and financial channels.

## 2.2 Plausibility of the scenarios

The NGFS short-term scenarios are not probabilistic forecasts, but rather stress test tools designed to explore plausible paths under specific assumptions. Their realization is conditional on the occurrence of distinct policy, technological, or physical risk triggers. Transition risk scenarios, such as Highway to Paris or Sudden Wake-up Call, require either globally coordinated and anticipated policy action or abrupt and unanticipated regulatory shifts, respectively.

Physical risk scenarios, such as “Disaster and Policy Stagnation,” assume the materialization of low-probability, high-impact compound climate events, which are not expected to occur with certainty within the five-year horizon but are included to assess systemic vulnerabilities. Consequently, these scenarios should be interpreted as internally consistent narratives for risk assessment rather than as the most likely trajectory for the global economy in the near term. These physical risk scenarios will not be used in this paper.

## 2.3 Sectoral coverage and scenario narratives

The NGFS scenarios offer projected trajectories of key financial variables adapted to representative firms within specific economic sectors. Table 1 lists the NGFS sectors we use for the analysis. In Section 3 we detail the process we use to align the sectoral classification of firms in our datasets with the NGFS sectors. NGFS formulates four plausible short-term scenarios to assess climate-related financial distress: two transition risk scenarios, one physical risk scenario, and one scenario that integrates both transition and physical risks. In our stress test exercise, we specifically employ the two transition risk scenarios.

The two transition risk scenarios we study are called Highway to Paris (HW2P) and Sudden Wake-Up Call (SWUC). Although both scenarios describe a pathway towards achieving

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<sup>4</sup>More details about these models in Capros *et al.* (2025), Battiston *et al.* (2023), and Monasterolo and Raberto (2018).

carbon neutrality by 2050, the SWUC scenario describes a trajectory in which delaying transition efforts increases the economic costs of decarbonization and results in additional financial stress. The HW2P scenario corresponds to an orderly transition scenario with a coordinated and proactive global approach to achieving the Paris agreement. The scenario assumes that climate policies are well-anticipated, technological advancements are effectively leveraged, and the financial sector remains resilient throughout the transition. Central to this pathway is a high degree of international cooperation, which facilitates the early adoption of ambitious yet gradual climate policies. In this scenario, carbon tax revenues are fully reinvested into green subsidies and investments, including public R&D and capital subsidies for clean energy technologies. This timely implementation partially mitigates the economic costs associated with the transition to a low-carbon economy, with estimated global GDP losses limited to approximately 0.4% by 2030.

In contrast, the SWUC scenario illustrates a disorderly transition pathway emphasizing the consequences of delayed and fragmented climate policy implementation. Characterized by low international cooperation, this pathway poses heightened risks to global macro-financial stability. In this scenario, only a fraction of carbon revenues is allocated to clean energy investments. The abrupt nature of policy shifts, triggered by mounting public pressure or geopolitical developments, leads to a more disruptive transition, with projected global GDP losses reaching 1.3% by 2030, more than triple those under the HW2P scenario. The lack of preparedness and limited policy foresight exacerbate transition risks, particularly in the context of uncertain fossil energy supplies and fragile financial systems.

In addition to the two transition risk scenarios, the NGFS also provides a common baseline pathway, serving as the reference point for both. This shared baseline covers the same countries and regions and spans the same time horizon, providing forecasts for key variables through 2030. It is based on projections of aggregate variables, such as GDP, population, and unemployment, published in the October 2023 edition of the IMF World Economic Outlook. To account for the anticipated trajectory of climate policies, the baseline scenario incorporates current greenhouse gas (GHG) emission targets, carbon pricing objectives, and existing policies aimed at promoting the transition to clean energy sources, including renewables.

## 2.4 Data limitations

Given our focus on credit risk, we leverage on the sectoral PD forecasts from the transition risk scenarios. One data-related limitation of this study is that Chile is not individually represented in the NGFS climate scenarios, therefore the probability of default forecasts under climate-distressed conditions is not available for Chile by itself. To address this shortcoming, we rely on the regional scenarios provided for South America. Furthermore, to enhance the robustness of our climate stress test estimations, we incorporate scenarios from two other countries in the region: Argentina and Mexico. Although this approach is not ideal, it is consistent with NGFS recommendations, which suggest that countries within the same region may experience similar climate-related shocks (NGFS, 2023).<sup>5</sup>

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<sup>5</sup>The economic structure of Chile is similar to those of Argentina and Mexico, with a closer resemblance to the latter. Panel (a) in Figure A.1 in the appendix illustrates a comparison of the sectoral composition of the 2024 GDP, showing parallels between the three countries. Panel (b) shows that, in Argentina and Mexico, coal and oil production are more prominent within the mining sector than in Chile, while manufacturing output displays similar patterns across the three countries. These similarities justify using Mexico and

Figure 1 shows the distribution of PD changes, categorized by region and scenario across all industries from 2025 to 2030. The dynamics of PD changes with respect to the base-line scenario reflect the severity of climate shocks and their differentiated impacts across regions. Under the SWUC scenario, PDs increase consistently across all sectors and regions, indicating that firms are exposed to a generalized increase of credit risk in this state of the nature representing a disorderly transition. In contrast, the HW2P scenario shows a more heterogeneous pattern of PD adjustments, with both increases and decreases across sectors. In this orderly transition scenario, firms experiencing a reduction in PDs are associated with greener sectors, whereas those operating in brown sectors face a deterioration in their debt repayment capacity. When comparing regions, we observe that both scenarios generally result in more pronounced increases in PD for Argentina, followed by South America, and lastly Mexico.

### 3 Methodology

Our analysis aims to estimate potential bank losses resulting from the materialization of a climate distress scenario. These climate shocks arise from the implementation of climate policies designed to achieve the net-zero emissions target by 2050. The transition to a greener economy imposes adverse effects on the broader economy, firms, and ultimately on the banking system. In particular, firms operating in a deteriorated economic environment may face financial distress, which undermines their ability to meet loan obligations and leads to an increased probability of default. This dynamic translates into an increased credit risk for commercial banks, which become more exposed to defaults among borrowing firms affected by transition-related climate shocks, leading to increased bank losses.

This climate stress test exercise relies on the transition pathways outlined in the NGFS short-term scenarios through 2030. We focus on two transition risk scenarios: one representing an orderly transition and the other a disorderly one. The severity of climate shocks varies across scenarios, resulting in differentiated effects on banks depending on their sectoral exposures. We structure our climate stress test methodology into three steps. First, we characterize the bank–firm relationship by identifying the loan portfolios of individual banks. Second, we classify borrowing firms according to their respective productive sectors. This classification enables us to assess the exposure of each bank to different sectors and, consequently, to determine the sectoral composition of their loan portfolios. Third, using these sectoral exposures, we estimate the potential losses that banks may face due to climate-related shocks, as projected in the NGFS scenarios.

To identify bank–firm relationships, we use the financial supervisor’s credit registry. This dataset provides loan-level transaction data in which both banks and borrowing firms are identified, enabling us to construct the loan portfolios of all banks operating in Chile. It includes a detailed set of loan characteristics, such as loan amounts, loan-level credit ratings, credit risk classifications (e.g., performing, non-performing), loan loss provisions, guarantees, and indicators related to credit delinquency. For the purposes of our study, we focus on three key variables: the bank–firm link, the loan amount, and the credit rating for each loan. The latter is readily available from the credit registry as it is assigned by banks based on

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Argentina as reference cases to define bounds for assessing our initial results based on the South America scenarios.

their internal credit risk assessments.<sup>6</sup> Following local regulation, banks must periodically reassess the credit scores of borrowing firms and classify them into risk categories defined by regulatory standards. Tables 2 and 3 summarize the credit risk categories defined in the regulation, along with the corresponding probabilities of default and loss given default associated with each category. Category A1 represents the highest credit quality, indicating that firms assigned to this category exhibit a robust capacity to meet their debt obligations, and the associated probability of default is minimal. Conversely, category B4 reflects the lowest performing credit tranche, typically encompassing firms with a history of poor repayment behavior. This category is linked to a significantly elevated probability of default. Categories C1 through C6 comprise defaulted loans. Although the credit registry provides comprehensive records of all loan transactions, probability-of-default data are available for most of commercial debt, leaving only a minority of credit unrated. These unrated firms tend to be comparatively smaller in size. The subset of firms for which PDs are available is close to 30 thousand, equivalent to about 90% of the total outstanding loans in the commercial loans portfolio of banks. Consequently, the exclusion of unrated firms is not expected to introduce significant bias into our results, as they represent only a small fraction of the dataset and are not concentrated in any particular productive sector.

