Transition Risks Assessment of Latin American Financial Institutions and the use of Scenario Analysis

2° Investing Initiative

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

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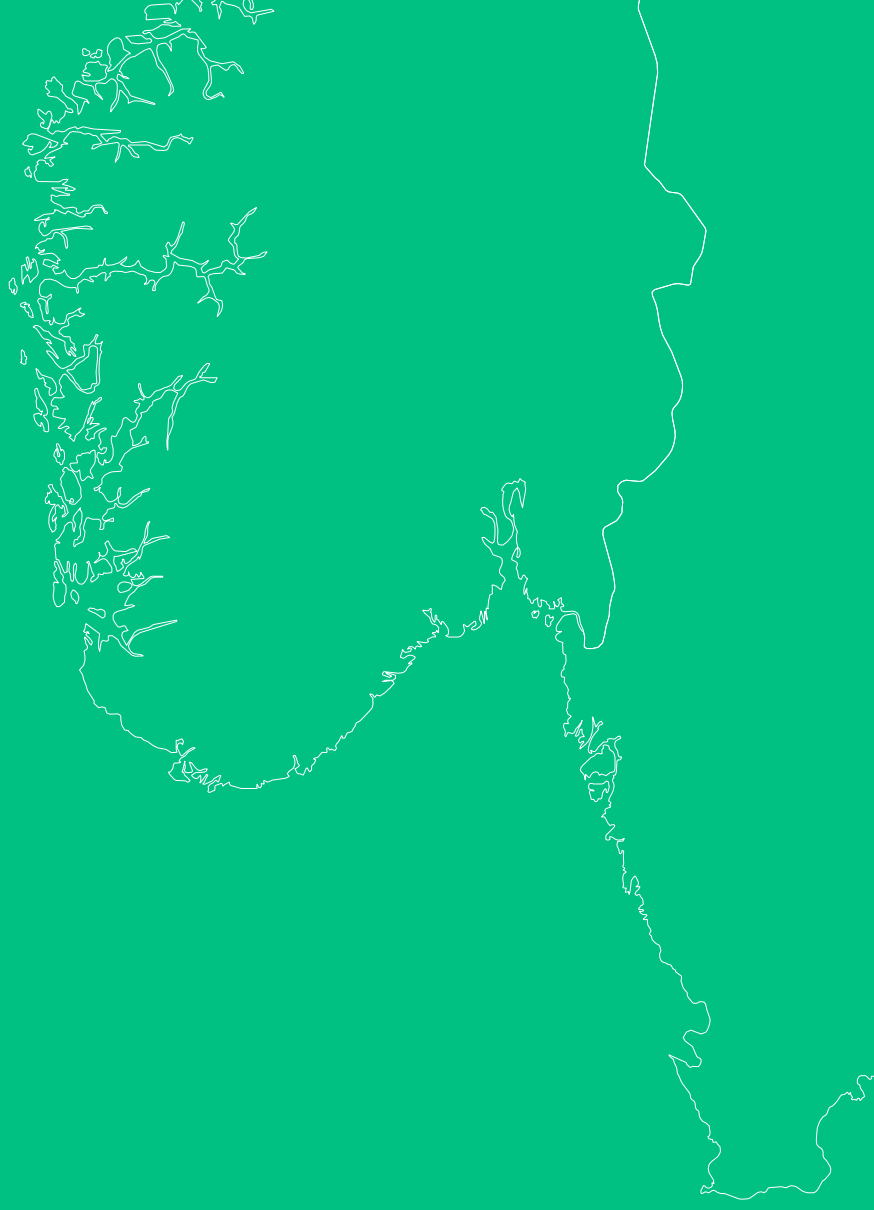

22.05.2020

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Disclaimer:

The views expressed in this report are the sole responsibility of the authors and do not necessarily reflect the views of the sponsor.

Funding:

This Project has received funding from the Inter-American Development bank and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany.

Acknowledgements:

We thank: Gabriel Acuña – **Financial Markets Comission Chile (CMF Chile)**, Mabyr Valderrama Villabona **- Federation of Colombian Insurers (FASECOLDA)** , Robert Edward Woodcock **- FASECOLDA**, Andrés Leonardo Jimenez **- FASECOLDA**, Jiae Kim, Victoria Nuguer, Gianleo Frisari, Matias Gallardo, Bridget Hoffmann**– Inter American Development Bank (IADB)** ; Carlota Garcia-Manas **- Royal London Asset Management**, Mariana Escobar **– Financial Superintendence of Colombia (SFC)** and Eduardo Atehortua **– United Nations Principles for Responsible Investment (UNPRI)** for their useful feedback on the report.

Executive Summary

Latin America is one of the most vulnerable regions to climate change. It is exposed to physical risks, which relate to changes in climate patterns and the increase in the occurrence and severity of extreme weather events, as well as transition risks, which relate to changes in policies, technologies and market prices that will materialize in the shift towards a low carbon economy. The exposure to transition risks of Latin American economies has been much less explored compared to physical risks. This is due, among other things, to the complexity of its modelling, as it is an endogenous risk created by the actors in the economy, while physical risks are mainly exogenous[1]. Transition risks are latent and have recently emerged due to the need to mitigate Greenhouse Gas (GHG) emissions originated by economic activity centered around fossil fuels and the increasing decline in low-carbon technologies costs.

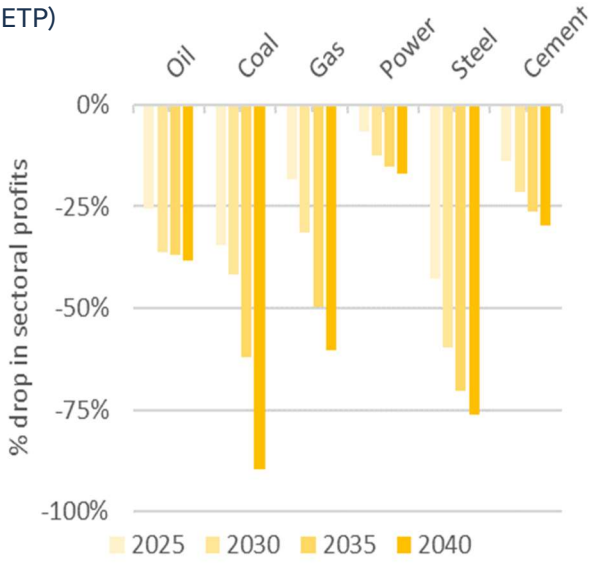
The economic losses associated with negative shocks stemming from the transition can be substantial. Mercure et al. (2018) estimate that the losses associated with stranded fossil fuel assets in the Latin American region could account for an approximate GDP loss of USD 300 billion up until 2035 [2]. This is equivalent to approximately 0.1% annual losses, which is not negligible considering that the rents of the sector represent 1.2% of the GDP of Latin America and the Caribbean[3]. Analysis carried out by 2° Investing Initiative shows that delaying the transition to a low carbon economy could lead to a decrease in Brazil's GDP growth rate of 5.5% one year after the necessary action is taken[4]. Sectoral shocks are naturally higher. Figure 0.1 shows the expected losses in sectoral profits in high-carbon sectors. The sectors that might have a higher decrease in profits are coal, steel, and gas.

A decrease in sectoral profits will eventually translate to changes in financial asset prices. As transition risks materialize, companies' value drivers will be affected, which in turn will materialize in changes of the valuation of companies and financial asset prices.

To identify the potential exposure to climate-related factors of financial portfolios, financial institutions have been using proxy metrics relying on CO_2 emissions data in the past 10+ years. The complexity and comprehensiveness of these metrics varies significantly[5], but in general their use as a tool to measure and manage climate-related risk is very limited. The most relevant limitations include (1) reliance on backward-looking nature, (2) transition risks are considered exogenous (2) and (3) reliance on self-reported data from companies (i.e. bringing a comparability problem as reporting changes from company to company).

In the past 5 years, a new generation of methodologies have been developed. These methodologies are connecting the dots between financial portfolios and climate-related risks and overcoming the caveats of traditional carbon metrics. Climate scenario analysis is one of these methodologies. It is used to assess the potential implications of the materialization of climate-related risks (both transition and physical) in financial portfolios[6]. It helps financial institutions understand if their investment or lending strategy will be resilient as the climate changes, regulations evolve, new technologies emerge, and consumer behavior shifts[7].

Figure 0.1. Expected decrease in sectoral profits in Brazil (%). (Source: 2DII based on IEA ETP)



The uptake of scenario analysis methodologies by financial institutions has been increasing over the past several years. This is due to the disclosure recommendations of the Task force on Climate-related Disclosures (TCFD), but also to the work of certain supervisory authorities and regulators which have recognized climate-related risk as a potential threat to the financial system and are supporting the assessment of these risks by their monitored entities.

The uptake of scenario analysis is, however, insufficient. The TCFD's second status report finds that of the 198 surveyed companies preparing disclosures, 110 use scenario analysis, of which 43% are financial institutions, meaning that around 47% of financial institutions surveyed do not use scenario analysis[8]. The lack of standardized scenarios or assumptions, the complexity and the high costs are among the most common reasons for not using scenario analysis. The report does not provide visibility on the differences between financial institutions in emerging or developed markets, thus it is not possible to understand how many financial institutions in Latin America are part of the cohort of preparers and their related uptake.

Regulators, supervisors, and financial institutions' networks in Latin America are assessing the uptake of scenario analysis and other risk assessment methodologies. In recent surveys carried out by the Financial Superintendence of Colombia (SFC), the Chilean Ministry of Finance's Public-Private Green Finance Roundtable, and Mexican Central Bank, it was found that the uptake of methodologies for the assessment of risk associated with climate change in financial portfolios is poor. In Colombia, only 31% of financial institutions have used methodologies to assess the implications of climate change on their core business and 20% have used some form of scenario analysis[9]. In Chile, only 8% of banks, 25% of asset managers and no insurance company or pension funds have used methodologies for the assessment of climate-related risks[10]. In Mexico, only 14% of banks and 29% of asset managers have undertaken forward-looking assessments of environment–related risks, and while more financial institutions do some form of assessment of exposure to environmental risks, it is mostly qualitative (61% of credit institutions and 53% of asset managers)[11].

This report supports the efforts made by these stakeholders by providing quantitative evidence on the relevance of climate-related risk for banks and investors in Latin America . It takes a closer look at how and which transition risks could affect the economy, local capital markets, and consequently financial portfolios of investors and banks in the largest financial markets in Latin America, namely Brazil, Chile, Colombia, Mexico and Argentina. To do so, the data analysis covered in this paper combines three types of data: physical asset-level data, financial data and investors' portfolio data.

Banking sector. Two levels of analysis are carried out to understand the potential exposure to transition risks of the sector. The first level seeks to understand if production or investment plans in climate-relevant sectors are changing in the next 5 years and whether these plans are underpinned by the deployment of low-carbon technologies. The second level compares the technology or energy mix of these sector to the mix required under a 2°C scenario.

The analysis for the banking sector uses physical asset-level data at country level. As banks finance their local economy, the analysis of country data serves as a proxy to understand the potential exposure to climate-related risks of banks. The analysis focuses on three of the most high-carbon intensive industries: fossil fuels, power utilities and automotive sector[12].

The report finds that the banking sector has a latent exposure to transition risks. This exposure comes mainly from power and fossil fuel companies that are not reducing their exposure to oil and coal at the pace required for a transition, as well as from automotive companies that are not investing (or investing as much as they should) in low-carbon alternatives for the required transition. For example, Figure 0.2 shows that in three of five countries examined, fossil fuels production plans are increasing in the next 5 years.

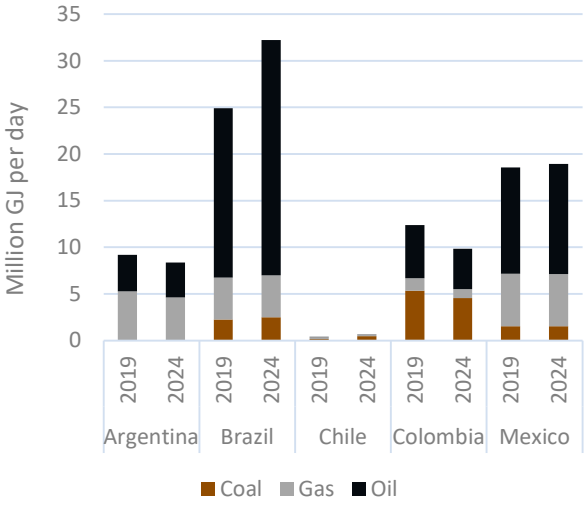
However, this is inconsistent with International Energy Agency (IEA) projections under a SDS scenario, which estimates a decrease in coal production in the Central and South American

region of 28% by 2030 to up to 87% by 2040 compared to 2018 levels, and a 32% decrease in oil production by 2040[13].

These results have implications for all participants in the banking sector, including governments, supervisory authorities, and regulators. Banks now have evidence to start assessing the exposure to transition risk of their corporate lending portfolio using tools such as scenario analysis. Governments have evidence of a potential mismatch between the progress made in some sectors and Art. 2.1.(c)'s objective of making financial flows consistent with the Paris Agreement goals. Finally, banking supervisory authorities and regulators now have evidence of the sector's potential exposure to transition risks, which could have an impact on financial stability. The results provided can equally be used to drive discussion around the need for increased transparency and standardization of data, as well as better practices in the integation of climate change that could be achieved either though regulation or local initiatives.

Investors. Three levels of analysis are carried out to understand the potential exposure of investors to transition risks. The first level seeks to understand the exposure of listed equity and corporate bond markets in five countries to the high-carbon sectors. Financial data of stock exchanges is used as a proxy indicator to understand investors' potential exposure to high-carbon intensive sectors for which no public portfolio data exist. The analysis focuses on instruments issued by local companies to consider that portfolios of most Latin American investors are concentrated in their local market. The second level compares the share of low-carbon and high-carbon technologies of different listed equity markets in selected sectors, namely, automotive, power utilities and fossil fuels. This analysis allows us to understand if the markets are more exposed to transition risks than they are to opportunities resulting from the low-carbon transition. The third level applies the Paris Agreement Capital Transition Assessment (PACTA) scenario analysis to investment portfolio data. This analysis provides evidence of the relevance and importance of applying climate-related risk assessment tools by financial institutions.

Figure 0.2: Current and future production plans by type of fossil fuel (Source: 2DII, based on Global Data)



The analyses for investors are based on three types of data: (1) Financial data from listed equity and corporate bonds instruments issued by local companies traded on the local stock exchanges and sourced from Bloomberg; (2) investment portfolios data; and (3) physical asset-level data which is then linked to financial instruments and portfolios[14].

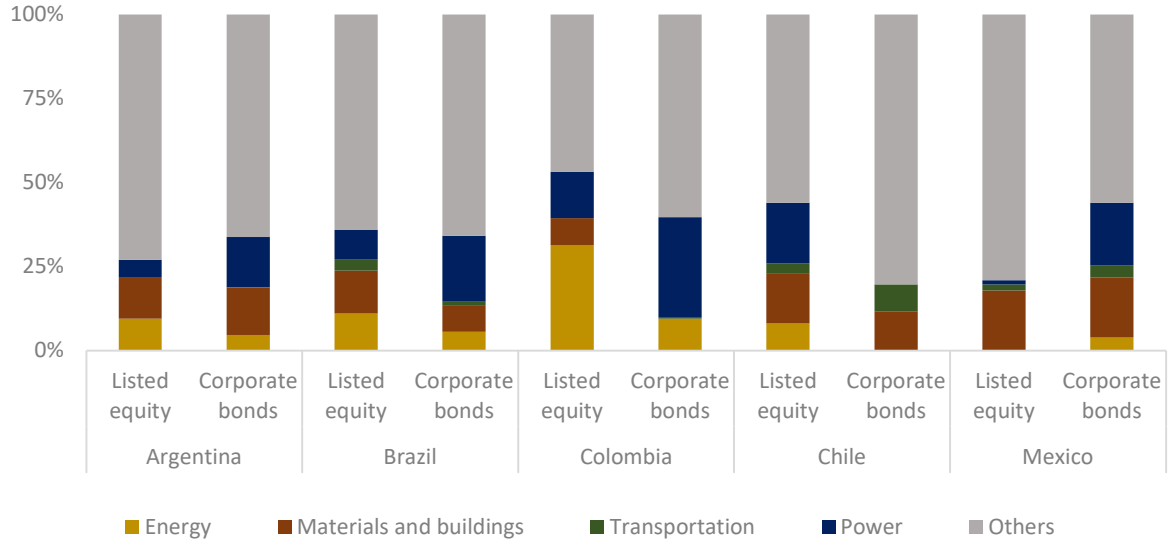
Two datasets of investment portfolio data were analyzed:

i. Mandatory pension funds' portfolio data sourced from the Financial Superintendence of Colombia. This was one of the few publicly available datasets which had the level of granularity required to apply the PACTA scenario analysis methodology. This analysis accounts for 92% of the total investments of pension funds as voluntary pension funds data is not publicly available[15].
ii. Insurers' portfolio data sourced from the Colombian Insurance Federation (FASECOLDA). 2° Investing Initiative and FASECOLDA partnered in 2018 to assess the potential exposure to transition risks of their member entities using the PACTA scenario analysis. This analysis accounts for 100% of the total investments of insurers. This exercise was the first of its kind in the Latin America. This report shows some of the results of that analysis[16].