We classify firms into productive sectors following the framework proposed by NGFS (2025), which delineates a correspondence between NGFS sectoral categories and the 2-digit NACE classification. Although the dataset provided by the Central Bank of Chile is organized according to ISIC, the existence of a one-to-one correspondence between the 2-digit NACE and the 2-digit ISIC codes enables a complete and consistent mapping of our data into the NGFS classification. This alignment ensures coherence in sectoral classification and facilitates the integration of our analysis within the NGFS framework.

### 3.1 Effects on banks' balance sheets

To estimate the impact of climate transition-induced shocks on banks' losses, we conduct a climate credit risk exercise. In this framework, banks experience losses due to their exposure to firms whose PD increases as a result of different climate transition pathways. The PD is the central variable in our analysis, as it captures the deterioration in firms' ability to meet their debt obligations under different climate transition scenarios.

A central assumption in our analysis is that banks' exposures remain constant throughout the five-year simulation horizon. This simplification is deliberate and aligns with the short-term nature of the NGFS scenarios, which are designed to capture immediate transition risks rather than long-term portfolio adjustments. Other authors have taken the same route with this assumption to focus on the immediate vulnerabilities in the banking system (Battiston *et al.* (2017) and Roncoroni *et al.* (2021)). Consequently, our results should also be interpreted as short-term impacts or, at most, an upper bound in the absence of credit reallocation away from sectors that become riskier during the transition. Modelling banks' dynamic responses—such as reducing exposures, repricing credit, or reallocating capital—would require a structural framework that captures credit flow dynamics and capital

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<sup>6</sup>This credit risk evaluation includes the analysis of both the current and prospective overall financial situation of the firm from the bank's point of view, and firm-specific indicators such as age, leverage, asset quality and liquidity, profitability, debt capacity, projected cash flows, as well as other loan delinquency indicators.

adequacy constraints, which is beyond the scope of this paper but represents an important avenue for future research.

We consider this assumption reasonable for two main reasons. First, the average maturity of commercial loans in Chile implies that significant portfolio adjustments typically occur gradually, limiting the scope for rapid reallocation within the simulation horizon. Second, historical evidence shows that banks’ exposures to carbon-intensive sectors have declined only marginally over the past 14 years, suggesting that structural and relationship-based lending practices constrain short-term adjustments. Furthermore, most of the losses under the transition pathways materialize within the first year of the simulations, which mitigates concerns that the fixed-exposure assumption introduces substantial bias into our results. Nevertheless, relaxing this assumption in future work—by incorporating behavioural responses or capital feedback effects—would provide a more comprehensive view of banks’ resilience under transition risk scenarios.

Starting from the observed firm-level PDs from the credit registry, we apply sectoral PD adjustments based on the climate transition pathways outlined in the NGFS scenarios, allowing us to incorporate scenario-specific changes in credit risk across sectors. Equation 1 defines the expected bank loss (also known as loan-loss provision) for bank  $b$  under scenario  $s$  at time  $t$ , denoted as  $EL_{bst}$ . This measure is computed as the sum of expected losses across all economic sectors  $k$  at time  $t$ . The components of the expected loss include the probability of default ( $PD_{kst}$ ), which captures the likelihood of default for exposures in sector  $k$  under scenario  $s$  at time  $t$ ; the loss given default ( $LGD_{kst}$ ), representing the proportion of exposure that is expected to be irrecoverable in the event of default, and the exposure at default ( $EAD_{bkt}$ ), which quantifies the value at risk at the time of default. PD projections are taken from the NGFS climate scenarios. LGD parameters are based on domestic regulatory provisions and are presented in tables 2 and 3. EAD is defined as loans plus contingent debt minus financial or real guarantees. Figures for EAD are obtained from the credit registry dataset and, as discussed above, are assumed to be constant within the stress test horizon.

$$EL_{bst} = \sum_k PD_{kst} \times LGD_{kst} \times EAD_{bk} \quad (1)$$

The approach we define above closely resembles that of Gross *et al.* (2025), who conduct a climate stress test for the German banking industry. While they also rely on NGFS scenarios, their study is based on an earlier version that did not include PD pathways, requiring them to estimate these values independently. In contrast, our analysis utilizes the updated NGFS short-term scenarios, which provide explicit PD forecasts, allowing for a more direct integration into our credit risk framework.

### 3.2 Firm-Level Allocation of Sectoral Climate Risk Shocks

As previously described, the NGFS short-term scenarios are available at the industry level and our dataset is organized at loan level; in order to maintain the granularity of our dataset, we considered two alternative approaches to increase sector-level PDs. The first approach, which we did not take, is an even lump-sum increase to all firms in a given industry that matches the NGFS scenario period by period, this basically translates to assuming that the transition risk is common across all firms in a given sector and that no mitigation policies were put in place by different units within an industry. We consider this assumption to be

too limiting and that it would not permit exploiting the heterogeneity among local firms, between and within sectors.

The second approach relaxes this uniform assumption by randomly assigning the shock to certain firms within an industry using bootstrap as in Efron and Tibshirani (1994). This can be understood as a situation where the shock is not necessarily homogeneous and/or that firms have some degree of action for precautionary mitigation of potential shocks (e.g. through technology shifts through investment for adaptation or insurance). In this approach, we randomly select firms within industries and increase their probability of default in an amount that matches the sectoral PD adjustment under the risk scenario period by period. We adopted this approach for subsamples of 30 thousand observations each period within the simulation horizon, matched with one thousand replications of random sampling with replacement. We report the fifth and 95th percentiles as confidence intervals around our results.

## 4 Results

To identify the subset of industries affected by climate transition scenarios we rely on firm-level probabilities of default (PDs), derived from the NGFS short-term scenarios, that we map onto a loan-level credit risk dataset. Within this subset of firms, we can identify four main groups, namely those highly affected by transition risks, moderately affected, not significantly affected, and those benefitting from the transition pathway. Table 4 illustrates the industries classified into four distinct groups, along with the projected change in their probability of default by 2030 under the orderly transition scenario (HW2P). The first group is comprised of firms in industries linked to fossil fuels such as oil and coal where PDs increase sharply (i.e. over the 75th percentile of PD change) since they are directly exposed to carbon pricing and regulatory shifts, and are less able to adapt quickly to a low-carbon economy. The second group includes those indirectly affected, these firms are usually placed downstream in the supply chain with respect to those directly affected and show less prominent PD increases under the transition scenarios (with PD changes between the median and the 75th percentile). Those not significantly affected show little to no changes in their PDs due to their industries being less connected to the previous two. Finally, those who benefit from the transition are in green industries and experience a negative adjustment to their PDs. Figure 2 shows the evolution of sector-level PDs from 2022 to 2030 for the case of South America under alternative climate transition scenarios based on NGFS projections.

### 4.1 Historical Trends

Over the past decade, Chilean banks have steadily reduced their exposure to sectors that are likely to be adversely affected by a transition toward a low-carbon economy. Figure 3 shows that in 2011, approximately 73% of commercial loans were linked to industries with high or moderate exposure to transition risks, including high CO<sub>2</sub> emitters and their upstream/downstream counterparts. By 2025, this figure has declined to around 60%, most of this reduction concentrated among industries with moderate exposure to transition risks, i.e. those that are located downstream from fossil fuel production.

The exposure to industries highly affected by transition risk (e.g., coal and oil) has

remained relatively stable over time, consistently accounting for around 7% of commercial loans. This relatively low figure reflects the productive structure of the Chilean economy, where oil extraction and refinement have a low participation and domestic coal production is negligible, in line with announced plans to phase out coal-fired power plants by 2040, with several plants already retired.

Overall, the banking sector reduced its exposure to highly and moderately affected industries in about 12 percentage points (pp) between 2011 and 2025. This is an equilibrium outcome, led by both supply and demand drivers, we do not make claims about the relative role of these forces, instead we see this change in exposure as a stylized fact that will shape the effect the transition pathways will have on the banks' balance sheets. There is also considerable heterogeneity among banks in this aggregate trend. Figure 4 shows that some banks have barely reduced their exposure, while others have decreased loans to these industries by more than 20 percentage points, with a few reducing it to more than twice the system's average. This dispersion may result from various factors, such as business models, risk aversion, and differences in initial portfolios, among others. In sum, the observed shift in banks' exposure to affected industries likely reflects a combination of both supply- and demand-side forces; however, disentangling these drivers lies beyond the scope of this paper.

These figures should be interpreted as upper bounds, given the inclusive nature of our methodology, which captures both direct and indirect exposures across the entire production network. Moreover, exposure is not synonymous with loss of value; rather, it should be understood as an approximate upper bound of direct and indirect exposures.