The report finds that most of the biggest Latin American capital markets show a significant exposure to transition relevant sectors. These sectors cover from 21% to 53% of the market capitalization of listed equity issuers and from 20% to 45% of the total assets outstanding of corporate bonds issuers (see Figure 0.3).

The high exposure is substantiated by a higher proportion of high-carbon technologies than low-carbon technologies, mainly coming from the power and energy sectors in most of the countries. The ratio between low-carbon and high-carbon technologies of Latin American listed equity markets is however higher compared to other listed equity markets. This is notably due to the important place that hydropower generation has in the region.

Figure 0.3: Capital market sectorial exposure by country (Source: 2DII, based on Bloomberg)

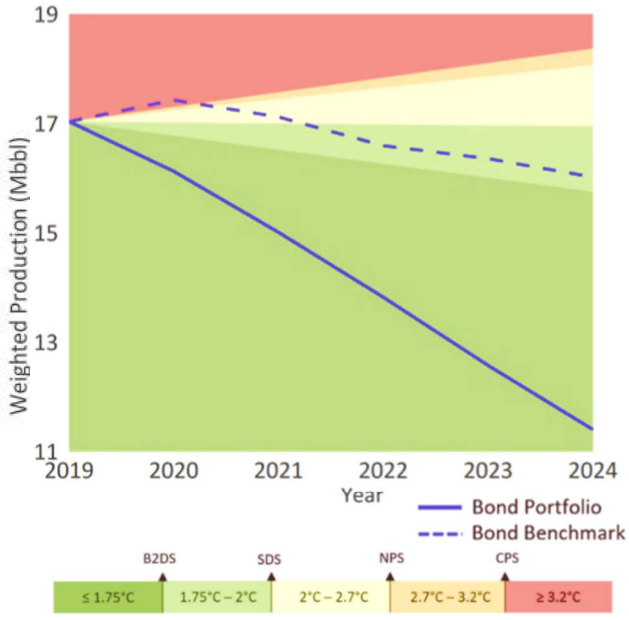


The application of the PACTA scenario analysis methodology in the Colombian insurers' and pension funds' portfolios show that the portfolios follow different trends in the next five years in the 7 sectors analyzed, namely, fossil fuels, power utilities, auto manufacturing, cement, steel, aviation and shipping. Some of these trends are shared in both the listed equity and corporate bond portfolios, while others are portfolio specific. However, all portfolios are potentially exposed to transition risks in some form.

For example, for both investors, the listed equity and corporate bond portfolios' trajectory in oil & gas is compatible with a <1.75°C (see Figure 0.4 for oil production results of the insurers' corporate bond portfolio), whereas in the case of the power sector, the corporate bond portfolios' trajectory in oil capacity is compatible with >3.2°C scenario. The portfolio is therefore exposed to transition risks ariring from a disruptive transition.

The scenario analysis finds that sectors and related technologies in which there is a low

Figure 0.4: Alignment of oil production in the corporate bonds portfolio of Colombian insurers relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



financial exposure can also be a potential relevant source of future transition risks. This is the case of pension funds' and insurers' listed equity portfolios, whose current exposure to coal powercapacity is quite low (0.32% and 0.02% of Assets Under Management (AUM), respectively), but which are potentially exposed to transition risks as the companies in the portfolios are either slightly increasing its production in the next 5 years or not planning any change in their investment plans.

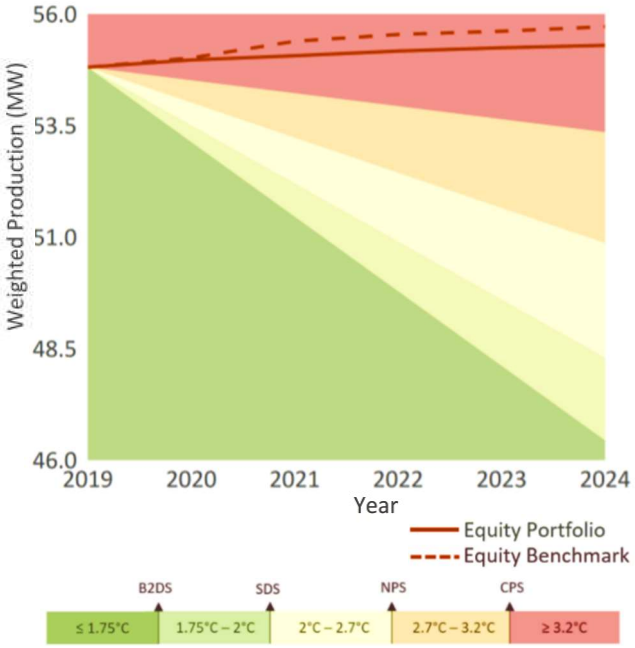
In the case of pensions funds (see Figure 0.5): the portfolio coal power capacity should decrease by around 15% by 2024 for their portfolio to be compatible with a <2ºC scenario. In the case of insurance companies: the decrease in their portfolio should be of 0.7% by 2024. This confirms that information covering a single point in time (i.e. current exposure to high-carbon sectors) provides limited understanding of the potential exposure to transition risks of financial portfolios and thus, the relevance of applying forward-looking methodologies such as scenario analysis.

The results of the analyses notably have implications for participants in capital markets, including investors, supervisory authorities, regulators, and governments. Investors now have evidence of their potential exposure to transition risk and therefore the need to assess their portfolios' exposure. Supervisory authorities and regulators now have evidence of the importance to implement activities to improve transparency and to measure themselves the exposure of the financial system to these risks. Governments now have evidence of how significant the exposure of investors is to industries that are critical for the achievements of the Paris Agreement and the need to develop or join initiatives that aim at assessing the potential misalignment of investors' portfolios with Art. 2.1 (c) of the Paris Agreement.

The results provided in this report can inform potentially regulation or local initiatives that seek to foster the integration of climate-change in the decision making of financial institutions.

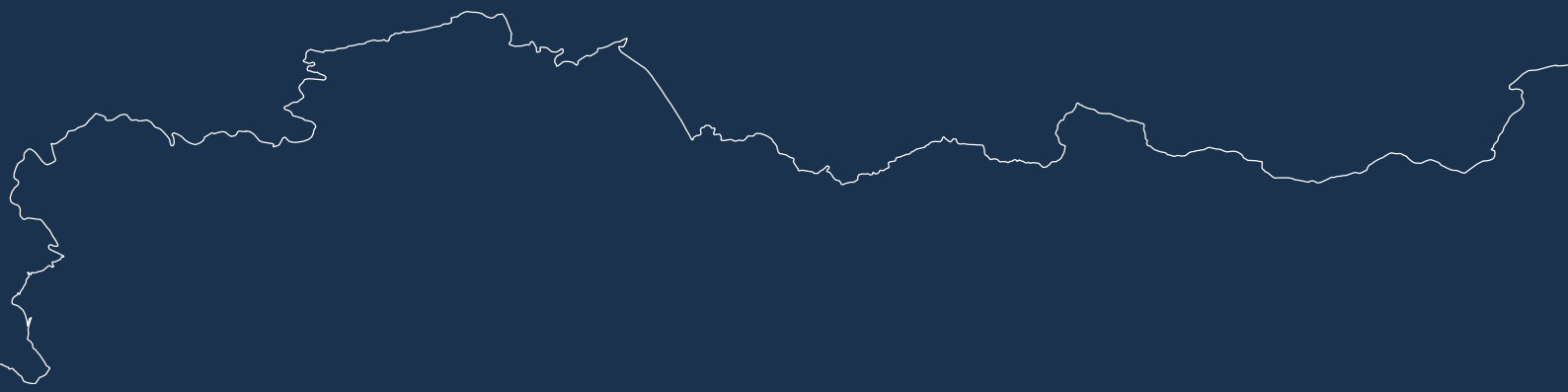
Finally, the report provides an overview of strategies available for transition risk mitigation and discusses which ones might be most suitable for Latin American financial institutions. The report argues that the choice of mitigation strategies is going to be largely driven by the financial market structure and the level of influence the financial institution has in the investee companies. The review of the financial market structure finds that the high sectoral concentration limits financial institutions mitigation strategies to use strategies that target behavioral change from companies, such as shareholder engagement or setting climate-related conditions as part of contractual conditions of financial instruments.

Figure 0.5: Alignment of coal power capacity in the listed equity portfolios of pension funds relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



To encourage the wider adoption of these strategies among financial institutions, the report proposes four avenues to increase the uptake of climate-related risk mitigation strategies: (1) build capacities around methodologies and frameworks to measure portfolio risks; (2) improve investors' understanding of the existing mitigation strategies and define parameters that will allow users to differentiate among various strategies; (3) share the experience with peers and opt for collective strategies; and (4) improve dialogue with investee companies.

These findings are equally relevant for international investors with exposure in Latin American markets that seek to better understand the exposure to transition risks of local markets as well as to support climate action in the region.



INTRODUCTION

This report is a primer on transition-risk assessment and scenario analysis for Latin American financial markets.

It seeks to provide quantitative evidence on the relevance of climate-related risks for investors, banks, supervisory authorities, regulators, and governments in Latin America.

It focuses on five financial markets: Argentina, Brazil, Colombia, Chile, and Mexico. It walks through the three key steps in the integration of climate related risks: identification, assessment, and mitigation.

According to the Intergovernmental Panel on Climate Change (IPCC), human activities have caused approximately 1ºC of global warming above pre-industrial levels. At the current rate of warming, the global temperature rise should reach the 1.5ºC threshold between 2030 and 2052. That extra 0.5ºC represents a risk for health, livelihoods, food security, water supply, human security, and economic growth as it will cause an increase in hot extremes in most inhabited regions, heavy precipitation, increase probability of droughts and precipitation deficits, an increase in the global mean sea level rise, increases in ocean temperature, impacts on (marine) biodiversity, fisheries and ecosystems including species loss and extinction[17].

The costs associated to climate change are huge and will exponentially increase if the necessary climate action does not take place. MunichRE has estimated that between 2016 and 2018, climate change has caused more than $630 billion in economic damage worldwide, which is equivalent to 0.27% of the world's GDP[18].

In 2015, 188 states and the European Union committed to take policy action to decarbonize their economies. However, their commitments fell short of the higher level of ambition that will be needed to achieve the Paris Agreement goal of limiting the global temperature rise to way below 2ºC. Under current commitments, the world will

warm by 2.8ºC by the end of the century[19]. In 2020 governments are required to increase their ambitions. So far, 8 countries have updated and strengthened their Paris Agreement pledges , while 106 countries have stated their intention to enhance ambition or action by 2020 (representing 15% of global emissions)[20].

In parallel, actors from the financial sector, such as the former Governor of the Bank of England, Mark Carney, have been vocal about how critical climate change is for the sector and how it could translate into financial risks[21]. Since then, the private sector, supervisory authorities, regulators, and governments have created a series of voluntary and mandatory initiatives to improve the identification, assessment, management and reporting of the impacts of climate-related risks in financial portfolios and systems.

Although the initiatives have largely originated in developed markets, financial sector actors in emerging markets (particularly in Latin America) are becoming increasingly involved. However, much more ambitious involvement and actions are needed to increase the scale of awareness and the integration of climate change as a core topic in the agenda of financial institutions.

This report contributes to this by: (1) identifying the types of climate-related risks the Latin American economy could potentially be exposed to and how this could translate to financial institutions (Section 1); (2) describing the ways in which climate-related risks can be assessed (Section 2); (3) estimating the extent to which banks and investors could potentially be exposed to risk associated to the transition to a low-carbon economy (Section 3); and (4) identifying the most suitable strategies for the mitigation of such risks (Section 4).

Section I

THE LATIN AMERICAN ECONOMY'S EXPOSURE TO TRANSITION

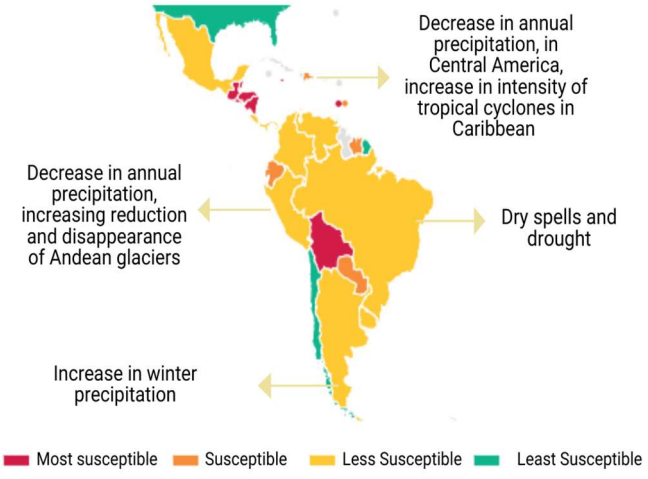
The two main types of risks considered in scenario analysis are transition and physical risks:

- **Transition risks** refer to risks that will arise due to the shift towards a low carbon economy as a response to climate change.
- **Physical risks** refer to the increase in the occurrence and severity of extreme weather events and changes in climate patters that can impact economic actors.

Both risks will affect Latin American economies, but in the past, a stronger emphasis has been put on physical risks. This is due to the fact that Latin America is one of the most vulnerable regions in the world due to the existence of low-lying coastal edges and small island areas; arid, semi-arid areas, exposed to forest degradation; propensity to natural disasters and heat waves; areas prone to drought and desertification; urban areas with air pollution problems; and areas of fragile and mountainous ecosystems such as the mountain ranges of the Coast and the Andes. Figure 1 shows some of the physical risks that could materialize in the region due to these vulnerability factors. Physical risks have an impact on agricultural sector yields, infrastructure, food security, population health and terrestrial ecosystems[22].

The rating agency Moody's considered several of these factors to analyze sovereigns' credit risk exposure and resilience to climate change and found that most countries in Latin America are considerably susceptible to climate change (see figure 1)[23].

Figure 1: Latin American countries exposure to physical risks (Source: Moody's and UNFCCC)



The exposure to transition risks of Latin American economies has been much less explored partially due to its nature: it is an endogenous risk created by the economy participants rather than an

exogenous risk created outside of the economy as is mostly the case with physical weather events[24]. It is a latent risk that has recently emerged due to the need to mitigate Greenhouse Gas (GHG) emissions originated by economic activities centered around fossil fuels and the increasing decline in low-carbon technologies costs. Latin America represents nearly 7% of the global Green House Gas emissions (GHG)[25]. Five economies are responsible for more than 70% of those emissions, namely, Brazil (2.25%), Mexico (1.62%), Argentina (0.74%), Colombia (0.35%) and Chile (0.23%).

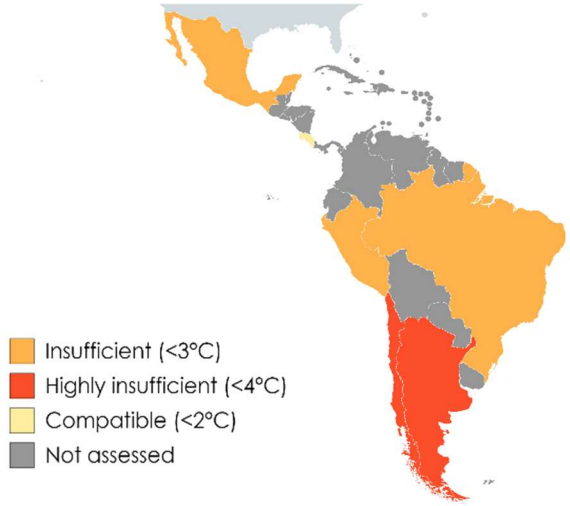
Sources of transition risks in Latin America. There are three main types of transition risks: policy, technology, and market risk. All these risks can potentially materialize in Latin America.

i. Policy risks will arise from the implementation of public policies aiming at setting up a low-carbon economic model and as a response to climate change and global climate agreements such as the Paris Agreement. Economies will not only be affected directly by new policies set up at government or municipal level but also indirectly, for example through new policies set up by economies with which strong trade flows exist.