In parallel, loan-loss provisions associated with these more affected firms have declined even more sharply than loan exposures. Figure 5 shows that between 2011 and 2025, provisions fell by 17pp, whereas loan exposure decreased by 12pp (Figure 3). This pattern suggests a proactive adjustment by banks, potentially reflecting enhanced risk management practices, regulatory incentives, or strategic portfolio reallocation away from carbon-intensive sectors

## 4.2 Current Heterogeneity

Despite the overall decline in exposure to transition-sensitive industries across the Chilean banking sector, our analysis reveals substantial heterogeneity at the individual bank level. As shown in Figure 6, in 2025 the share of loans allocated to firms moderately affected under transition risk scenarios varies considerably, ranging from 45 to 60% of total commercial lending, while for highly affected firms this ratio ranges between 2 and 10%. This dispersion suggests that while some banks have actively rebalanced their portfolios away from carbon-intensive sectors, others continue to maintain relatively high exposure, potentially due to differences in client composition, strategic orientation, or internal assessment of transition risk.

Even greater variation is observed in the allocation of loan-loss provisions to these exposures. Figure 7 shows that, among banks in 2025, the share of provisions linked to moderately affected firms ranges from 50 to 78% of total provisions, while for highly affected sectors it spans from 1 to 18%. This wide dispersion reflects divergent perceptions of credit risk and transition vulnerability, likely stemming from differences in internal risk models, provisioning policies, or expectations regarding the pace and nature of Chile's energy transition,

These disparities are further compounded by methodological challenges encountered during the stress testing exercise. A key issue is the absence of a one-to-one correspondence

between the sectoral classification used in the NGFS scenarios and the Chilean industry taxonomy. To address this, we developed a mapping framework to align sectors across both systems; however, but this adaptation introduces uncertainty regarding how transition shocks are applied to firms.

Furthermore, determining which firms within a given industry should receive a credit rating downgrade under stressed scenarios is inherently uncertain. To address this, we employ a bootstrap sampling approach to simulate a range of plausible outcomes, following Efron and Tibshirani (1994). Nonetheless, alternative probabilistic methods, such as sampling from beta-binomial distributions, could provide additional ways to capture firm-level heterogeneity and enhance the robustness of future exercises.

### 4.3 Prospective Stress Testing

To assess future vulnerabilities, we perform a stress test exercise using the NGFS short-term climate scenarios, which simulate two distinct transition pathways: an orderly transition (Highway to Paris, HW2P) and a disorderly transition (Sudden Wake-up Call, SWUC). These scenarios incorporate general equilibrium dynamics and sectoral interdependencies, allowing us to estimate firm-level default probabilities and aggregate them into bank-level exposures. As mentioned above, we assume fixed bank exposures over the five-year horizon, consistent with NGFS short-term scenarios and prior studies (Battiston *et al.*, 2017; Roncoroni *et al.*, 2021). This assumption reflects the short-term nature of the effects we are interested in and the abrupt nature of the risk adjustment, which leads to a sharp concentration of losses within the first simulation year. Future work could relax this assumption by modeling dynamic portfolio responses.

Figure 8 shows that, for the entire banking system under the orderly transition scenario (HW2P), expected losses are projected to increase from 2.5% of total commercial loans in 2025 to around 4% of the outstanding loan portfolio by 2030, with more than half of this effect taking place during the first year. This projected loss by the end of the horizon is comparable in magnitude to the losses experienced during the COVID-19 pandemic. To further contextualize these figures in terms of the size of the economy, the amount of expected losses under this scenario ranges around 2% of 2024 Chile’s GDP. In addition, to provide robustness to our results, we replicate the exercise for the Chilean banking industry, applying the stress scenarios originally developed for Argentina and Mexico. Figure A.2 in the appendix shows that while the results are broadly similar across countries, the Argentine scenario leads to a substantially larger increase in bank losses, thereby establishing an upper bound for our estimations.

Under the HW2P pathway, the deterioration of the stressed portfolio results in a marked shift in perceived credit risk. Figure 9 shows that categories A1 through A4, which account for about half of the portfolio in 2025, decline to less than 20% by 2030. This occurs as categories A5 and A6, along with B and C, gain prominence, together representing over 80% of the commercial portfolio by the end of the simulation horizon.

Under the disorderly transition scenario (SWUC), expected losses are projected to rise significantly, and much more rapidly, compared to the orderly transition scenario (HW2P). As shown in Figure 8, expected losses for the banking industry reach approximately 4.6% of the outstanding loan portfolio by 2030, most of this effect taking place during the first year of the simulation. These projected losses are statistically different from those estimated

under the HW2P scenario. The SWUC pathway implies relatively higher provisioning needs, comparable to those seen during the Global Financial Crisis, as green industries would lack sufficient time to scale and absorb redirected capital flows. Consequently, under this disorderly transition scenario, banks would face elevated credit risk without the opportunity to adjust their portfolios in time. Comparatively, the amount of expected losses under this disorderly pathway would range close to 2.3% of 2024 Chile’s GDP. In terms of risk shifting, Figure 10 depicts that the reduction of safer categories is even more prominent, as groups A1 to A4 nearly disappear from the portfolio, while over 30% of commercial loans concentrate in riskier categories such as B and C.

At the bank level, there is substantial heterogeneity in stressed expected losses, reflecting the differences in exposure and the distribution of risk in within individual portfolios. Figure 11 illustrates that, under the orderly scenario, a larger number of banks experience loss increases that are smaller than the system-wide outcome, represented by the cross mark. These banks typically exhibit initial low exposure to affected sectors and their loan portfolios are skewed toward better credit ratings. In contrast, a few banks face substantially worse outcomes than the system, showing increase in losses more than 60% higher than the average. For the Sudden Wake-up Call pathway, the dispersion of results among banks is even greater. While for most of the banks their losses remain below the system, a number of them experience considerable losses by 2030, more than doubling those seen for the orderly scenario. The ample heterogeneity and economic significance of the losses results emphasize the relevance of the transition risks for the local banks.

## 5 Policy recommendations

Our results from the previous sections suggest that, although system-wide exposure to transition-sensitive sectors has declined over the past decade, vulnerabilities remain significant. The evidence we present has direct implications for banks’ capital positions, given that provisions reduce retained earnings and, consequently, Common Equity Tier 1 (CET1) capital (Acharya *et al.*, 2023; European Systemic Risk Board, 2016). Under the HW2P scenario, the increase of losses to levels comparable to those observed during the COVID-19 pandemic suggests a material erosion of capital headroom, potentially bringing some institutions closer to their minimum regulatory thresholds. This effect is amplified under the SWUC scenario, where provisioning needs are substantially higher, reflecting the abrupt and disorderly nature of the transition. In such a setting, banks with initially thin capital buffers could face binding constraints on their ability to absorb losses without breaching prudential requirements or severely retrenching in terms of loans, as highlighted in similar stress-testing exercises for other jurisdictions (Bebczuk *et al.*, 2025; Gross *et al.*, 2025). Moreover, the interaction between increased credit risk and capital requirements under Basel III implies that risk-weighted assets would rise in tandem with deteriorating credit quality, further pressuring capital ratios. These dynamics underscore the importance of forward-looking capital planning and the potential role of countercyclical and systemic risk buffers to mitigate procyclical effects (Bank of England, 2021; European Central Bank, 2022).

Overall, our findings suggest that climate transition shocks could not only elevate provisioning needs but also constrain lending capacity through their impact on regulatory capital, reinforcing the case for integrating climate risk into supervisory stress-testing frameworks

and capital adequacy assessments.

The observed heterogeneity in exposure and provisioning suggests that some institutions may be more vulnerable than others, raising concerns about systemic risk and the potential for uneven credit supply disruptions. Moreover, the stress testing results highlight the need for regulatory guidance and scenario-based planning to ensure that the financial system remains resilient under different transition pathways.

Our analysis contributes to the growing literature on climate-related financial risks by providing a detailed, data-driven assessment of transition risk exposure in an emerging market context. The use of granular administrative data and forward-looking scenarios enables a more precise evaluation of vulnerabilities, offering valuable insights for policymakers, regulators, and financial institutions seeking to navigate the challenges of a low-carbon transition.

## 6 Conclusions

This paper presents the first climate transition risk stress test for the Chilean banking sector using general equilibrium-consistent scenarios, marking a significant step in aligning local financial stability analysis with global best practices. We are also among the first to apply the recently released NGFS short-term climate scenarios, which provide a forward-looking and internally consistent framework for assessing transition risks. A key strength of this study is the use of a unique loan-level dataset covering the entire Chilean banking industry, enabling a granular evaluation of exposures and credit risk dynamics that aggregate data cannot capture.