Figure 2 shows how far Latin American countries have gotten in the development of the policy framework required to meet the Paris Agreement goals. It additionally infers that the current country commitments in the form of National Determined Contributions (NDCs) are not ambitious enough, suggesting that stringent policy action will need to take place in the short to medium term to effectively mitigate the effects of climate change.

Some countries in Latin America already have a legal framework established that allows for stringent policy action to happen. For example, Chile, Colombia and Mexico have a carbon tax[26] [27] [28], however the price of carbon is significantly lower (on average USD 5 per tCO2) compared to the average low-end current carbon costs of a ton of CO2 estimated by the OECD to be at EUR 30 [29]. Policies incentivizing the use of renewable energy sources are also in place. For example, Chile is requiring companies to have at least 20% of their electricity supply from renewable energy sources by 2025[30]. However, the IEA estimates that the share of electricity generation under a 2°C scenario should be approximately 28% by 2025. More importantly, few countries in the region have started to develop the legal and institutional frameworks required to achieve the 2050 carbon neutrality commitment pledged at the 2019 United Nations Climate Change Conference. This is the case of Chile and Costa Rica[31] [32].

Figure 2: Latin American countries climate policy scoring (Source: Climate Action Tracker)



ii. Technology risks are risks stemming from technological improvements or innovations supporting the transition to a low-carbon and energy efficient economy. It relates to the development of new low-carbon technologies but more importantly its capacity to be economically viable up to a point in which they can replace high-carbon technologies. In general, technology risks are considered to be global as technologies can be traded or purchased relatively easily in open markets. One latent source of technology risks for electricity producers using conventional sources of energy in Latin America is the decrease in the cost of renewables. The levelized cost of electricity has decreased by over 50% for solar PV since 2012, and by around 20% for hydropower and onshore wind since 2010, ranking among the lowest globally. The competitiveness of solar PV is contributing to achieve record-low energy prices in countries like Mexico and Peru. Technological progress is one of the main factors driving the costs decrease. Other factors include local supply chain development, resource quality, reduced

financing costs and increasing the sector's maturity[33].

iii. Market risks arise from shifts in supply and demand, and its impacts on prices of certain commodities and products, as climate-related risks and opportunities are integrated in the market economy. Market risks are considered to be global as commodities can be somewhat easily purchased around the globe. Currently, these risks are rather latent, as supply and demand forces are driven by macroeconomic factors which so far do not factor in the risks posed by climate change.

What does the materialization of transition risks mean for Latin America?

All economic sectors will be impacted by the materialization of transition risks in one way or another. For some sectors, the impact will be direct as new policy and the increasing efficiency of low-carbon technologies will affect their core business activity. For some others, the impact will be indirect as mainly the activities supporting their core business will be affected (e.g. changes in electricity prices, travel costs associated to higher fossil fuel prices, etc).

The sectors which are exposed the most to transition risks are energy, transport, and materials and buildings.

Approximately 85% of the GHG emissions in Latin America are concentrated in 6 countries: Brazil (33%), México (24%), Argentina (11%), Venezuela (9%), Colombia (5%) and Chile (3%)[34]. These 6 countries account for approximately 84% of Latin America's GDP. Figure 3 shows their economies' exposure to the three aforementioned sectors. These sectors represent between 20% to 35% of their GDP.

In Latin America, these three sectors are responsible for 52% of GHG emissions[35] (see Figure 4). These sectors equally contribute to 76% of GHG global emissions.

The economic losses associated with negative shocks stemming from the transition can be substantial. Mercure et al. (2018) estimate that the losses associated with stranded fossil fuel assets in the Latin American region could account for an approximate GDP loss of USD 300 billion up until 2035[36].

Figure 3: Share of transition risk relevant sectors in GDP (Source: countries statistics agencies)

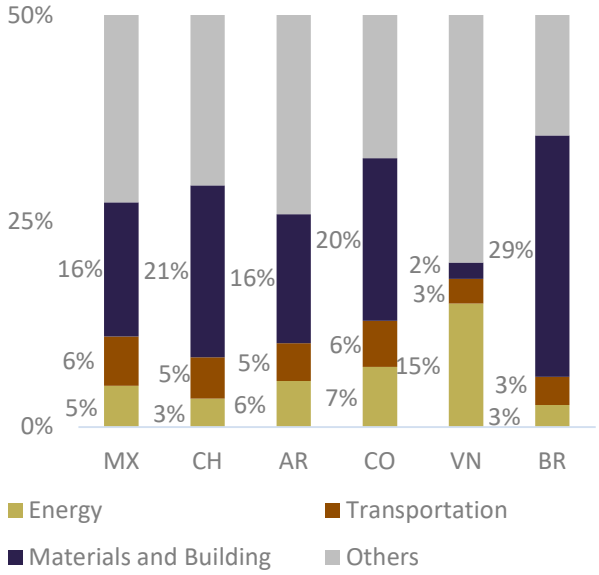
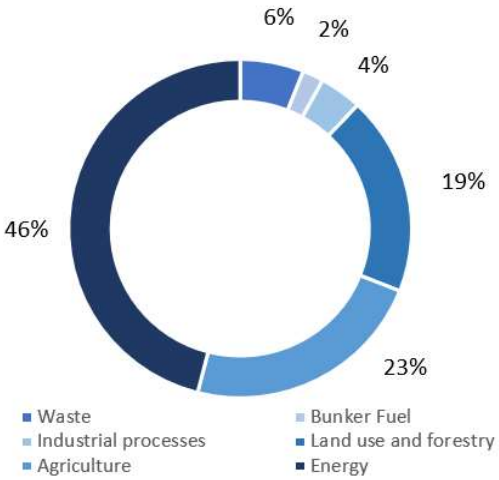
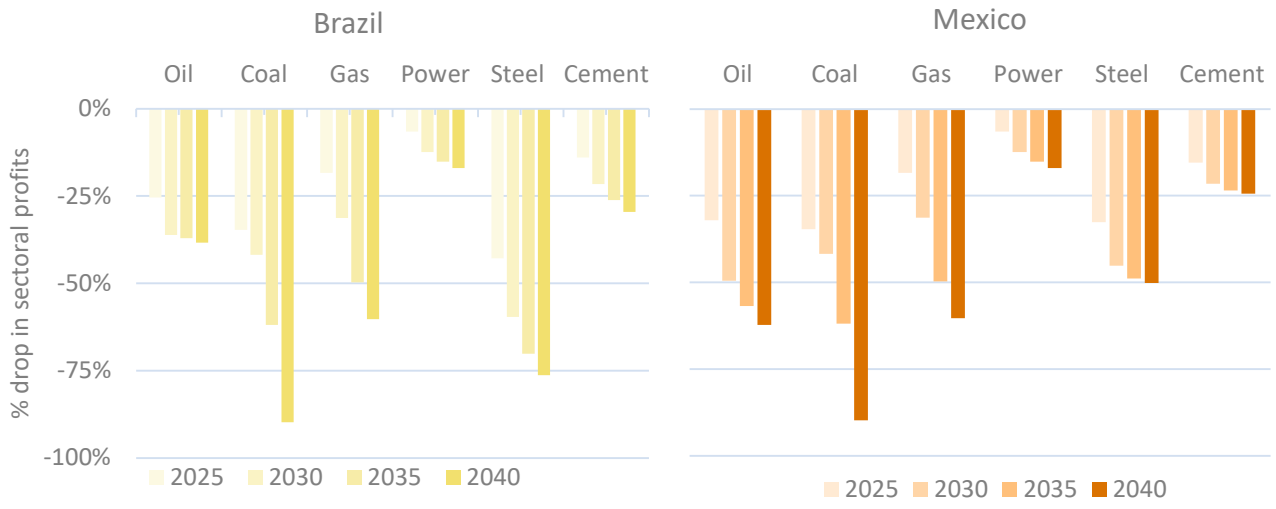


Figure 4: Share of GHG emissions by sector, 2014 (MtCO2eq) (Source ECLAC 2018)



This is equivalent to approximately 0.1% annual losses, which is not negligible considering that the rents of the sector reprent 1.2% of GDP of Latin America and the Caribbean[37]. Further analysis carried out by 2° Investing Initiative shows that delaying the transition to a low carbon economy could lead to a decrease in Brazil's GDP growth rate of 5.5% one year after the necessary action is taken[38]. Given Brazil's dependency on the sector as top oil exporter, the negative effects of delayed action can be persistent even 10 years after the shock[39].

Figure 5. Expected decrease in sectoral profits in Brazil and Mexico (%). (Source: 2DII based on IEA ETP)

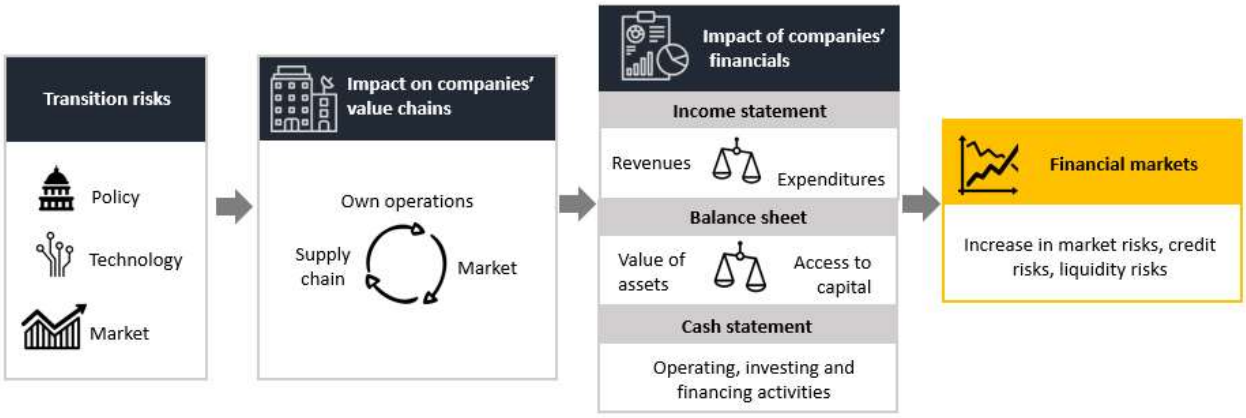


Losses within the sector will be notably more pronounced. Figure 5 shows an estimation of the expected decrease in the profits of carbon-intensive sectors in Mexico and Brazil in deleyed transition under a 2ºC scenario in relation to a baseline scenario in which this transition does not occur[40]. The decline of the profits is incremental in the long-term as countries fail to act. In both countries, the fossil fuel sector will see the highest decrease in the profits with up to 90% by 2040 in the case of coal mining. The steel sector will equally see high losses, especially in Mexico, with up to 76% loss by 2040. More information on the estimations can be found in Annex A.

The losses estimated will not be as high in the case that countries decide to not carry out the required policy actions needed to meet the Paris Agreement; however, this is just only one source of potential transitions risks. As new low-carbon technologies emerge and the costs of low-carbon alternatives decreases, the market economy forces, and consumer preferences will push the shift from high-carbon to low-carbon technologies.

As transition risks (and opportunities) materialize, companies' value chains will be affected, which in turn will affect their value drivers. Any changes in the company financials will translate in changes of asset prices, which in turn can lead to increased market, credit and even liquidity risks and related financial losses (see Figure 6). Thus, financial institutions should be carefully monitoring developments around policy and non-policy related transition risks to mitigate financial losses and to timely seized the opportunities that will equally come with the transition.

Figure 6: Propagation channels of transition risks for the financial sector (source: 2DII[41])



Section II

HOW TO ASSESS CLIMATE-RELATED RISKS OF FINANCIAL INSTITUTIONS

2.1. The first generation of climate-related risk metrics

The first generation of climate metrics relies purely on CO_2 emissions data. These are metrics that financial institutions have been using over the past 10+ years, but they have been used for a number of objectives in addition to addressing climate-related risks. In general, carbon metrics have been used to:

- Understand the impact of investments on climate. This use assumes that by investing in instruments issued by companies that are decreasing their emissions or by companies in low-carbon sectors (e.g. healthcare, communications) the investments are having a lower impact on climate, which is very often compared against the one of a market benchmark (e.g. MSCI ACWI).
- Understand the exposure to carbon risks. This use assumes that by investing in instruments issued by companies that are decreasing their emissions or by companies in low-carbon sectors (e.g. healthcare, communications) they have a lower exposure to carbon risks arising from GHG emissions related policies, regulators, sanctions, among others[42].

Carbon metrics has been used to address these two objectives interchangeably, among other reasons due to the lack of metrics which makes it a one-size-fits all proxy[43]. The use of a single metric to address two objectives has created confusion in the market as achieving the two objectives requires two independent strategies and types of progress indicators. Indicators used in a carbon-risk perspective (e.g. high-carbon assets located in jurisdictions exposed to GHG emissions policies) are not the same as indicators associated to the impact of investments (e.g. % companies that have set science-based targets as part of the portfolios engagement strategy)[44].

Evidently, with time these metrics have evolved to cover more asset classes, more emissions scopes and model data gaps. However, from a climate-risk perspective there are a number of factors that limit the use of these metrics as a risk assessment tool. The most common and relevant limitations are:

- Lack of a forward-looking nature. The effects of climate change, from a physical to a policy and even reputational perspective, will materialize in the future. Thus, there is a need for metrics that account for changing future events. However, proxy metrics generally quantify current exposure to climate or rely on extrapolations from past events to predict future events.
- Climate factors are taken as exogenous. This occurs when the interrelations between climate and financial factors are not modelled, such as changes in asset prices due to climate-related events. This results in an indicator, whose use for strategic decision-making and monitoring is limited as results may change due to factors that are not related to climate change.

- Reliance on self-reported data. Most corporate data are sourced directly from companies or through data providers. Although corporate disclosure has improved, there is still a significant share of corporates in emerging markets that do not disclose social and environmental data. Data providers model data gaps (e.g. missing CO_2 emissions scopes), but coverage in emerging markets is still limited.

2.2. The second generation of climate-related risk metrics

A new set of metrics have been and are in the process of being developed. These combine multiple data sources in an attempt to overcome the caveats of traditional carbon metrics, including company forward-looking data and climate scenarios.

The objective underlying these metrics goes further than just understanding the exposure to climate-related risk (both physical and transition risks), they aim at providing relevant information to the user that can be used to develop strategies for the mitigation of climate-related risks. This latter objective is however still a work in progress given the methodological complexities associated.

In line with traditional financial risks assessment, there are three main types of tools that have been developed: climate scenario analysis, climate value at risk, and stress testing tools.

- **Climate scenario analysis** models future plausible climate outcomes (e.g. well below 2°C Paris agreement goal) to understand the implications of the materialization of climate-related risks and opportunities in the real economy and financial portfolios in terms of risk exposure.
- **Climate Value at Risk (VaR)** estimates the size or percentage of the loss a portfolio may experience as a result of the materialization of climate-related risks, within a given time horizon, at a particular level of confidence.
- **Climate Stress tests** assess hypothetical unfavorable climate scenarios to understand the resilience of financial institutions to climate related risks (see a practical example in Box 1).

This report focuses on scenario analysis as it is the first step in the journey towards the integration of climate-risks by financial institutions.

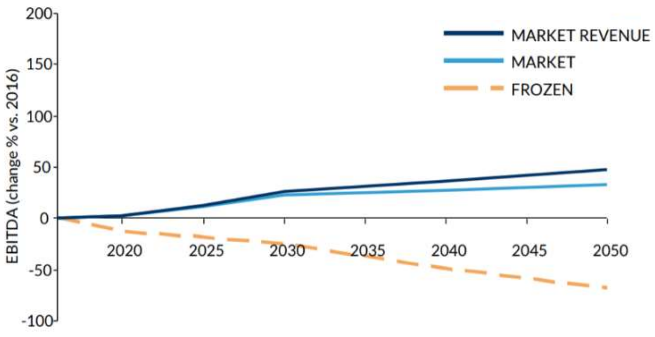
What is scenario analysis and why is it useful for financial institutions?