Our analysis shows that, while system-wide exposure to transition-sensitive sectors has declined in the past decade, vulnerabilities remain significant. Stress test simulations indicate that under a disorderly transition scenario, loan-loss provisions could nearly double relative to current levels, with the upper tail of the estimates approaching losses observed during the Global Financial Crisis. The bootstrap-based framework confirms the statistical significance of these results and reveals striking heterogeneity across banks, strongly conditional on initial portfolio composition and credit quality. These findings underscore that transition risk is both systemic and highly idiosyncratic.

Our analysis faces some limitations. First, Chile is not individually represented in NGFS scenarios, requiring us to rely on regional proxies and complementary assumptions. Second, while our dataset is highly granular, it does not capture dynamic portfolio adjustments or second-round macro-financial effects. These constraints suggest that future exercises should incorporate Chile-specific scenarios, enhanced sectoral mapping, and models that allow for adaptive bank behavior.

Key challenges included aligning domestic sector classifications with NGFS categories and modeling firm-level heterogeneity under stress. Resampling mitigated some of these issues, but further methodological refinements—such as alternative probabilistic sampling or dynamic credit flow modeling—could improve robustness. The recent availability of NGFS short-term scenarios and growing access to granular supervisory data create opportunities to deepen this line of research.

These findings are relevant for financial stability purposes. The results highlight the importance of integrating climate-related risks into supervisory stress testing, capital planning, and macroprudential frameworks. Strengthening data infrastructure, refining scenario

design, and enhancing disclosure requirements will be critical steps to ensure the resilience of the Chilean financial system in the face of a low-carbon transition.

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Table 1: Industry code correspondence

ISIC 2-digit	Description (ISIC)	NGFS sectors
01	Crop and animal production, hunting and related service activities	Agriculture
02	Forestry and logging	Biomass Solid
03	Fishing and aquaculture	Agriculture
04	Mining of copper ores	Non-ferrous metals
05	Mining of coal and lignite	Coal
06	Extraction of crude petroleum and natural gas	Crude Oil
07	Mining of metal ores	Non-ferrous metals
08	Other mining and quarrying	Non-ferrous metals
09	Mining support service activities	Non-ferrous metals
10	Manufacture of food products	Consumer Goods Industries
11	Manufacture of beverages	Consumer Goods Industries
12	Manufacture of tobacco products	Consumer Goods Industries
13	Manufacture of textiles	Consumer Goods Industries
14	Manufacture of wearing apparel	Consumer Goods Industries
15	Manufacture of leather and related products	Consumer Goods Industries
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Consumer Goods Industries
17	Manufacture of paper and paper products	Paper products, publishing
18	Printing and reproduction of recorded media	Paper products, publishing
19	Manufacture of coke and refined petroleum products	Oil
20	Manufacture of chemicals and chemical products	Chemical Products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Basic pharmaceutical products
22	Manufacture of rubber and plastics products	Rubber and plastic products
23	Manufacture of other non-metallic mineral products	Non-metallic minerals
24	Manufacture of basic metals	Fabricated metal products
25	Manufacture of fabricated metal products, except machinery and equipment	Fabricated Metal products
26	Manufacture of computer, electronic and optical products	Computer, electronic and optical products
27	Manufacture of electrical equipment	Advanced Electric Appliances
28	Manufacture of machinery and equipment n.e.c.	Other Equipment Goods
29	Manufacture of motor vehicles, trailers and semi-trailers	Transport equipment (excluding EV)
30	Manufacture of other transport equipment	Transport equipment (excluding EV)
31	Manufacture of furniture	Other Equipment Goods
32	Other manufacturing	Other Equipment Goods
33	Repair and installation of machinery and equipment	Other Equipment Goods
35	Electricity, gas, steam and air conditioning supply	Power supply
36	Water collection, treatment and supply	Market Services
37	Sewerage	Market Services
38	Waste collection, treatment and disposal activities; materials recovery	Market Services
39	Remediation activities and other waste management services	Market Services
41	Construction of buildings	Construction
42	Civil engineering	Construction
43	Specialized construction activities	Construction
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	Market Services
46	Wholesale trade, except of motor vehicles and motorcycles	Market Services
47	Retail trade, except of motor vehicles and motorcycles	Market Services
49	Land transport and transport via pipelines	Land Transport
50	Water transport	Water transport
51	Air transport	Air transport
52	Warehousing and support activities for transportation	Warehousing and support activities
53	Postal and courier activities	Market services
55	Accommodation	Market Services
56	Food and beverage service activities	Market Services
58	Publishing activities	Market Services
59	Motion picture, video and television programme production, sound recording and music publishing activities	Market Services
60	Programming and broadcasting activities	Market Services
61	Telecommunications	Market Services
62	Computer programming, consultancy and related activities	Market Services
63	Information service activities	Market Services
64	Financial service activities, except insurance and pension funding	Market Services
65	Insurance, reinsurance and pension funding, except compulsory social security	Market Services
66	Activities auxiliary to financial service and insurance activities	Market Services
68	Real estate activities	Construction
69	Legal and accounting activities	Market Services
70	Activities of head offices; management consultancy activities	Market Services
71	Architectural and engineering activities; technical testing and analysis	Market Services
72	Scientific research and development	R&D
73	Advertising and market research	Market Services
74	Other professional, scientific and technical activities	Market Services
75	Veterinary activities	Market Services
77	Rental and leasing activities	Market Services
78	Employment activities	Market Services
79	Travel agency, tour operator, reservation service and related activities	Market Services
80	Security and investigation activities	Market Services
81	Services to buildings and landscape activities	Market Services
82	Office administrative, office support and other business support activities	Market Services
84	Public administration and defence; compulsory social security	Non Market Services
85	Education	Non Market Services
86	Human health activities	Non Market Services
87	Residential care activities	Non Market Services
88	Social work activities without accommodation	Non Market Services
90	Creative, arts and entertainment activities	Market Services
91	Libraries, archives, museums and other cultural activities	Market Services
92	Gambling and betting activities	Market Services
93	Sports activities and amusement and recreation activities	Market Services
94	Activities of membership organizations	Market Services
95	Repair of computers and personal and household goods	Market Services
96	Other personal service activities	Market Services
97	Activities of households as employers of domestic personnel	Market Services
99	Activities of extraterritorial organizations and bodies	Market Services

This table provides the correspondence between 2-digit ISIC industry classifications and the NGFS sectoral categories used in the analysis. The mapping follows the official alignment guidelines from NGFS (2025), ensuring consistency between domestic industry codes and the sectoral structure applied in NGFS climate transition scenarios. Source: Authors' calculation based on Central Bank of Chile, Chilean Tax Authority and United Nations (n.d.).

Table 2: Credit risk parameters by category for portfolio not in default

Rating	Probability of default (%)	Loss given default (%)
A1	0.04	90.0
A2	0.10	82.5
A3	0.25	87.5
A4	2.00	87.5
A5	4.75	90.0
A6	10.00	90.0
B1	15.00	92.5
B2	22.00	92.5
B3	33.00	97.5
B4	45.00	97.5

This table reports the credit risk classification categories used in the analysis, along with their corresponding probability of default (PD) and loss given default (LGD) parameters applied for credit risk assessment. Categories range from A1, representing the highest credit quality and lowest default risk, to B4, indicating the weakest credit quality and highest default risk. Riskier (non-performing) categories are not included in the Table since they follow a different set of parameters. Source: Financial Market Commission (CMF).

Table 3: Credit risk parameters by category for portfolio in default

Rating	Expected Loss (%)	Provision (%)
C1	Up to 3	2
C2	3 to 20	10
C3	20 to 30	25
C4	30 to 50	40
C5	50 to 80	65
C6	More than 80	90

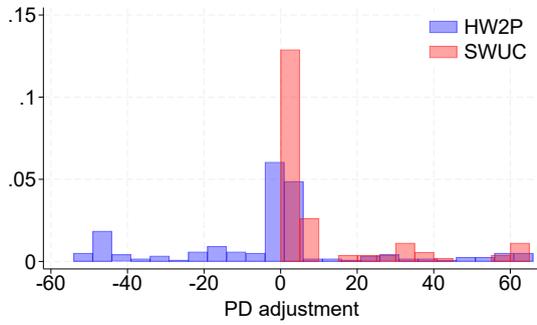
This table presents the credit risk classification categories for defaulted portfolios, along with their corresponding expected loss ranges ( $PD \times LGD$ ) and provisioning percentages applied under the standard methodology for credit risk assessment. Categories range from C1, representing the lowest expected loss, to C6, indicating the highest expected loss and provisioning requirement. These parameters are applied to non-performing exposures as defined by regulatory standards. Source: Financial Market Commission (CMF).

Table 4: Sectoral categories as a function of the PD changes under the HW2P scenario

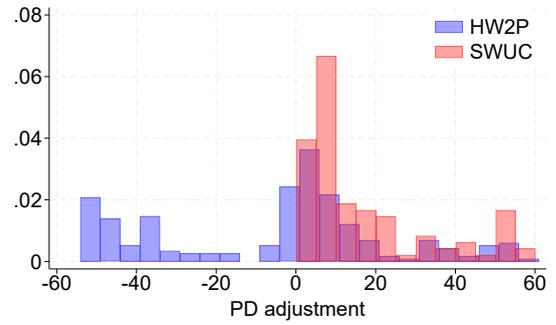
Sensitivity	Economic sector	PD change
High	Coal	64.6
	Oil	36.3
	Crude oil	31.0
	Transport equipment (excluding EV)	6.4
	Chemical products	4.8
	Agriculture	4.6
	Water transport	4.5
Moderate	Air transport	4.0
	Warehousing	3.5
	Land transport	3.2
	Consumer goods industries	2.5
	Market services	2.1
	Rubber and plastic products	1.8
Not significant	Basic pharmaceutical products	1.0
	Non-ferrous metals	0.9
	Paper products, publishing	0.7
	Non-market services	0.6
	Fabricated Metal products	0.6
	Non-metallic minerals	0.2
	Advanced electric appliances	0.0
	Computer, electronic and optical products	0.0
Benefited	Other equipment goods	-0.8
	Construction	-1.1
	Biomass solid	-3.4
	Power supply	-19.3
	R&D	-23.1

This table lists the economic sectors included in the analysis and reports their projected changes in probabilities of default (PD) by 2030 under the Highway to Paris (orderly transition) scenario, relative to the baseline. It also indicates the classification of each sector into groups based on their degree of sensitivity to transition risk, defined using percentiles of PD changes from the simulation. These groupings—high, moderate, not significant, and benefiting—provide a structured view of how transition shocks are expected to affect credit risk across different industries. Source: Authors’ calculation based on NGFS scenarios.

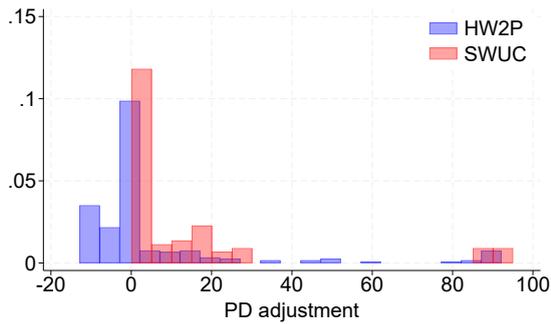
Figure 1: Adjustment to probabilities of default by region and scenario



(a) South America



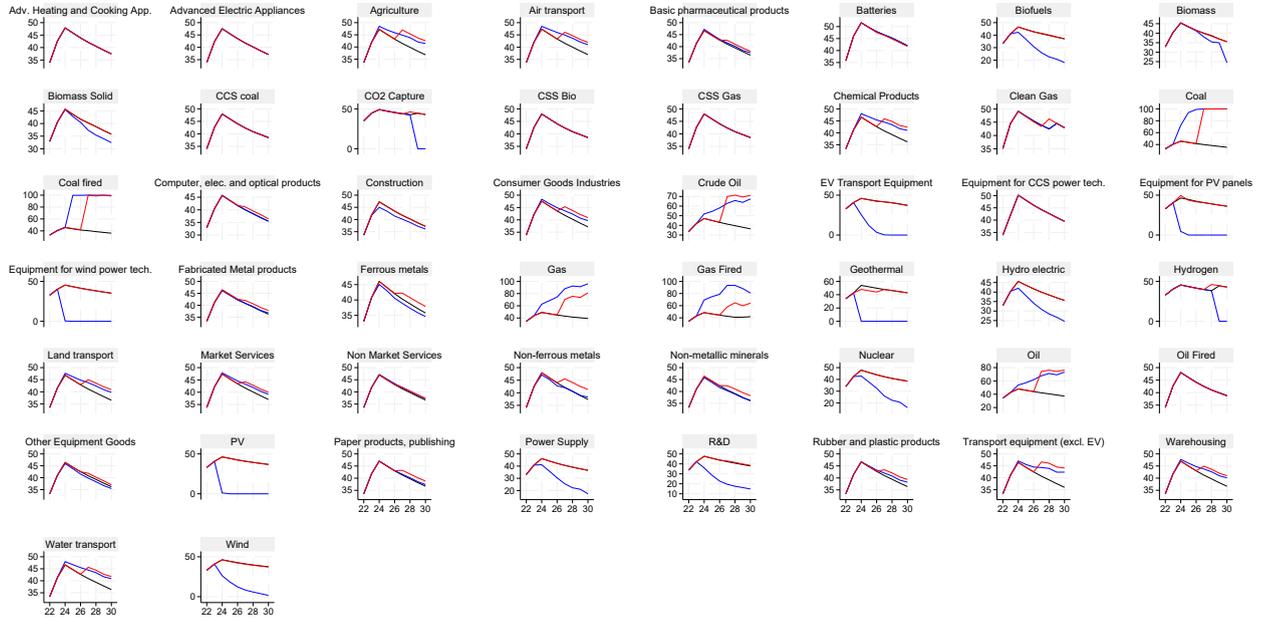
(b) Argentina



(c) Mexico

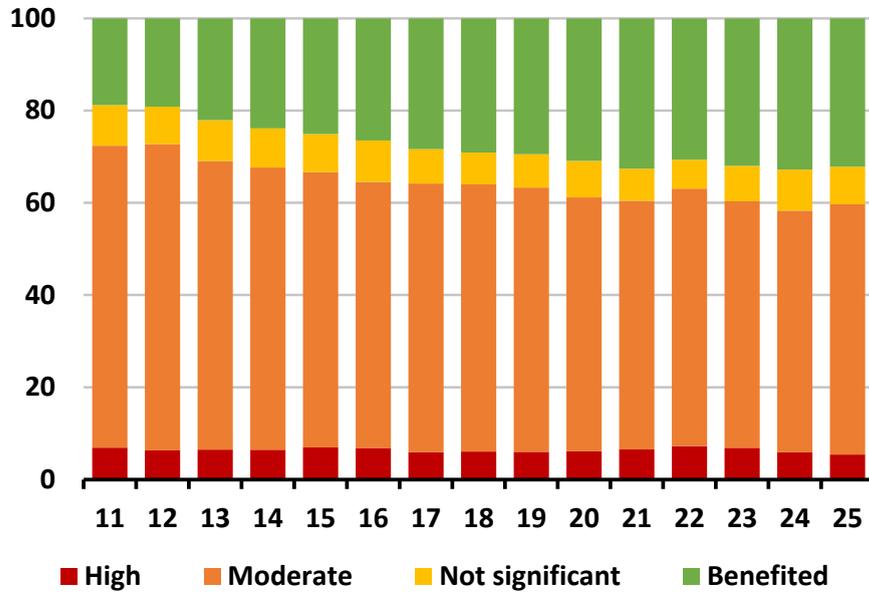
This figure displays a histogram of changes in probabilities of default (PD) across all sectors for the period 2025–2030, relative to the baseline scenario. PD adjustments are expressed as changes in percentage points. Blue bars correspond to the Highway to Paris (orderly transition) scenario, while red bars represent the Sudden Wake-Up Call (disorderly transition) scenario. For clarity, sectors with zero PD adjustment have been excluded. The distribution highlights the broader and more severe PD increases under the disorderly scenario, reflecting the heightened credit risk associated with abrupt policy shifts. Source: NGFS.