Scenario analysis tools emerged to overcome the caveats of traditional carbon metrics, to effectively assess the potential exposure of financial portfolios to climate-related risks. Its use has expanded partly as a result of the recommendations of the Task Force of Climate-related Financial Disclosures (TCFD) of the Financial Stability Board and as a response to governments' and supervisory authorities' signals on the importance to use such metrics in risk management (see box 1) [45] [46] [47].

Climate scenario analysis helps us to understand the potential implications of climate-related risks and opportunities of financial portfolios by estimating the deviation between the pathway of the financial portfolio and the portfolio under plausible climate outcomes, assuming that the portfolio can follow optimal pathways (see Fig. 7 for an example). The deviation between these climate pathways and the portfolio pathways shows the degree of exposure to transition or physical risks and the changes required for this exposure to be minimized.

Scenario analysis can help financial institutions understand if their investment or lending strategy is resilient as climate changes, regulations evolve, new technologies emerge, and consumer behavior shifts[48].

Figure 7. Expected decrease in EBITDA under different climate scenarios (%). (Source: The CO Firm)



It helps investors answer two key questions:

1. Is my portfolio aligning with the Paris Agreement climate objective of limiting the global temperature increase to well below 2ºC?; and if not
2. Which sectors, technologies and companies are more exposed to the risk that will materialize to reach that climate outcome?

By answering these questions, financial institutions can therefore identify hotspots and actions to mitigate a potential risk exposure.

To carry out scenario analysis and to integrate its results in investments and lending processes is not an easy task. The learning curve is steep and there is not a one size fits all solution, because portfolios differ in the types of asset classes, geographies and sectors and respond to different mandates.

In June 2019, the TCFD released its second status report which monitors the uptake of its recommendations, including the application of scenario analysis. The report finds that of the 198 surveyed companies preparing disclosures, 110 use scenario analysis, of which 43% are financial institutions, meaning that around 47% of financial institutions surveyed do not use scenario analysis. The lack of standardized scenarios or assumptions, the complexity and the high costs are among the most common reasons for not using scenario analysis[49]. The report does not provide visibility on the differences between financial institutions in emerging or developed markets, thus it is not possible to understand how many financial institutions in Latin America are part of the cohort of preparers, and their related uptake.

Evidence on the use of scenario analysis in Latin America.

Regulators, supervisors, and financial institutions' networks in Latin America are equally assessing the uptake of scenario analysis and, more broadly, the uptake of climate related issues by financial institutions. In recent surveys carried out by the Financial Superintendence of Colombia (SFC), the Chilean Ministry of Finance's Public-Private Green Finance Roundtable and the Mexican Central Bank, it was found that the uptake of methodologies for the assessment of risk associated with climate change in financial portfolios is poor. In Colombia, only 31% of financial institutions have used methodologies to assess the implications of climate change and 20% have used scenario analysis[50]. Not surprisingly, uptake is low as only 39% of financial institutions have identified that climate-related risks represent a material financial impact for them[51]. In Chile, the use of methodologies is equally poor: insurers and pension funds have never used methodologies to assess the implications arising from climate change at portfolio level, while only 8% of banks and 25% of asset managers have used methodologies. In Mexico, only 14% of banks and 29% of asset managers have undertaken forward-looking assessments of environment–related risks, and while more financial institutions do some form of assessment on their exposure to environmental risks, it is mostly qualitative (61% of credit institutions and 53% of asset managers)[52]. The consideration of climate change as an issue that could cause material impact to the organization is however higher in Chile and Mexico in comparison to Colombian investors and banks. 64% of Chilean insurers, 69% of banks, 92% of asset managers, and 67% of pension funds, consider that climate change is a risk that affects or could affect their performance[53], while in Mexico most credit institutions believe that they are exposed to some type of transition (68%) or physical (64%) risks, while 54% of asset managers believe that their portfolio could be affected by physical risks and transition risks.

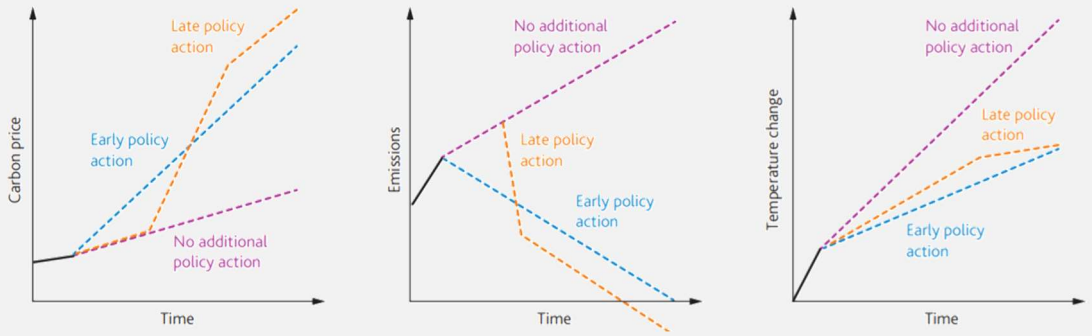
There are different reasons for the low uptake of scenario analysis in Latin America. From a "theoretical" standpoint, there is lack of awareness on the topic, not only regarding scenario analysis but in general on the potential impact of climate change on portfolios. This is well reflected in both surveys mentioned above. From a practical standpoint, there are important data gaps in terms of scenarios and company environmental data that represent a challenge for both, the development of in-house methodologies by financial institutions, and the expansion of the scope of proprietary models that already exist.

The following sections shed light into the relevance of transition risks assessment and the use of scenario analysis for Latin American financial institutions.

Box 1: Governments and supervisory authorities signals on the relevance of climate-related risk assessment by financial institutions

De Nederlandsche Bank. The Netherlands central bank set up its first climate stress tests in 2018. It consisted of a transition risk stress test covering four scenarios and applied to Dutch banks, insurers, and pension funds. The results show that the losses for financial institutions in case a disruptive energy transition materializes could be sizeable but manageable by timely implementing effective climate policy in a timely manner.

Bank of England and Prudential Regulation Authority. In 2015, the Bank of England (BoE) was the first central bank in the world to vocalize the risk to financial stability that climate-related issues could pose. However, it was not until June 2019 that the Prudential Regulation Authority (PRA) of BoE made a first request for information from its regulated entities. As part of an exploratory exercise, the PRA requested the UK's largest regulated life and general insurers to provide information on the impact that different scenarios covering both transition and physical risks could have in their investments. More recently, the BoE has announced that by 2021 stress tests will be carried in the entire UK financial system. This stress test will include the scenarios , one in which there is early policy action to reduce carbon emissions to well below 2ºC scenario, a second one in which policy action is delayed by 10 years but the well below 2ºC climate target is still met, and a third one in which investors face a critical exposure to climate related risks due to the lack of policy action (see below an illustration of these scenarios)[54].



Bank of France and Prudential Supervision and Resolution Authority. In November 2019, the central bank governor announces that climate stress tests are going to be carried out in French banks and insurance companies in 2020. The stress test will include two or three climate scenarios.

Chilean Pension Funds Supervisory Authority. In September 2019, the regulator informed that climate-related risks will be incorporated into the risk matrix used in the risk-based monitoring process.

Network for Greening the Financial System. Network for Greening the Financial System (NFGS) is the only forum worldwide bringing together central banks and supervisors committed to better understanding and managing the financial risks and opportunity of climate change. The NFGS members have developed four representative high-level scenario narratives for which more quantitative parameters will be drawn in order to enable central banks and supervisors to explore how these scenarios may be applied in their domestic work programs. The network has 54 members, 6 of which are Latin American: the Mexican Central Bank, one of the founding members, the Central Bank of Colombia and Costa Rica, Colombia's supervisory authority, the Mexican Banking and Securities Commission, and the Chilean Financial Market Commission.

France Energy Transition Law. In 2015, France became the first government in the world requiring institutional investors and asset managers to disclose "the compatibility of their investment policies with an energy transition scenario" and to set targets supporting a 2ºC scenario.

Section III

RELEVANCE OF SCENARIO ANALYSIS IN LATIN AMERICAN FINANCIAL INSTITUTIONS' CLIMATE-RELATED RISK ASSESSMENT

As reflected in the surveys made in Chile and Colombia, the uptake of scenario analysis by Latin American financial institutions is poor. More importantly, there is little evidence of the scenario analysis practices carried out. The surveys focus on having a general understanding on the level of integration of this topic and therefore do not capture relevant information on the methodologies being used nor the relevance of them in the context of climate-related risk management.

In the past several years, a few Latin American banks have joined working groups that pilot methodologies on scenario analysis and climate risk assessment. This is the case, for example, of the UN Environment Finance Initiative (UNEP FI) working groups on TCFD and the bank pilot group that is working with 2° Investing Initiative to test the PACTA methodology.

This section aims at providing evidence on why financial institutions in Latin America should start including scenario analysis in their practices. It identifies the sectors and capital markets for which the measurement of climate-related risks is more critical and provides practical examples of scenario analysis application in selected countries.

3.1. The banking sector exposure to transition risks

Banks are a fundamental player in the transition to the low carbon economy in Latin America because in most countries, banks hold more assets than the institutional investors combined (see figure 8).

There are different ways banks could support the transition: they can provide specific products aimed at increasing the investments in low-carbon solutions, but more importantly, as the main providers of capital, they can use their influence to persuade and help companies align their strategy to the transition required. This can be done through direct engagement (e.g. discussions with the client that would lead to the set-up of decarbonization targets) or through the development of loan lines linked to the improvement of sustainability factors of their clients (see table 1)[55]. More importantly, to ensure these actions are leading to actual changes in the real economy, banks should rely on science-based indicators.

However, in order for banks to exploit all the capacity they have as agents of change in the real economy, they need first to understand the exposure of their corporate lending portfolios to transition risks as well as the companies that are

supporting or threatening this transition. This requires an understanding of the bank's sectoral/subsectoral exposure, the concentration of clients along those parts of the value chain of the sector that are more carbon intensive - which are therefore potentially more exposed to transition risks, and the identification of transition-related trends within those companies.

There is limited public information that allows for such analysis of the Latin American banking sector. Regulators in Argentina, Brazil, Colombia, Chile, Costa Rica, Mexico and Panama disclose information on the sectoral/subsectoral exposure of its supervised commercial banks, however, the scope and indicators used differs – thus a comparison between them is not possible[56 57 58 59 60 61 62]. This information can be used to understand the weight of high carbon sectors in the portfolio of banks but provides little information on the potential assets at risk. For example, the banking sector of a country can be heavily exposed to the power sector, but if the financed companies are renewable energy producers or are companies planning to phase out coal or oil assets and replace them with renewables alternatives, the exposure does not represent a risk but rather an opportunity.

Forward-looking, country-level, economic activity data can be used as an alternative proxy to understand the potential exposure to transition risks of the sector, given that banks finance the real economy and, in particular, Latin American banks finance mainly their local or regional economy. However, the data used needs to reflect the changing dynamics within the sector, which in the context of the transition is the shift from high to low-carbon technologies.

Figure 8: Total assets (Billion USD) by financial institutions in targeted Latin American countries .

Using physical asset-level data at country level and the scenarios of the International Energy Agency, we analyzed the exposure to potential transition risks of selected Latin American countries by looking at the current and future high- and low-carbon technologies production build out and comparing it to the build-out required in an economy compatible with a 2°C scenario. We focused on three main high carbon sectors: namely, fossil fuels, power utilities and automotive[63]. These sectors are not only of high relevance for the countries' GDP but also their debt exposure to environmental risks is considered to be at elevated risk according to rating agency Moody's.[64]

Table 1: Examples of sustainability-linked loans in Latin America

Borrower	Loan type and amount	Internal Sustainability targets	Issuer
Fibra Uno[65]	Revolving credit facility – 1.1Bn$	Environmental performance in electricity consumption	Consortium led by Santander and BBVA
Renewi	Revolving credit facility – 550M EUR	Environmental performance in area such as recycling, carbon avoidance and fleet efficiency	Consortium led by ING
Consumers Energy	Revolving credit facility – 1.48Bn$	Reducing carbon emissions by 80% by 2040, Zero coal used to generate electricity by 2040, etc.	Consortium led by Barclays
Danone	Revolving credit facility – 2Bn EUR	Transformation to a B-Corp Certified Group	Consortium led by BNP Paribas

Power utilities sector. The transition in this sector will require an overall increase in electricity production as population grows and demand increases. This increase will be supported by an increase in electricity production of low carbon technologies (e.g. solar, wind etc.) and a decrease in the production of high carbon technologies (e.g. coal and oil). This change will be driven by (1) the decrease in investment costs of renewable energy projects, for example, the value of photovoltaic modules between 2006-2018 decreased by around 80%; and (2) the implementation of public policies, which can either incentivize the supply of renewable energy, for example, through a subsidy; or disincentivize investments in high-carbon technologies, for instance, by implementing a carbon tax[66].

Gas-based electricity production will increase in the short term as it is considered a transition technology. The IEA estimates that in a <2°C scenario, 76% of the electricity capacity will be in renewable sources while only 1% will be on coal by 2040, this would require an increase of 13% and a decrease of 3% respectively in the current shares.

Figure 9 shows that all selected countries are increasing their generation capacity in the next five years. In all countries but Mexico, renewable energy is the source with highest capacity additions, with Chile and Colombia at least doubling their renewables capacity. This implies that the capital expenditures and related financing sources are being directed towards renewable energy sources. Figure 9 additionally shows that the only country that is decreasing its exposure to oil is Mexico, while no country is decreasing its exposure to coal. Thus, the required decrease of high-carbon technologies is not observed yet.

To understand if the increase in renewable energy investments are supporting the transition required to achieve the <2°C objective, we compare the country's currently planned energy mix for 2024 with that required in a <2°C scenario[67]. Figure 10 shows that Brazil is the only country that is roughly aligned with the technology mix of IEA's Sustainable Development Scenario (SDS) in 2024. The renewables share is lower than that required in the scenario for Mexico and Colombia, which suggest that more financing will be required in those countries. On the other hand, the share of coal in electricity capacity in Chile, Colombia and Mexico is higher than what is required in a <2°C scenario. This suggests that companies operating in those jurisdictions are likely to be pushed (either by regulation or market forces) to phase out a portion of those assets. Banks financing those companies are therefore potentially exposed to transition risks.

Figure 9: Current (2019) and future (2024) generation capacity production plans in the power sector (Gigawatts) (Source: 2DII, based on GlobalData)

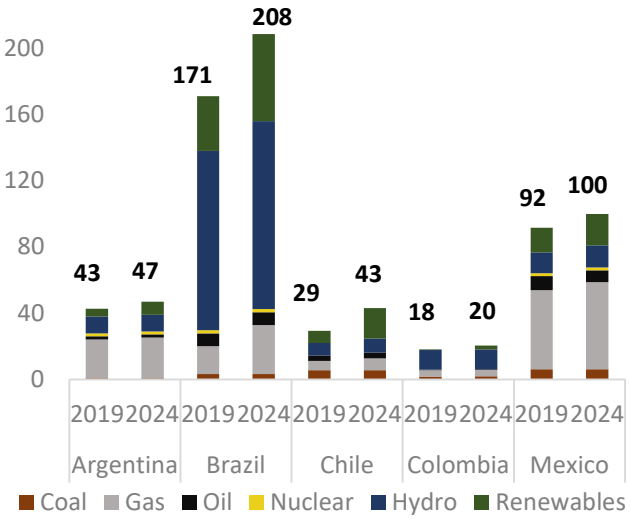
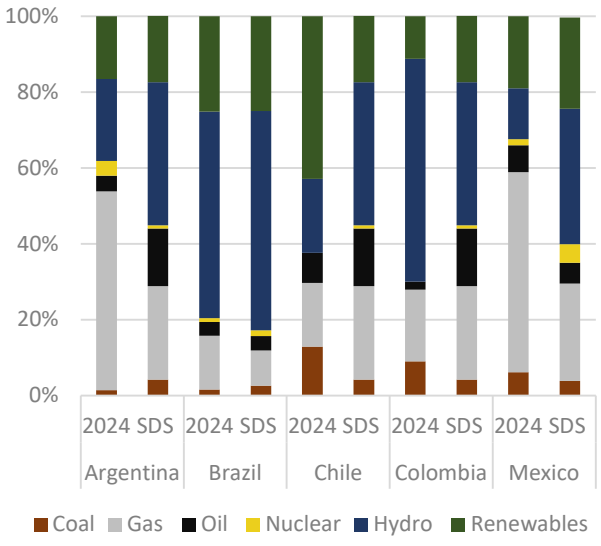


Figure 10: Future energy mix (2024) and SDS scenario in the power sector (Source: 2DII, based on Global Data and IEA WEO 2018)



Automotive sector. As in the power sector, the transition in this sector will require an overall increase in automotive production as population grows and demand increases. The potential increase of demand will be supported by an increase in production of low carbon vehicles (e.g. hybrid vehicles[68]) and a decrease in the production of high carbon vehicles (e.g. Internal Combustion Engine (ICE)). Different factors will drive this dynamic, including (1) an increase in the competitiveness of electric vehicles - for instance, Bloomberg New Energy Finances (BNEF) estimates that by 2024, electric vehicles will become cheaper than their equivalent combustion engine; and (2) stringent policies, such as the ban of ICEs. Such policies are already in the agenda of some EU member states [69] [70].

This is a critical sector for banks to monitor as currently most countries are not showing signs of a transition. Argentina, Brazil, and Colombia are only increasing their ICEs production. Banks lending to automotive companies in these countries are therefore not financing the transition required in this sector[71].

Mexico is the only country which is substantially decreasing the production of ICEs and increasing the production of hybrid and electric vehicles (see figure 11). However, the technology share of both is nearly half of the required global average in a <2°C by 2024 (see figure 12). Banks can therefore be instrumental in the financing of the additional production required in the transition.

Fossil fuels sector. In the transition, the fossil fuels sector will see a decrease in the global demand for oil, gas, and coal. A key factor that will drive this dynamic is public policy targetting fossil fuels subsidies phased out in both net-importing and net-exporting countries and the staggered introduction of CO_2 prices. Evidence of this is already present in Latin America. For example, Argentina, a net-exporter of oil, phased out its oil production subsidies in 2017, while Mexico phased out the gasoline consumption subsidies for manufacture and transport activities which indirectly benefited the production of fossil fuels.

The IEA estimates that countries in Central and South America will follow the global trend, however, a small increase in production is foreseen from 2035[72]. The region could see a decrease in coal demand of 10% by 2025 to up to 42% by 2040 compared to 2017 levels.

Figure 11: Current and future (2024) production plans in the automotive sector (Source: 2DII, based on AFS)

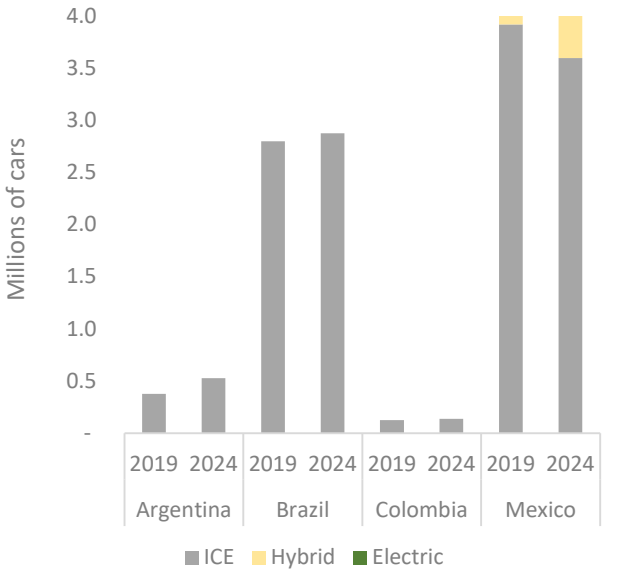
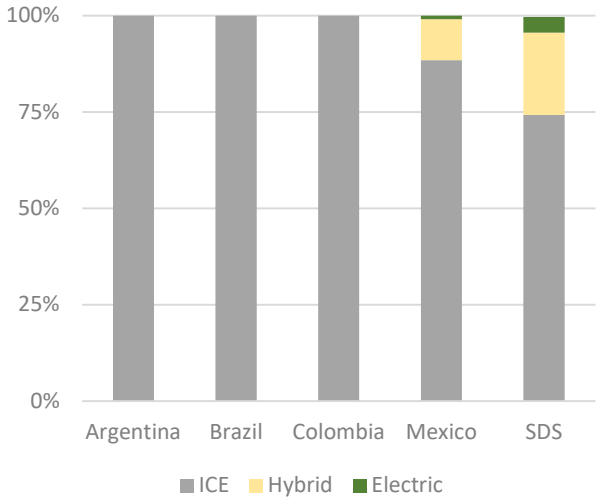


Figure 12: Future technology mix (2024) by country compared to 2DS in the automotive sector (Source: 2DII, based on AFS and IEA ETP)



This trend is, however, not observed in most of the countries examined. Figure 13 shows that while Colombia and Argentina are reducing fossil fuels production, Brazil, Mexico, and Chile are increasing it. This is more pronounced in Brazil, where oil and coal production are increasing 40% and 11% respectively in the next 5 years.

Banks providing financing to companies in countries in which an increase in production and reserves is observed are more prone to be exposed to transition risks as the world's demand decreases and 'unburned' assets become stranded. This is particularly critical in countries that are net exporters such as Brazil and Colombia. Evidence of the decline of the coal industry is starting to be seen, with the CEO of the Colombian Cerrejon coal mine stating that the industry is in terminal decline as prices slump[73] and Brazilian coal giant Vale SA. reporting a -4.3% in its EBIT adjusted margin for 2018 in its coal business[74]. This decline not only relates to decreasing coal prices but also to the impact of stronger weather events. Local commercial banks Bradesco and Banco do Brazil provide financing to Vale SA[75].

Implications for banking sector. The physical asset level data analysis shows that the banking sector in Latin America's largest economies might have an important exposure to transition risks. Even though the analysis above is limited in scope as it only covers three carbon-intensive sectors and focuses on a specific part of the sectors' value chain, it provides guidance to banks, governments, regulators and supervisory authorities on which of the three sectors might be more at risk in the different jurisdictions, considering the magnitude of the exposure and the dynamics within the sector[76]. This analysis however finds two similarities across the banking sectors of all jurisdictions – there is a latent exposure to transition risks as banks finance:

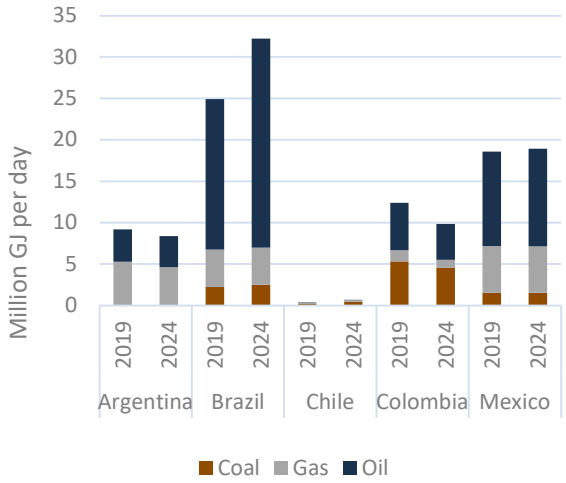
i. power and fossil fuel companies that are not reducing their exposure to oil and coal at the pace required for a transition; and

ii. automotive companies that are not investing in low-carbon alternatives or whose investments are not as high as they should be for the required transition.

These findings notably have implications for all participants in the banking sector:

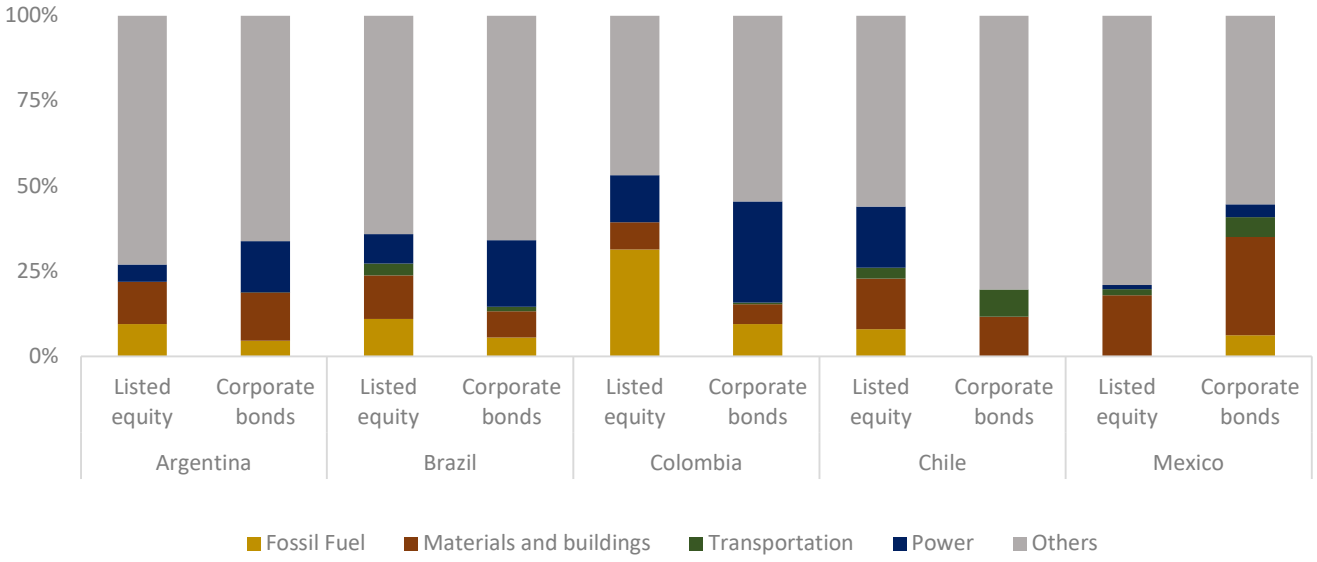
- Banks now have evidence to start assessing their corporate lending portfolios' exposure to transition risk by using scenario analysis tools. However, this will be one of the very first steps in a journey towards the mitigation of these risks. Section 4 provides further insights about the avenues for mitigation;
- Governments now have evidence of the lack of compatibility between the progress made in some sectors of the real economy and the progress required to meet the objectives of the Paris Agreement goals, which equally signals a potential mismatch with the Art. 2.1(c) objective of the Paris Agreement of making financial flows consistent with climate goals; and
- Banking supervisory authorities and regulators have now evidence of the sector's potential exposure to transition risks, which could have an impact on financial stability. They are therefore called to join initiatives such as the NGFS to build their capacities on the topic in a view to ultimately define i. how to improve transparency on the integration of climate change by banks at portfolio level; ii. how regulatory stress tests can integrate climate-related risks considering different scenarios and test the resilience of the financial system; and iii. how to better shape regulation or local initiatives to foster the integration of climate-related risks in the decision making of financial institutions.

Figure 13: Current and future production plans by type of fossil fuel (Source: 2DII, based on Global Data)



It is equally relevant for investors to understand how their bank investees are managing their exposure to climate related risks as an impact in banks' corporate lending portfolios could potentially impact banks' value drivers and consequently the market prices of their issuances.

Figure 14: Capital market sectorial exposure by country (Source: 2DII, based on Bloomberg)



3.2. Asset owners' and managers' exposure to transition risks

Setting the context. Asset owners and asset managers in Latin America can be equally exposed to transition risks. Their exposure is notably a function of the capital markets they are exposed to, which in turn varies as a result of the sectoral composition of the local economy, the types of instruments available, and the size of the market - as larger markets tend to have more international companies trading.

The main driver of transition risk for investor portfolios are however the corporate issuers of financial instruments. As transition risks (or opportunities) materialize, companies' value drivers will be affected, which in turn will materialize in changes in asset prices. For instruments whose issuer is not a company, the propagation channels of transition risk are more muted, which is particularly the case of sovereign bonds (see box 2).

Locally, the corporate issuers' universe of Latin American investors is reduced and limited mainly to companies with local operations that have publicly listed equity or debt instruments and a few foreign companies with listed instruments in the local stock exchanges. International investments are mainly focused in the Latin American Integrated Market stock exchange and in funds issued in Europe and the US. In general, investments outside the local stock exchange have a very low proportion in financial portfolios.

What capital markets data tells us. The sectoral exposure of companies trading in the local stockmarket can shed light on asset owners and asset managers' potential exposure to transition risks. Figure 14 shows the exposure to four transition-relevant sectors of stock exchanges in 5 countries, namely fossil fuels, materials, and buildings, transportation, and power. It considers the instruments issued by local companies or which primary stock exchange is one of the countries examined. These sectors cover from 21% to up to 53% of the market capitalization of listed equity issuers and from 20% to 45% of total amount of assets outstanding of corporate bonds issuers[77]. There is not a common trend between the exposure of the listed equity and the corporate bond markets, as exposures varies with the country context. For example, in Mexico the higher exposure of the corporate bonds market is explained by the instruments issued by state owned enterprises, Petroleos Mexicanos in the fossil fuels sector and the Federal Electricity Commission in the power sector. In Argentina, the higher exposure is mainly driven by the issuances

of electricity producer Pampa Energia S.A. However, this exposure will decrease in the future as the company is planning to repurchase nearly 50% of the corporate bonds outstanding.

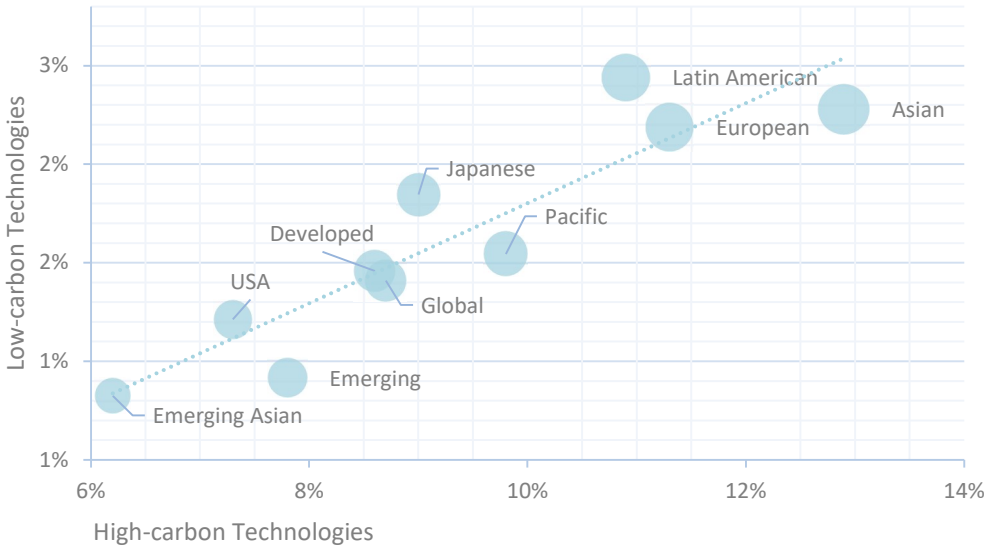
The estimated exposure levels are not negligible as the four sectors examined cover more than 70% of the CO_2 emissions in the real economy[78]. Figure 14 shows that the countries with the highest exposure to transition relevant sectors are Colombia and Brazil. In these countries, the high exposure of both the listed equity and corporate bonds markets is mainly driven by the weight of the fossil fuel and power sector. Most capital markets have a very low exposure to the transport sector, with Chile's corporate bonds market having the highest one (41%).

A high exposure to high carbon sectors does not automatically translate into a high exposure to transition risk; it all depends on the sectoral dynamics. A high exposure that is sustained by investments in low carbon technologies and a phase-out of high carbon technologies will result in investment opportunities rather than risks.

Figure 15 compares the low-carbon and high-carbon technologies share of different equity markets for selected sectors, namely automotive, power utilities and fossil fuels. It builds on physical-asset level data and links it to the companies with listed equity instruments issued in each market[79]. It shows that the Latin American equity market has the highest low-carbon share of around 3%, mainly driven by its share of hydropower. The share of high carbon technologies is however one of the highest ones with around 11%, mainly driven by oil production. Overall, Latin America's equity market low- to high- carbon ratio is the highest compared to other markets. This signals a potential lower impact of transition risks compared to the other equity markets, as the opportunities that low-carbon technologies can bring might offset part of the losses of that high-carbon technologies can cause.