Figure 2: Probability of default forecasts by sector and scenario, South America



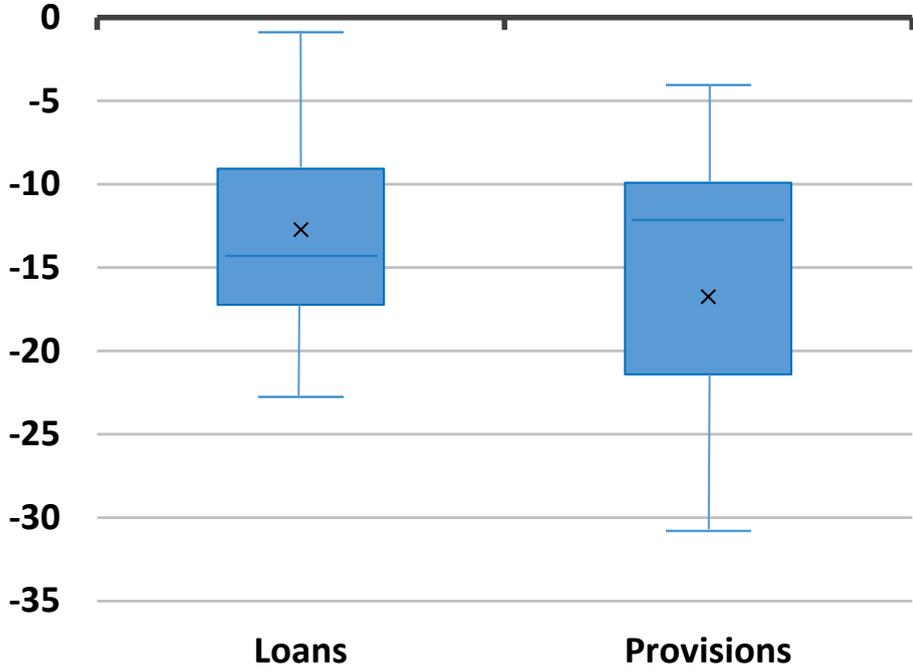
This figure illustrates the evolution of sector-level probabilities of default (PD) from 2022 to 2030 under alternative climate transition scenarios based on NGFS projections. The black line represents the baseline scenario, while the blue and red lines correspond to the Highway to Paris (orderly transition) and Sudden Wake-Up Call (disorderly transition) scenarios, respectively. The chart highlights how PD trajectories diverge across scenarios, with the disorderly transition producing sharper and more widespread increases in credit risk compared to the orderly pathway. Source: Authors' calculation based on NGFS scenarios.

Figure 3: Commercial loans by groups of firms



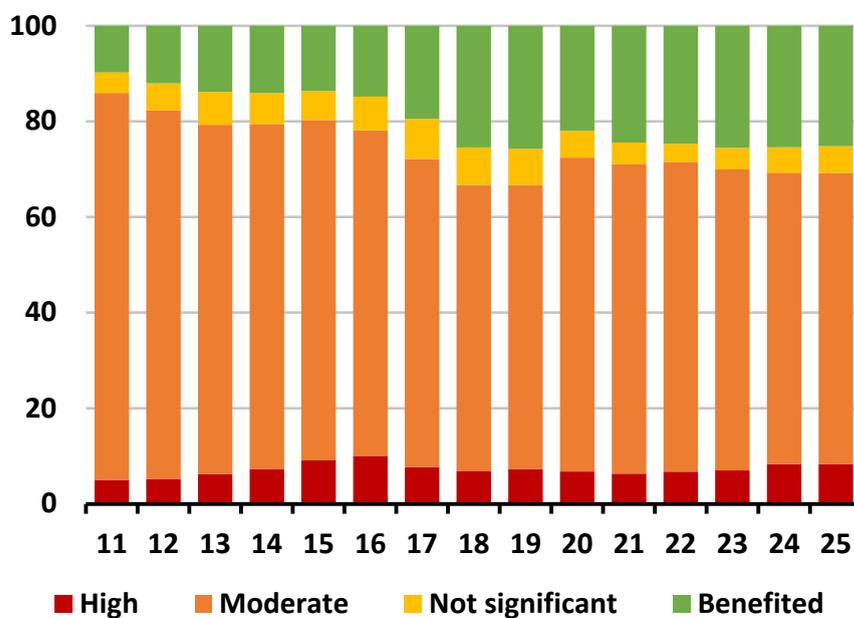
This figure illustrates the distribution of commercial loans, from 2011 to 2025, across firm groups classified by their degree of sensitivity to transition risks, as defined in Table 4. The chart shows how credit is allocated among firms highly affected, moderately affected, unaffected, or benefiting from the transition, providing insight into the composition of banks' loan portfolios under different transition risk categories. Source: Authors' calculation based on Central Bank of Chile.

Figure 4: Distribution of changes in commercial loan exposure and loan loss provisions to affected sector between 2011 and 2025, percentage points



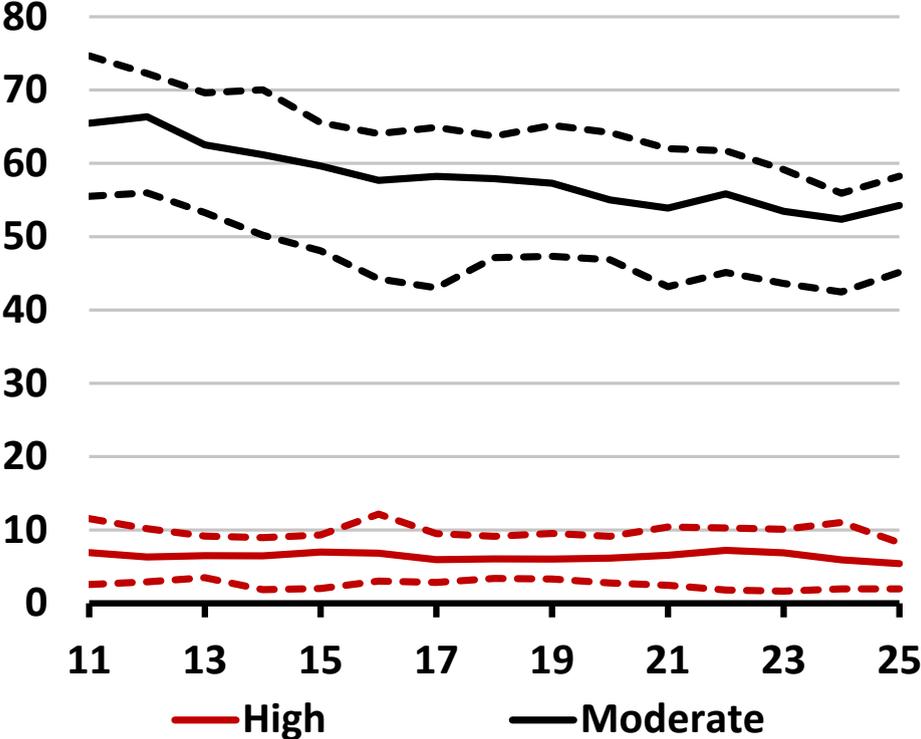
This figure illustrates the change in each bank’s exposure and loan loss provisions to sectors classified as highly or moderately affected by the transition to a low-carbon economy, expressed as percentage points of total commercial loans between 2011 and 2025. Each box shows percentiles 25 and 75 of the change distribution, the cross corresponds to the entire system, the horizontal line within the box is the median, and the whiskers show percentiles 5 and 95. The chart highlights the heterogeneity across institutions, with some banks maintaining their exposure and others reducing it by more than twice the system average. Source: Authors’ calculation based on Central Bank of Chile.

Figure 5: Loan Loss Provisions by groups of firms



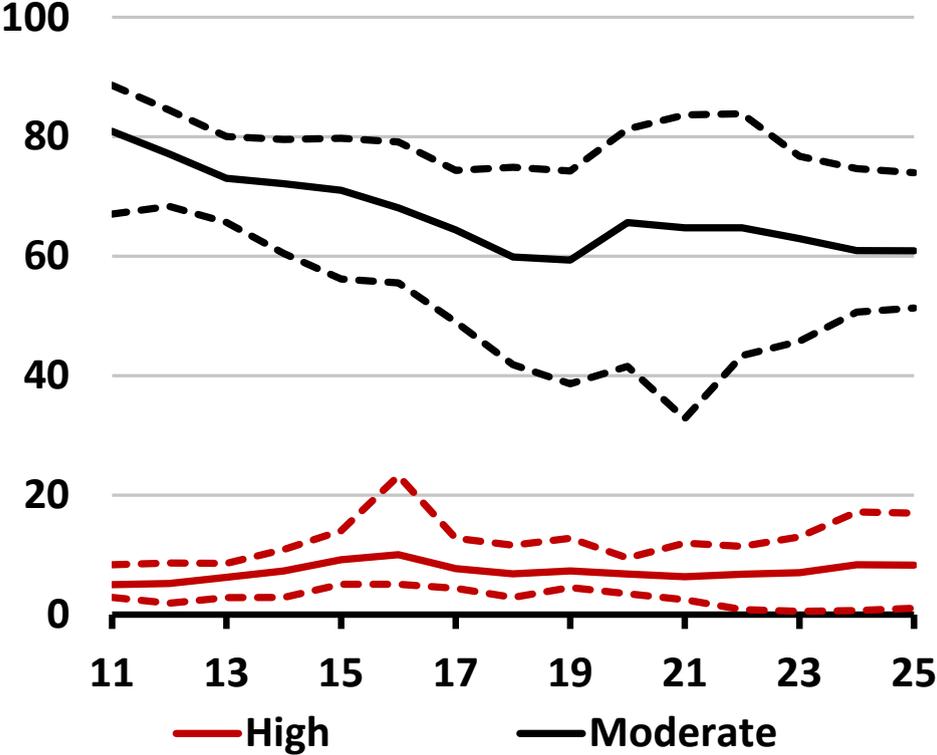
This figure illustrates the distribution, from 2011 to 2025, of effective loan-loss provisions associated with loans granted to firms grouped by their degree of sensitivity to transition risks, as defined in Table 4. The chart highlights how provisioning is concentrated among firms classified as highly or moderately affected by the transition, providing insight into the risk allocation within banks' portfolios and the potential vulnerability of specific sectors under climate transition scenarios. Source: Authors' calculation based on Central Bank of Chile.