Public capital markets data show a high exposure to the sectors and related technologies that will be affected the most in the transition to a low carbon economy. In particular, most Latin American markets show significant exposure to two key sectors: the fossil fuels and the power sector. This was found in both the listed equity and corporate bonds markets of most countries examined. The high exposure is substantiated by a higher proportion of high-carbon technologies than low-carbon technologies. This suggests that transition risk materializing in the short term might negatively hit companies' value drivers, which in turn will result in a negative impact on capital markets.

Figure 15: Exposure to low- and high-carbon technologies of different equity markets (Source: 2DII, based on Global Data and AFS)



Box 2: Transition risk exposure of sovereign bonds investments

Institutional investors in Latin America have an important share of their investments in sovereign bonds. This is due to factors such as minimum investment thresholds set by supervisory authorities, incentives under the capital requirements of Solvency II, high liquidity and/or high interest rates. In some jurisdictions the portfolio share of investments in sovereign bonds can go up to 60% [80]. The high share notably raises the question on how transition risks can be factored and managed in sovereign bonds investment.

A low-carbon transition, if it isn't well designed and/or initiated early enough, can have severe implications for a country's economy – although less severe in the long run than taking no action to mitigate climate change, which consequently can affect sovereign bonds ratings and yields due to changes in:

- **Institutional strength** through the capacity of governments to build effective and predicable policies.
- **Economic strength** through lower revenues from high carbon economic sectors having an impact on GDP. High GDP concentration in exposed sectors increase the sovereign's susceptibility to transition risks.
- **Fiscal strength** through increased expenditures (green investments, social policies, etc.), decreased fiscal revenues due to lower economic activity of high-carbon sectors, and increased cost of borrowing.

Revisions of country outlooks addressing changes in policy have already taken place (e.g. S&P on Mexico due to changes in energy policy), but there is no evidence of downgrades as a result of climate change considerations.

Managing climate-related risks. The main strategies institutional investors carry out relate generally to investment in "green" /divestment in "brown" or engagement. Engagement in sovereign bonds on climate or any sustainability-related topics is rather inexistent due to high burdens associated with the number of parties involved (e.g. different local ministries) and diverging priorities. To our knowledge, there is no public evidence on results of government engagement on climate-related topics other than specific engagement on green bonds issuance. This dynamic notably diminishes the risk mitigation potentials of this asset class and often pushes investors towards the divestment of risky assets, thus leading to a risk transfer rather than an economy's de-risk.

Recently, Sweden's central bank sold off bonds from the Canada province of Alberta and Australian states Queensland and Western Australia due the financial risks associated to their excessive carbon intensity[81].

The data analytics used here are however a proxy indicator for what investors could expect in their portfolio exposure, as the exposure will vary due to differences in investment policies, regulatory limits, and the share of investments made in instruments issued in other countries. More importantly, these analytics provide information about a specific point in time in the past and as that transition risks will materialize in the future, they fail to address future changes in the exposure (positive or negative) arising from companies' production and investment strategies.

Implications for capital markets participants. The capital markets data coupled with the physical asset level data tells us that investors in Latin America's largest capital markets might have an important exposure to transition risks. Even though the analysis above is backward looking, it provides guidance to investors, governments, regulators and supervisory authorities on which market (i.e. listed equity or corporate bonds) might be more at risk and which sectors are the driving those risks. These findings notably have implications for all participants in the sector:

- Investors now have evidence to start assessing the exposure to transition risk of their listed equity and corporate bond portfolios. Scenario analysis can be an excellent tool for this (see below one application);
- Supervisory authorities and regulators now have evidence of investors' potential exposure to transition risks, which could have an impact on financial stability. They are therefore called to put initiatives or regulation in place that allows them to better understand the exposure of their supervised or regulated entities to these risks and the resilience of the financial system. The initiatives or regulation could have for objective to improve transparency (e.g. in the form of dedicated surveys of the integration, assessment and management of climate-related risks) or target the measurement of these risk through the use of supervisory data as some supervisory authorities have already done (e.g. California Department of Insurance) or will do (e.g. Bank of England and Bank of France); and
- Governments now have evidence of how significant the exposure of investors is to industries that are critical for the achievements of the Paris Agreement. They are called to engage more with investors on the topic and to join governmental initiatives that aim at assessing the potential misalignment of investors' portfolios with the Art.2.1. (c) of the Paris Agreement such as the PACTA 2020 initiative[82].

Specific application of scenario analysis . To substantiate the results derived from the capital markets and physical-asset level data, 2° Investing Initiative applied scenario analysis on Latin American investors' portfolios.

Two datasets of investment portfolio data were analysed:

i. Mandatory pension funds portfolio data sourced from the Financial Superintendence of Colombia, with a portfolio of USD 42.9 billion[83]. This was one of the few publicly available datasets found with the level of granularity required to apply scenario analysis. This analysis accounts for 92% of the total investments of pension funds, voluntary pension funds data is not publicly available; and

ii. Insurers' portfolio data sourced from the Colombian Insurance Federation (FASECOLDA), with a portfolio of USD 14.9 billion. 2° Investing Initiative and FASECOLDA partnered in 2018 to assess the potential exposure to transition risks of their member entities. This analysis accounts for 100% of the total investments of insurers. This exercise was the first of its kind in the Latin America. This report shows some of the results of the analysis [84].

The scenario analysis model used is the Paris Agreement Capital Transition Assessment (PACTA) (see box 3 for details on the model). The analysis showed that:

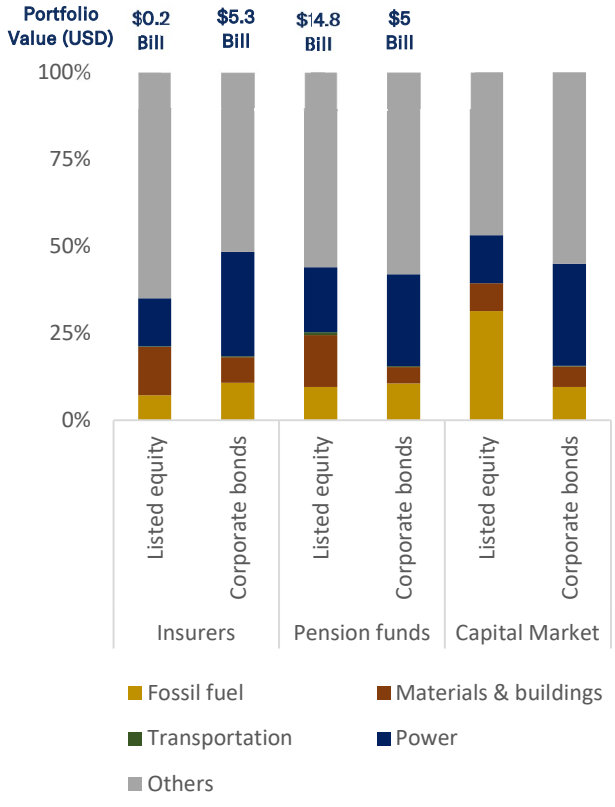
1. **The corporate bond portfolios' exposure to transition-relevant sectors of Colombian pension funds and insurance companies is relatively similar to the Colombian capital markets' exposure in terms of magnitude and sectoral proportion, while in the listed equity portfolios there are differences, some of which relate to the investors' exposure to international instruments. The materialization of transition**

risks will therefore affect differently each portfolio.

Overall, the insurers corporate bond portfolio has a slightly higher exposure to transition relevant sectors (48%) than the pension funds (42%), while the capital market shows an exposure of 45% (see Figure 16). In terms of sectoral exposure, both investor's portfolios are heavily exposed to companies in the power and fossil fuel sector in a similar proportion to the capital markets, these two sectors represent 84% of the total exposure to transition relevant sectors of insurers and 88% for pension funds. The similarity of the portfolio's exposure to the capital markets exposure can be explained by the portfolio's high concentration in the local market. The materialization of transition risk in these sectors might therefore result in similar changes in the corporate bond portfolio rate of return of both investors.

On the other hand, the listed equity portfolios of both investors show a lower exposure to transition relevant sectors when compared to the market (53%), with the pension funds having a total exposure of 44% and the insurers of 35%. The two main sectors driving this exposure are the power sector, and materials and buildings. The exposure to energy sector companies is significantly lower than the market (31%), at 7% for the insurers and 10% for the pension funds. This means that the materialization of transition risk in the energy sector might have a lower negative impact in the listed equity portfolio and in the rate of return of pension funds and insurers compared to the market. However, in absolute terms the negative impact could potentially be higher for pension funds as their listed equity portfolio is ~70 times bigger than the insurers portfolio.

Figure 16: Exposure to transition relevant sectors of Colombian pension funds and insurers (Source: 2DII, based on portfolio and market data)



2. Colombian pension funds' and insurers' portfolios current proportion of high-carbon technologies in the listed equity portfolio, is higher than the proportion of low-carbon technologies, while in the corporate bond portfolios the low-carbon portion is considerably higher. The high-carbon sectors' exposure is however different in each portfolio. The materialization of transition risks will therefore stem from different drivers that could potentially negatively affect the financial performance of both investors.

Figure 17 shows the exposure (in terms of percentage of AUM) to low- and high-carbon technologies of insurers and pension funds in three sectors, namely, fossil fuels, power utilities and automotive. The exposure to high-carbon technologies is higher in the listed equity portfolio (76% for insurers and 85% of pension funds) compared to the corporate bond portfolio (around 40% for pensions funds and 49% for insurers) which suggest the former portfolio might be more at risk. However, each portfolio is exposed to a different potential risk.

The potential risk exposure of the listed equity portfolio is driven by the significant weight that oil & gas producers have in the portfolios. The listed equity portfolio is financing more oil & gas production (around 8% for both investors) than the corporate bond portfolio is (around 4% in the case of pension funds and 6% in the case of insurers), resulting in a slightly higher relative exposure to high-carbon technologies (see Figure 17). Even though the proportion of oil & gas is higher, in absolute terms the amount of assets at risk is not necessarily higher for both investors. In the case of

insurers, the oil & gas investments in listed equity are about 4% of the total investments of the corporate bond portfolio. Thus, the assets at risk in the corporate bond portfolio are considerably higher than in the listed equity one.

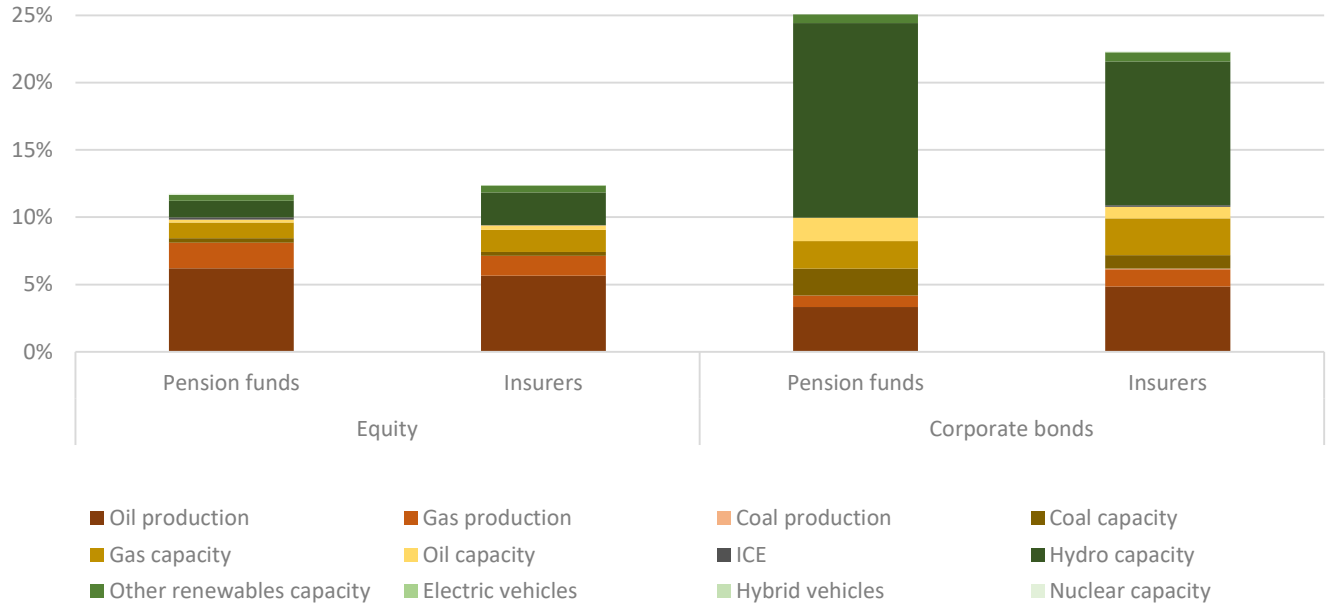
Most of this exposure is driven by oil production, which is responsible for over 60% of the exposure to high-carbon technologies. Oil is a technology that is set to decrease in the transition to a low carbon economy, while gas production is expected to increase as it is needed as a 'transition' technology.

High-carbon technologies of both the power and fossil fuel sector in the corporate bond portfolios of insurers and pensions funds are slightly outweighed by low-carbon technologies . Both investors have a similar exposure to high-carbon technologies: 10% in the case of pension funds and 10.8% in the case of insurers. Pension funds have a slightly higher exposure to high-carbon technologies in the power sector, while insurers do the same for the fossil fuel sector. However, the most critical exposures come from oil and coal capacity, as these are energy sources that are meant to be phased out in the transition to a low carbon economy. The portfolios' exposure to these technologies is very similar: 7.1% in the case of pension funds and 6.8% in the case of insurers. On the other hand, renewable energy sources account for 15% of the pension funds' portfolio and 12% of the insurers' portfolio.

No portfolios are seizing the financial opportunities the low carbon economy will bring through non-conventional renewable energy sources. Both portfolios' current exposure is significantly low (<0.5%). In absolute terms the corporate bonds portfolio of pension funds is financing half of the non-conventional renewables financed in the listed equity portfolio, while in the case of insurers, this portfolio is financing 33 times what is being financed in the listed equity one.

Forward looking information in needed to establish who will be hit the most by the transition. The current financial exposure shows that, overall, the technology and sectoral exposure of pension funds and insurers is quite similar and that the main differences in terms of impact may arise from the listed equity portfolio as the pension funds listed equity portfolio is 70 times bigger than the insurers one. However, as transition risks will materialize in the future, it becomes more relevant to estimate changes in the technology exposure over the next years and relate those changes to the ones required under scenarios that integrate the materialization of transition risks as well as the size of both investors' portfolios.

Figure 17: Exposure of the portfolios to high-carbon and low-carbon activities, as a % of the portfolio (Source: 2DII, based on portfolio data)



Box 3: The Paris Agreement Capital Transition Assessment Model (PACTA)

The Paris Agreement Capital Transition Assessment Model is a scenario analysis model that assesses the alignment of investors and banks portfolios with different climate scenarios. It allows users to understand if financial portfolios are potentially exposed to transition risk arising from a disruptive transition and to identify avenues for risk mitigation. This model, developed by 2° Investing Initiative, has been used by 1,500+ financial institutions, governments, supervisory authorities, and industry associations such as the Swiss Federal Office for the Environment, the California Insurance Commissioner, and the Colombian Insurers Federation. Investors can access an online version of the tool at https://www.transitionmonitor.com/.

PACTA provides a **forward-looking, 5 years** in the future bottom up analysis that builds on investment and production plans of investee companies at physical asset-level and consolidates the information to identify the energy transition profile of these companies and their related financial instruments. This information is aggregated at portfolio level and compared against the production plans projected in different climate scenarios. The current (mis-) alignment between the portfolio and these scenarios allows users to infer potential exposure to transition risks in the case of a disruptive transition.

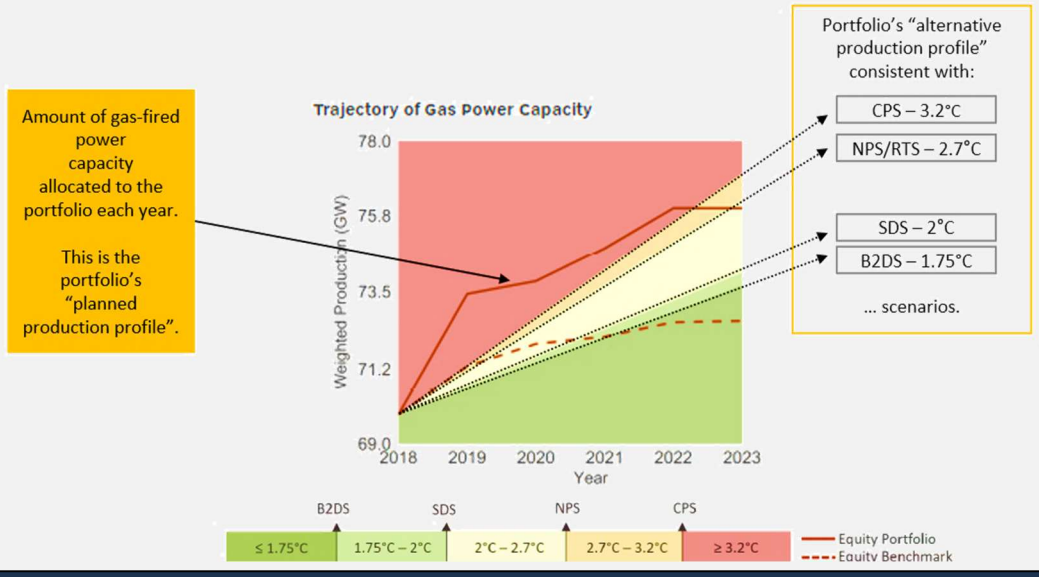
Scope. PACTA covers 7 sectors, namely fossil fuels, power, automotive, aviation, shipping, cement, and steel. These sectors account on average for 10 to 25% of the AUM in a financial portfolio and between 70 to 90% of the CO_2 emissions. It assesses listed equity, corporate bond, and corporate lending portfolios.

Inputs of the model . Three main types of inputs are needed:

i. Financial portfolio data, including ISINs, market value and the currency of each position;
ii. Investee companies' physical asset level data sourced from market intelligence data providers covering 230,000+ individual assets globally, 40,000+ companies and 30,000+ securities; and
iii. Climate scenarios data. The model currently uses 4 IEA scenarios the Below 2°C Scenario (B2DS – <1.75°C), the Sustainable Development Scenario (SDS - ~2°C), the New Policy Scenario (NPS – ~2.7°C) and Current Policy Scenario (~3.2°C).

Outputs of the model . The model provides a sector or technology specific analysis that includes:

- Trajectory the portfolio is following compared to the required in different transition scenarios in terms of production (see figure below);
- Technology mix under or over-exposure in terms of percentage points compared to the IEA SDS scenario and different benchmarks; and
- The sectoral emissions intensity trajectory, in those sectors for which low-carbon technologies are not commercially available.



Scenario analysis allows us to understand the future exposure to transition risk of investors' portfolios, differences between portfolios (i.e listed equity and corporate bonds portfolios), and the magnitude of their exposure. In particular, the PACTA scenario analysis estimates the (mis-)alignment of financial portfolios to different climate scenarios, which in turn allows us to identify the sectors and related technologies that could potentially be more exposed as a result of a disruptive transition risk materializing in the future. This is done through a bottom-up analysis that considers investment and production plans of the companies in the portfolio.

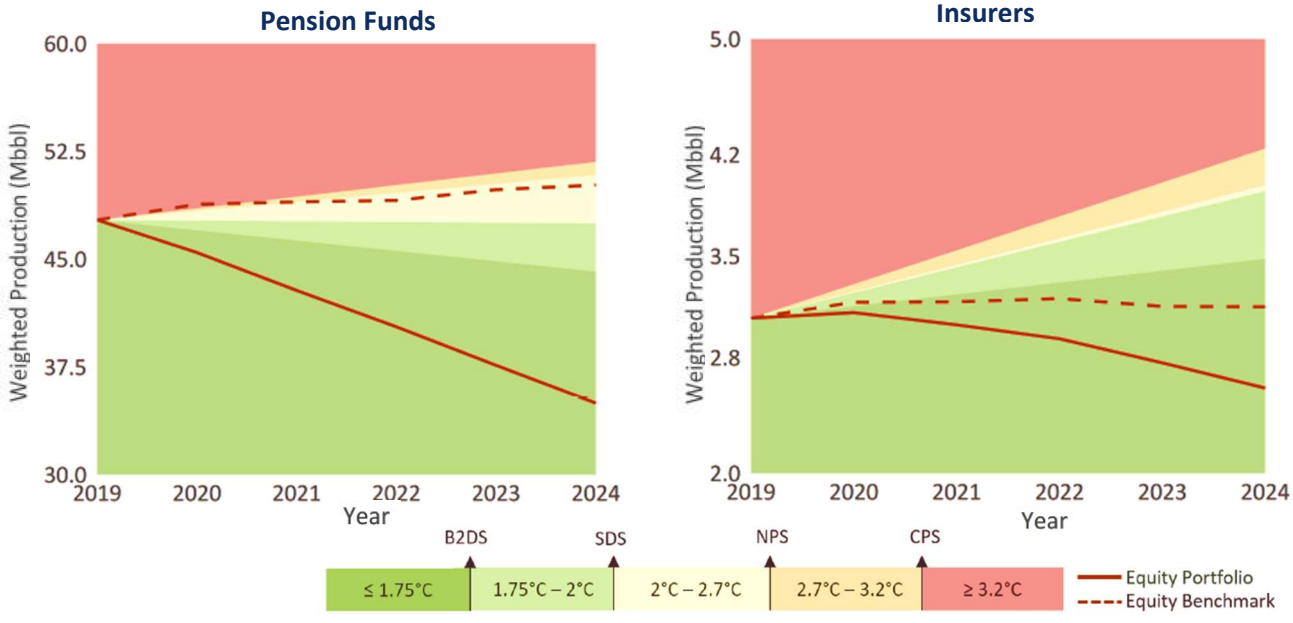
3. Both the pension funds' and insurers' portfolios follow different trends in the next five years. Some of these trends are shared in both the listed equity and corporate bond portfolios, while others are portfolio specific, but all portfolios are exposed to transition risks in some form. The scenario analysis results show:

Fossil fuel sector. The scenario analysis covered three technologies: oil and gas production, and coal mining. The results show that pension funds and insurers:

- Are potentially not exposed to transition risks affecting the oil & gas sector in the next five years; however, this exposure or lack of it needs to be monitored as it results from macroeconomic factors and not climate-related ones;
- Are exposed to transition risks potentially affecting the coal mining sector. While the pension funds' exposure is in the listed equity portfolio, in the case of insurers this exposure is in corporate bond portfolio. The assets at risk of pension funds are about twice the assets of insurers. The absolute losses of the materialization of transition risks in the pension funds portfolio are therefore potentially higher.

Oil & gas. The portfolios of both insurers and pension funds are potentially not exposed to transition risks materializing in the next five years as their trajectories are aligned with a <1.75°C scenario due to a significantly decreasing production of both oil and gas in the next five years. This is the case in both the listed equity and corporate bond portfolio. As an example, figure 18 shows the insurers' and pensions funds' corporate bond portfolios alignment in oil production relative to the IEA scenarios. The decreasing production shown in figure 18 implies that the high exposure of the portfolios to the oil & gas sector (figure 17) does not necessarily represent a risk in the next five years as the companies in the portfolios are adjusting the production in line with the lower supply that is foreseen in a <1.75°C scenario. It however raises

Figure 18: Alignment of oil production in the corporate bond portfolios of insurers and pensions funds relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



questions around other alternative businesses the companies could be developing to compensate the revenue loss due to the decreasing production.

However, results should be put into context and identify if the drivers of this decreasing production result from changing strategies that consider the transition to a low-carbon economy or relate to other non-climate related factors. In this case, the driver is the latter. The decreasing production plans result from operational and production strategies that have negatively impacted the production profiles of the companies, even considering a context in which the oil industry was recovering (as of 2018). This does therefore raise questions around future changes in the alignment of the portfolio, as a consequence of a better macro-economic context, and calls for close monitoring.

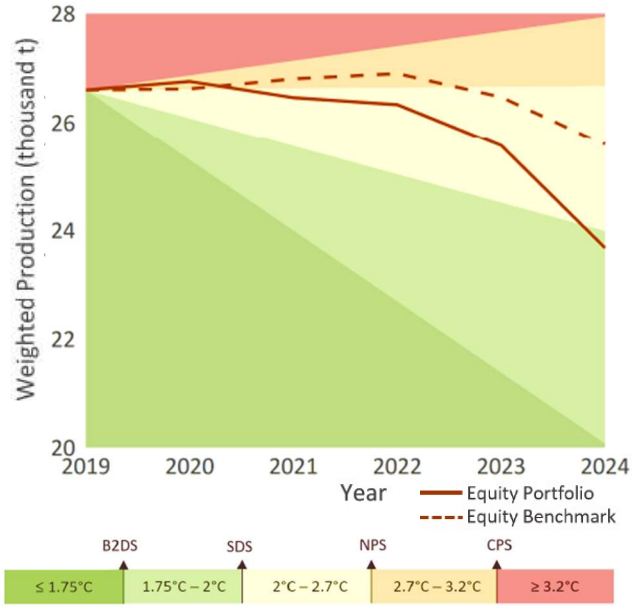
Coal mining. Despite the lower proportion of this sector in the portfolio, pension funds and insurers are both potentially exposed to transition risks arising from a disruptive transition and affecting coal mining companies in the portfolio. The pension funds scenario analysis results show this exposure is in the listed equity portfolio, while the insurers' exposure is in the corporate bond portfolio. Investee companies in both portfolios are decreasing their coal production, but the decrease is not as ambitious as it should be for the portfolios to be aligned with a <2°C scenario. Both portfolios are compatible with a 2°C – 2.7°C scenario.

The pension funds listed equity portfolio trajectory starts to align with a <2°C scenario in 2024 (see Figure 19). The absolute losses from the materialization of a disruptive transition in the pension funds' portfolio are however potentially higher as the assets at risk of pension funds are about twice the assets of insurers.

Moreover, these results confirm that information covering a single point in time (as seen in point 2) provides limited information on the potential exposure to transition risks and thus the relevance of forward-looking methodologies such as scenario analysis.

Power sector. The scenario analysis covered six technologies: oil, gas, coal, nuclear, hydro, and other renewables. Its results show that insurers and pension funds:

Figure 19: Alignment of coal mining production in the listed equity portfolio of Colombian pensions funds relative to the IEA transition scenarios (Source: 2DII, based on based on Global Data, Bloomberg, and IEA)



- are potentially exposed to transition risks arising from a disruptive transition that affects coal power utilities, but this exposure varies for each investor. In particular, the pension fund's listed equity portfolio is potentially highly exposed to transition risks as its portfolio trajectory is currently compatible with a >3.2°C trajectory.
- corporate bonds and listed equity portfolios investments in gas power are potentially not exposed to transition risks materializing in the next five year, as they are aligned with a SDS (<2°C) scenario; however, the pension funds listed equity exposure needs to be monitored as there is a potential risk of future misalignment.
- corporate bonds and listed equity portfolios are exposed to transition risks arising from a disruptive transition that affects oil power utilities. They are currently following a trajectory that is compatible with a >3.2°C scenario.
- are not seizing the opportunities the low-carbon economy will bring with non-conventional renewable energy sources. Some portfolios are however aligned with a <1.75°C scenario trajectory in hydropower and could potentially offset part of the losses associated with the misalignment in oil and coal power.

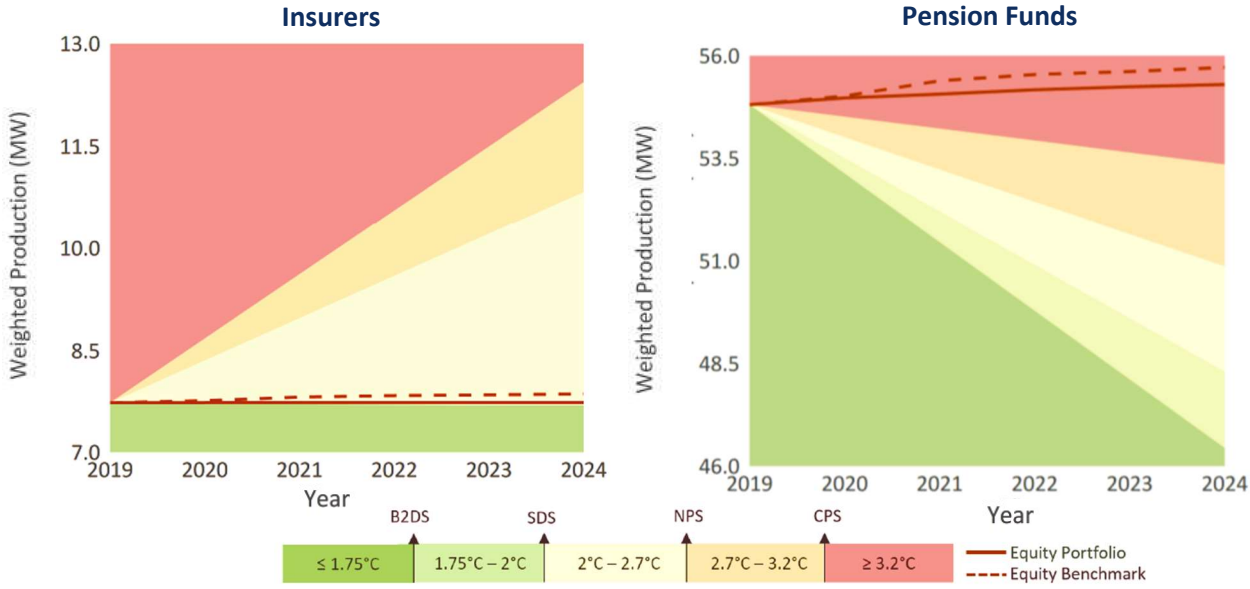
Coal power. Pension funds and insurers are both potentially exposed to transition risks arising from a disruptive transition that affect coal power utilities, but the future exposure of each investor is different. The scenario analysis results show that the pensions fund listed equity portfolio is compatible with a >3.2°C trajectory (see Figure 20), while the corporate bond portfolio is potentially not exposed as it is compatible with a <1.75°C trajectory. The listed equity portfolio, which has a low financial exposure (see Figure 17), slightly increases its production in the next 5 years, while it should decrease by around ~15% by 2024 for the portfolio to be compatible with a <2°C scenario.

This result shows that technologies with low financial exposure can also be a relevant source of transition risks, as these risks evolve over time and will materialize in the future.

On the other hand, insurers are potentially exposed to transition risks in both of their portfolios. The trajectory of both portfolios is just above the SDS scenario trajectory (see Figure 20); minor reductions of 1% to 2.3% by 2024 are needed for both portfolios to be aligned with a 2°C trajectory. Both investors are however outperforming their benchmarks.

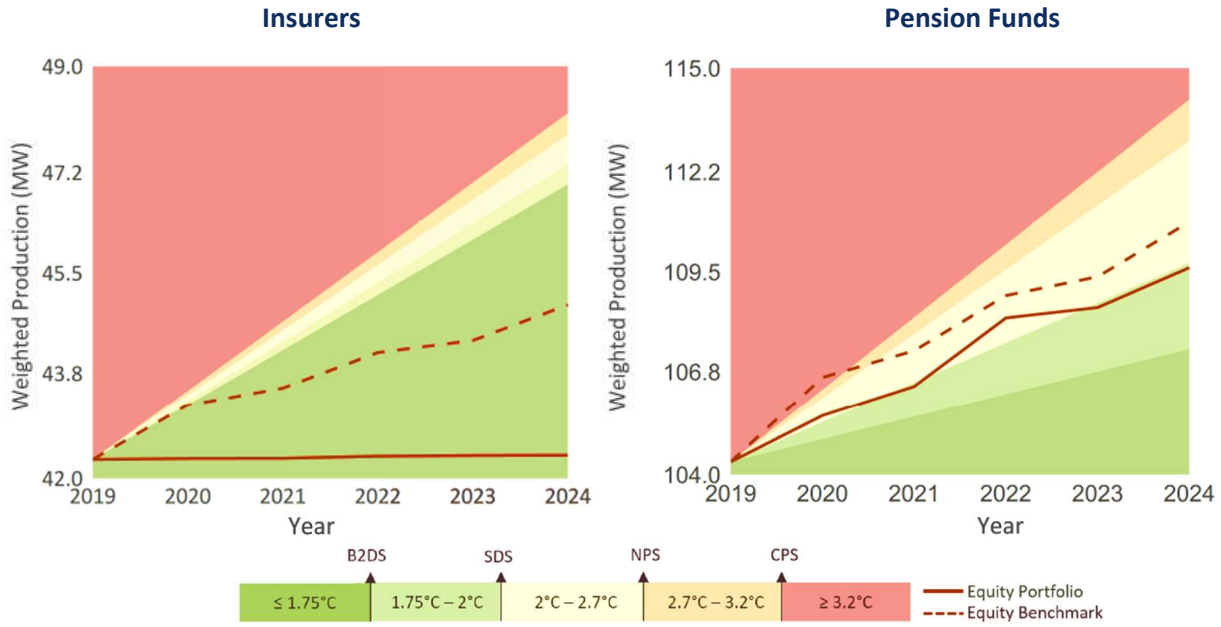
The assets at risk in the insurers' listed equity and corporate bonds portfolios are however only 14% higher than the assets at risk in the pension funds listed equity portfolio, thus there might not be substantial differences in the absolute losses of both investors.