Figure 6: Commercial loans to affected sectors by groups of firms over total commercial loans of each bank, percentage



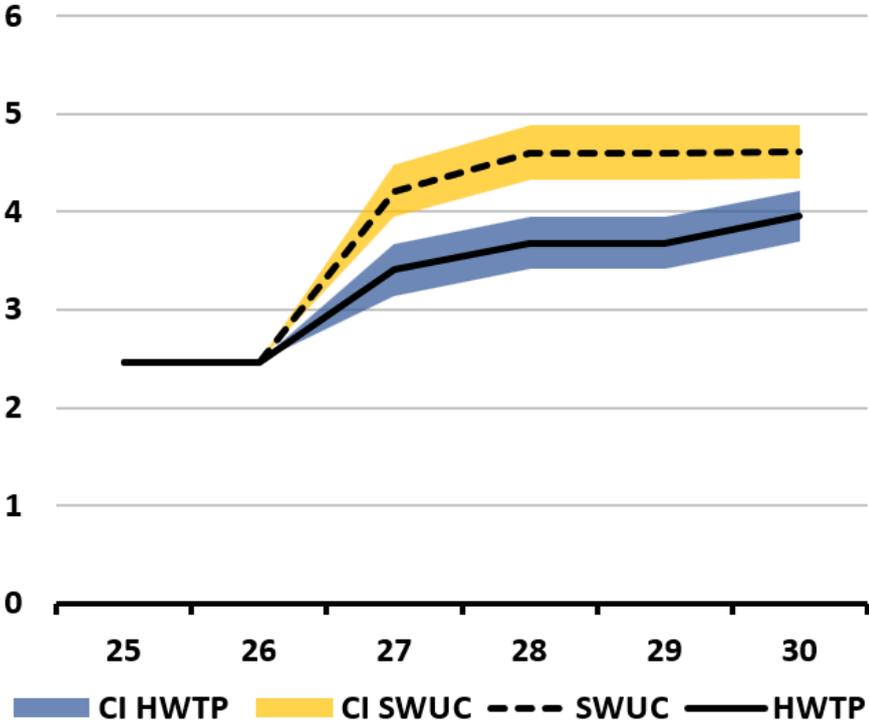
This figure illustrates the evolution of banks’ exposures to sectors most affected by the low-carbon transition for groups defined in Table 4, expressed as a share of each bank’s total commercial loan portfolio since 2011. The solid black line represents the system-wide average for sectors with a moderate transition risk, while the dashed lines indicate the minimum and maximum values across institutions. Red lines depict the corresponding metrics for sectors with high transition risk. The chart highlights a general decline in these exposures over time, alongside notable heterogeneity in banks’ adjustment strategies. Source: Authors’ calculation based on Central Bank of Chile.

Figure 7: Loan loss provisions for affected sectors by groups of firms over loan loss provisions of each bank, percentage



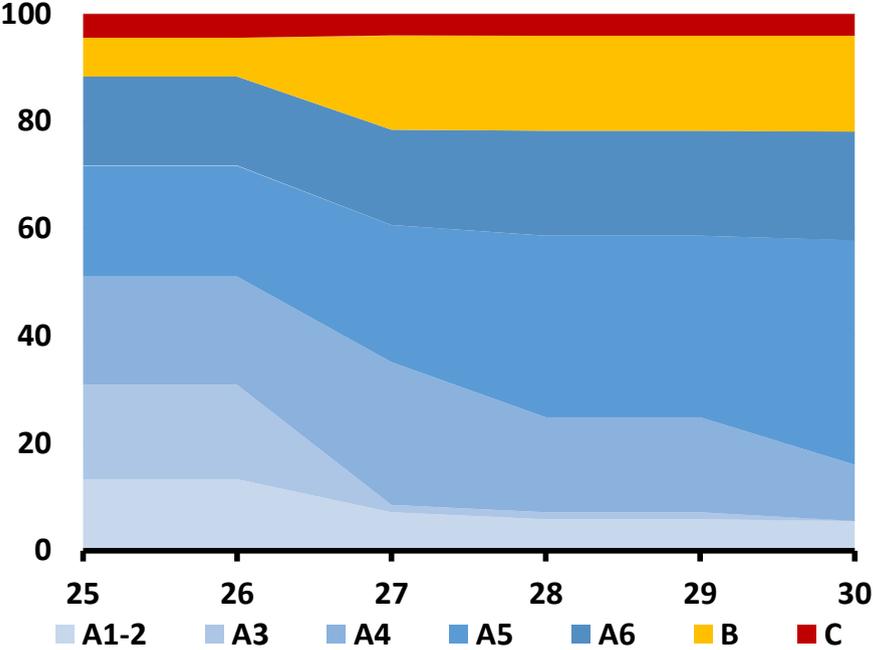
This figure depicts the evolution of banks’ loan loss provisions for sectors most exposed to the low-carbon transition for groups defined in 4, expressed as a percentage of each bank’s total commercial loan portfolio since 2011. The solid black line shows the system-wide average for sectors with moderate transition risk, while dashed lines indicate the minimum and maximum values across institutions. Red lines represent the corresponding metrics for sectors with high transition risk. The chart underscores a gradual decrease in provisions over time with some heterogeneity, reflecting different provisioning strategies among banks. Source: Authors’ calculation based on Central Bank of Chile.

Figure 8: Expected Losses over total commercial loans for the South America scenario, percentage of commercial loans



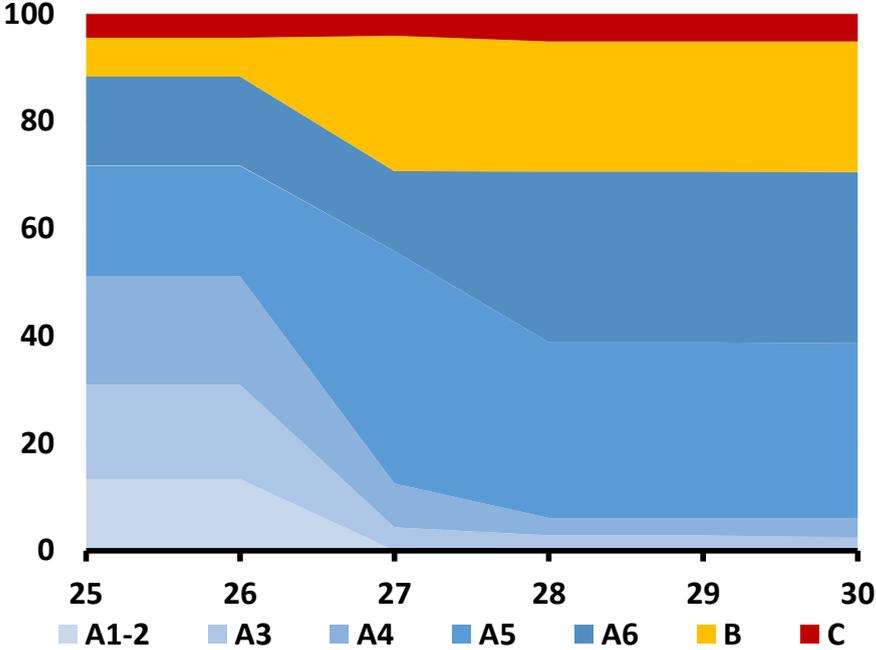
This figure depicts the projected expected losses for the Chilean banking system under the Highway to Paris (orderly) and Sudden Wake-Up Call (disorderly) transition scenarios, expressed as a percentage of total commercial loans for the period 2025–2030. The solid line represents the system-wide average under the HW2P scenario, while the upper dashed line corresponds to the SWUC scenario. Shaded areas indicate the 5th–95th percentile confidence intervals derived from the bootstrap procedure, highlighting the uncertainty and potential dispersion of outcomes. The results show that losses under the disorderly transition are consistently higher and exhibit greater variability, underscoring the systemic and idiosyncratic risks associated with abrupt policy shifts. Source: Authors’ calculation based on Central Bank of Chile.

Figure 9: Loans by risk category for the South America HW2P scenario for all banks, percentage of commercial loans



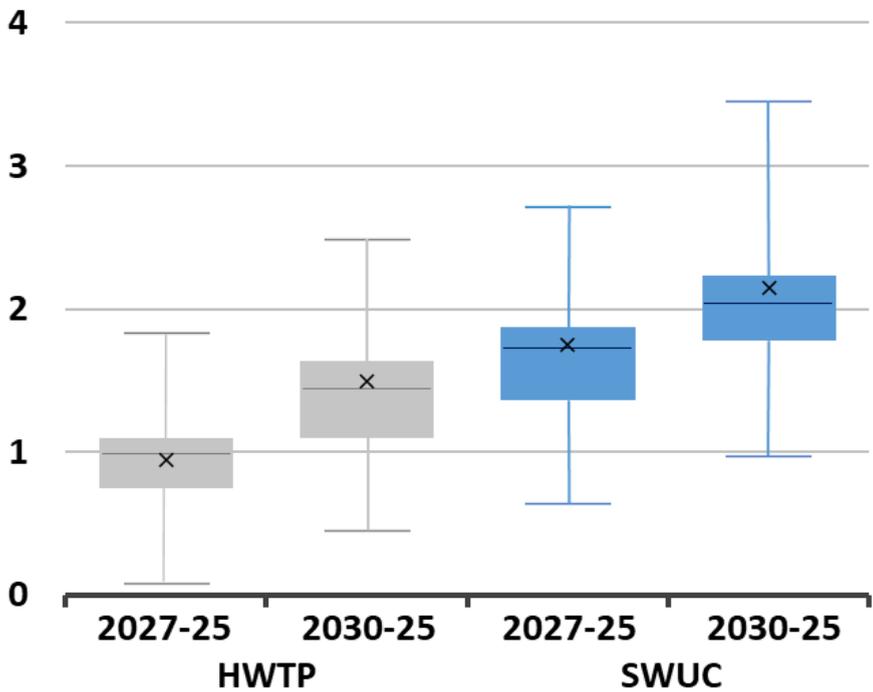
This figure illustrates the evolution of the distribution of commercial loans across credit rating categories from 2025 to 2030 under the Highway to Paris (orderly transition) scenario. The chart highlights how the share of high-quality ratings (A1–A4) declines over time, while riskier categories (A5, A6, and B–C) gain prominence, reflecting the deterioration in credit quality as transition risks materialize. Source: Authors’ calculation based on Central Bank of Chile.

Figure 10: Loans by risk category for the South America SWUC scenario for all banks, percentage of commercial loans



This figure illustrates the evolution of the distribution of commercial loans across credit rating categories from 2025 to 2030 under the Sudden Wake-Up Call (disorderly transition) scenario. The chart shows a pronounced deterioration in credit quality: high-grade categories (A1–A4) shrink dramatically, while riskier segments (A5, A6, and B–C) expand substantially. This shift reflects the abrupt and disruptive nature of the transition, which amplifies credit risk across most sectors. Source: Authors’ calculation based on Central Bank of Chile.

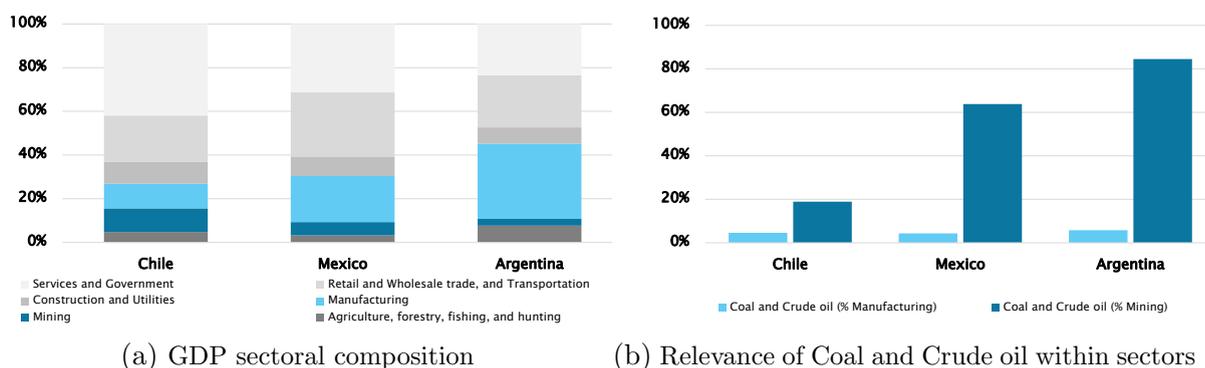
Figure 11: Distribution of changes between 2025-2030 in Expected Losses over commercial loans for the South America scenario, change of ratio per bank



This figure illustrates the simulated change in expected losses (EL) for individual banks between 2025 and 2027 and also between 2025 and 2030 under the Highway to Paris (orderly) and Sudden Wake-Up Call (disorderly) transition scenarios. The boxes show percentiles 25 and 75, the cross corresponds to the average effect over the whole system, the horizontal line within the box is the median, and the whiskers depict percentiles 5 and 95 of EL change. Results show that the effects on losses are highly concentrated within the first year of the simulation (2026 through 2027), especially for the disorderly scenario where PD increase is more abrupt. It is also clear that while some banks experience relatively moderate increases, others face losses significantly above the system average, reflecting differences in initial portfolio composition and exposure to transition-sensitive sectors. Source: Authors' calculation based on Central Bank of Chile.

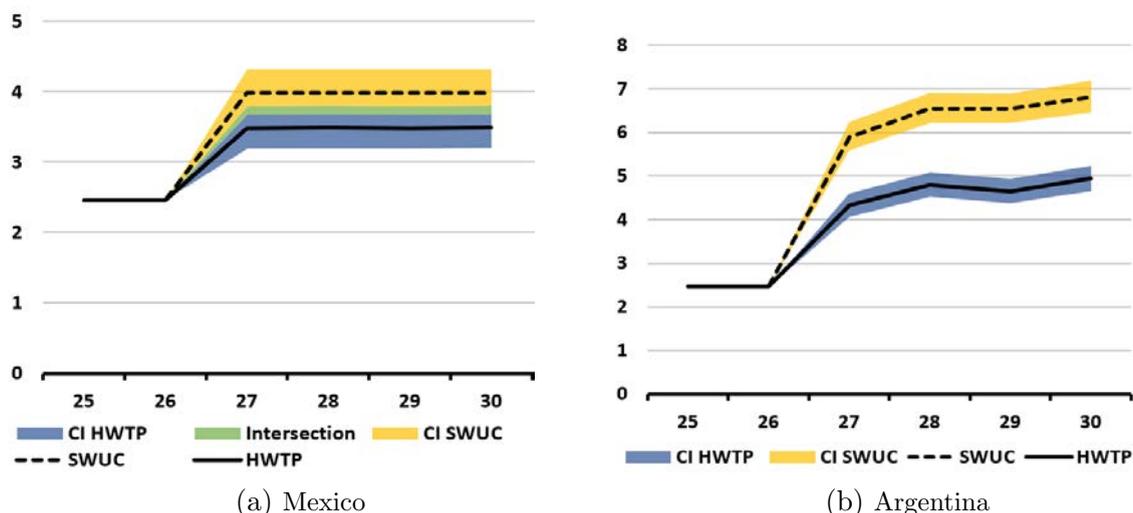
# Appendix

Figure A.1: Breakdown of sectoral production



Panel (a) of the figure presents the sectoral composition of GDP for Chile, Mexico, and Argentina in 2024, expressed as a percentage of each country’s total GDP. Panel (b) illustrates the relative importance of coal and crude oil production within two sectors, manufacturing (light blue) and mining (dark blue), for the same countries. Source: Authors’ calculation based on Central Bank of Chile, Central Bank of Argentina, and Central Bank of Mexico.

Figure A.2: expected losses for others scenarios, percentage of commercial loans



This figure presents the projected expected losses for the Chilean banking system under the Highway to Paris (orderly) and Sudden Wake-Up Call (disorderly) transition scenarios, expressed as a percentage of total commercial loans for the period 2025–2030. Panel (a) reports results using the scenario calibrated to Mexico’s productive structure, while Panel (b) uses the scenario calibrated to Argentina’s structure. In each panel, the solid line represents the system-wide average under HW2P, and the upper dashed line corresponds to SWUC. Shaded areas denote the 5th–95th percentile confidence intervals derived from the bootstrap procedure, highlighting the uncertainty and dispersion of outcomes. The results show that losses under the disorderly transition are consistently higher and more volatile, underscoring the sensitivity of stress test outcomes to both scenario assumptions and structural differences across economies. Source: Authors’ calculation based on Central Bank of Chile.

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