Figure 20: Alignment of coal capacity generation in the listed equity portfolio of Colombian insurers and pensions funds relative to the IEA transition scenarios. (Source: 2DII, based on Global Data, Bloomberg, and IEA)



Gas power. The corporate bond portfolios and the listed equity portfolio are potentially not exposed to transition risks affecting gas power utilities as they are currently aligned with a <2°C scenario. However, the alignment of the pension funds' listed equity portfolio is at risk and should be monitored. Figure 21 shows both pension funds' and insurers' listed equity portfolios. The pension funds' listed equity portfolio is largely aligned with a <2°C scenario trajectory, but any increase in the production plans of the companies in the pension funds' portfolio would result in a misaligned portfolio and thus a potential exposure to transition risks. The companies contributing to this technology alignment should therefore be closely monitored. On the other hand, the insurers' listed equity portfolio is not increasing the gas power build out and it is aligned with a <1.75°C scenario. Corporate bond portfolios of both investors are currently not financing companies that are planning to increase their gas power capacity, the portfolios are thus aligned with a <1.75°C scenario.

Figure 21: Alignment of gas power utilities in the listed equity portfolio of insurers and pensions funds relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



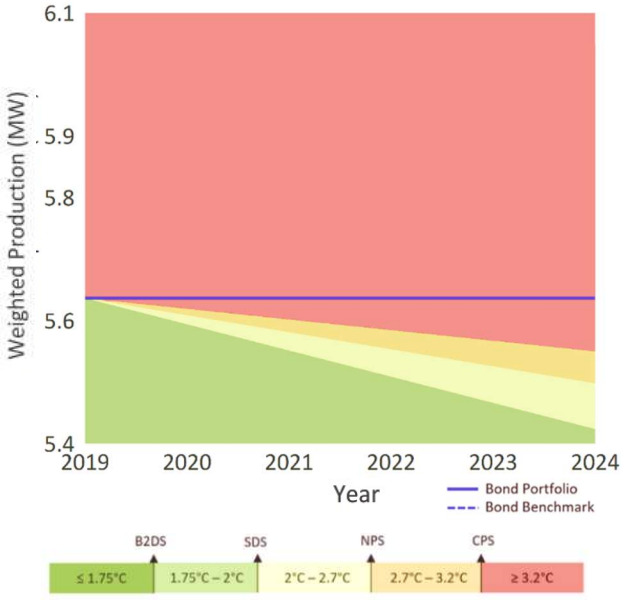
Oil power. Both the listed equity and corporate bond portfolios of insurers and pension funds are potentially exposed to transition risks arising from a disruptive transition. All portfolios are currently following a trajectory of more than >3.2°C. Figure 22 shows the example of the pension funds' corporate bond portfolio.

Reductions in the oil power capacity build out are needed for the portfolios to be aligned with a <2°C scenario. While the insurers would need a reduction of 5% to 6% by 2024, pension funds would need a reduction of up to ~25% in their listed equity portfolio. Once again, this is a case in which the lower proportion of a sector in the financial exposure of a portfolio results in a future potential exposure to transition risks.

The assets at risk in the insurers' portfolios are however 40% of the assets at risk in the pension funds' portfolio. Thus, absolute losses from the materialization of transition risks in the pension funds' portfolios are potentially higher than for insurers.

Non-conventional renewable energy. Both investors are not seizing the opportunities the low-carbon economy could bring with non-conventional renewable energy sources, all portfolio trajectories are consistent with >3.2 scenario. The corporate bonds and listed equity portfolio are not increasing their non-conventional renewables capacity enough in the next five years, thus resulting in a trajectory that is compatible with a >3.2°C (see Figure 23 for the case of listed equity). The SDS scenario for Central and South

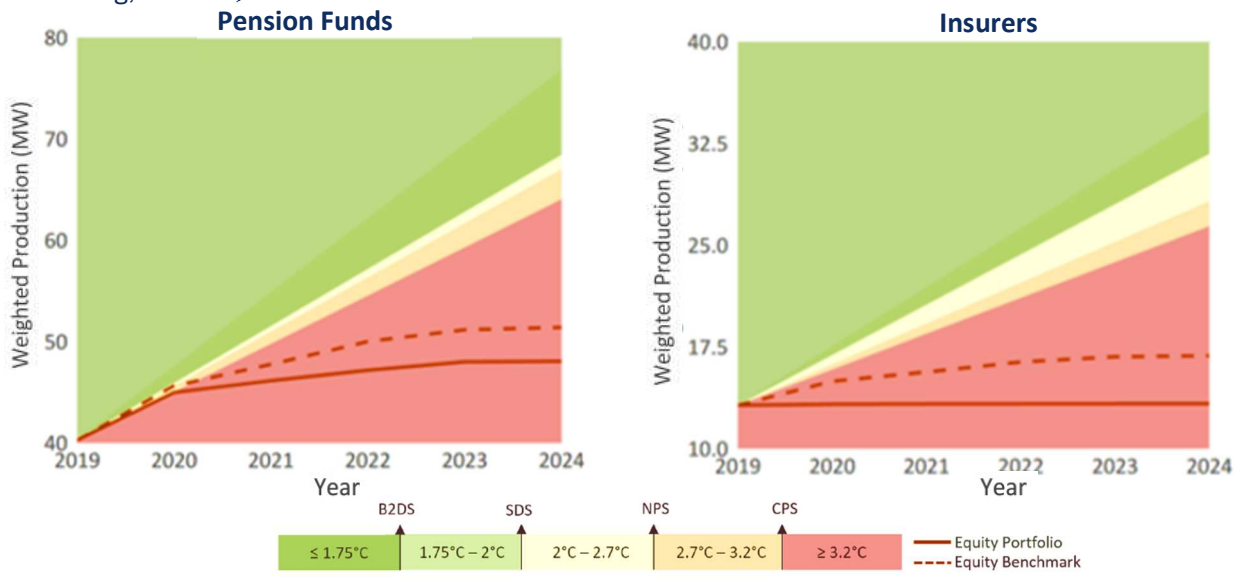
Figure 22: Oil capacity generation in the corporate bond portfolio of pensions funds relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



America estimates a two-fold increase in non-conventional renewables capacity by 2025 with respect to 2017 levels. Wind, and solar are the main technologies supporting that increase. For the listed equity portfolios to be aligned with a <2°C scenario, an increase in the renewables build out of 91% is required in the case pension funds by 2024, while insurers would require a 164% increase. Similar increases are required in the corporate bond portfolios.

This result can be seen as an opportunity loss that might reduce future revenues of those companies that are not investing in non-conventional energy sources as their price is estimated to continue to decrease to levels that will undercut conventional technologies and even hydroelectric plants. The International Renewable Energy Agency (IRENA) estimates that the costs of non-conventional renewable technologies entering service in 2023 will be lower than conventional technologies and hydroelectric plants[85]. The results can also show that future losses the transition can cause in the portfolio (i.e. through oil and coal power companies) are not going to be offset by positive returns from non-conventional renewables.

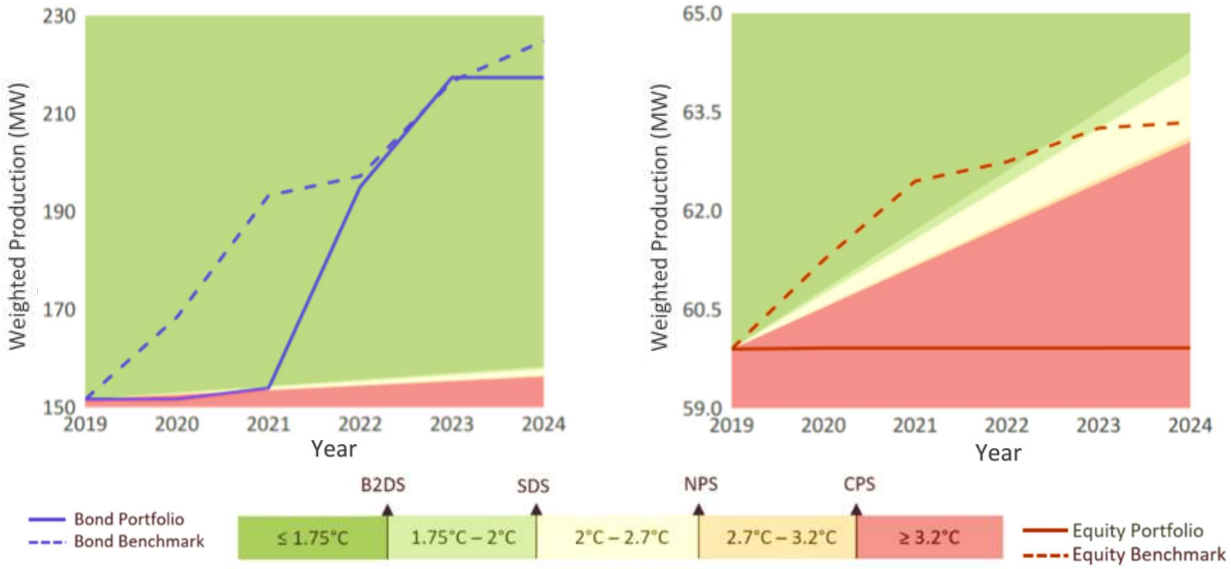
Figure 23: Alignment of non-conventional renewable energy capacity in the listed equity portfolio of insurers and pensions funds relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



Hydroelectric power. Insurers and pension funds listed equity portfolios are not compatible with a <2°C scenario, whereas their corporate bond portfolios are. The listed equity portfolios of both investors are aligned with a >3.2°C scenario as currently their portfolios are not increasing its hydropower capacity (see the example of insurers in Figure 24), this is however not the case of the corporate bond portfolios in which there is a significant increase in their hydropower capacity in a magnitude that is compatible with a <1.75°C scenario.

The hydropower exposure of the corporate bonds portfolios could potentially offset some of the financial losses associated to the assets at risk in oil and gas power companies. The investments in hydropower are four to six times higher than those in oil & coal power.

Figure 24: Alignment of hydro power utilities in the insurers corporate bond (left) and listed equity portfolios (right) relative to the IEA transition scenarios (Source: 2DII, based on Global Data, Bloomberg, and IEA)



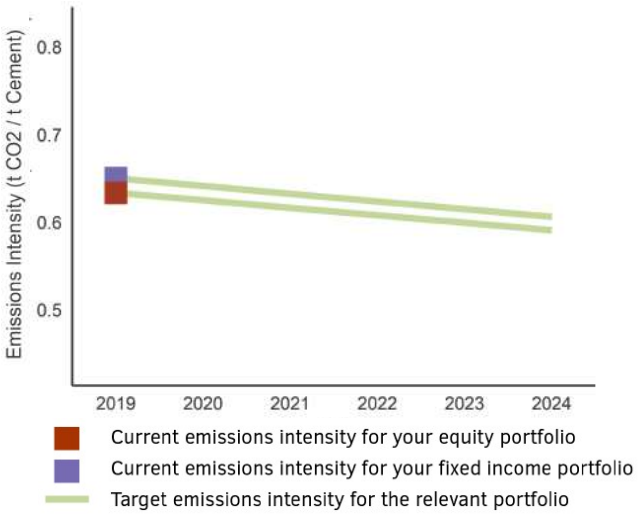
Cement, steel, and aviation sectors. Currently, there are no low-carbon alternatives commercially at scale in the cement, steel, and aviation sectors. The scenario analysis is therefore limited to understanding the required decrease in the portfolios' emissions intensity for it to be aligned with a climate scenario. The main results of these sector show:

- **Aviation.** The sector which is potentially more exposed to transition risk is the aviation sector. The emission intensity decrease of insurers and pension funds portfolios is similar. The emissions intensity needs to decrease by 43% in the listed equity portfolio and 72% in the corporate bond portfolio for them to be aligned with a <1.75°C scenario by 2024.

- **Cement.** This is the sector in which less reductions are needed. Insurers and pension funds need to decrease by the emissions intensity of both their listed equity and corporate bond portfolio by ~7% by 2024 for their portfolios to be aligned with a <1.75°C scenario (see in Figure 25 the results of pension funds).

- **Steel.** Only the listed equity portfolios are exposed to companies in the steel sector. A decrease of 23% in the emissions intensity of this sector is required for the insurers portfolio to be aligned with a <1.75°C scenario by 2024, while the pension funds portfolio requires a decrease of 20%.

Figure 25: Cement: Emissions intensity decrease under a B2DS for the listed equity and corporate bonds portfolio of pension unds (Source: 2DII, based on Global Cement Directory, Bloomberg, and IEA)



4. Sectors that do not have a significant weight in the portfolio should not be undermined as these can equally bring risks and opportunities .

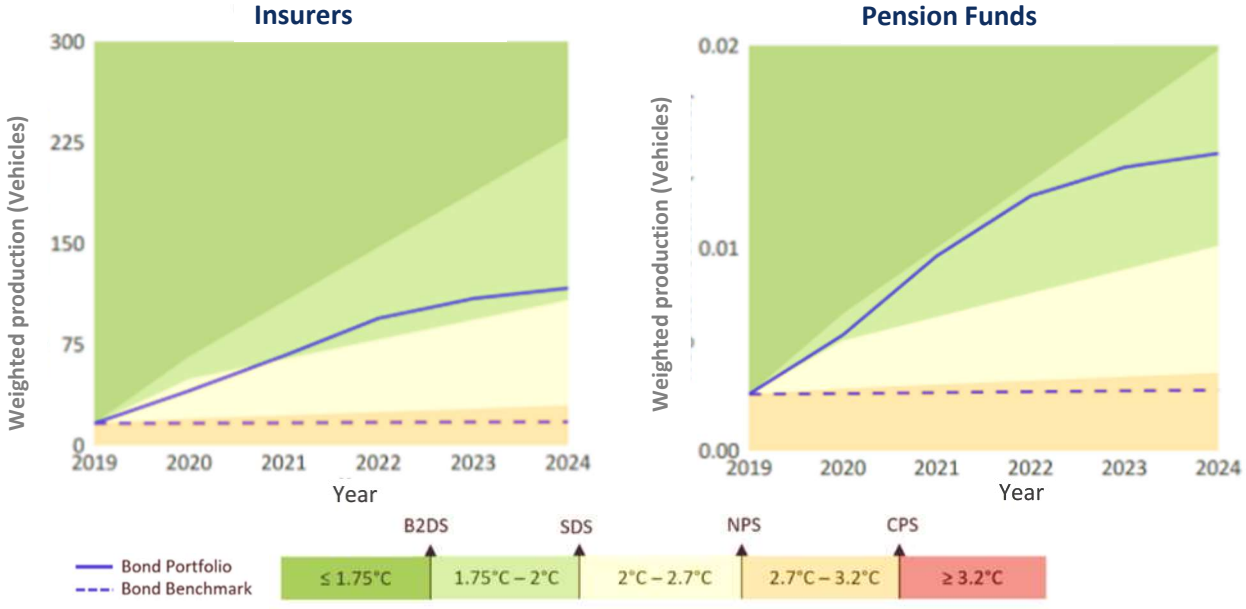
This is particularly the case of the automotive sector, which has a very small weight in the portfolio (<0.5%) coming mainly from investment in funds.

ICE production. Insurers' and pension funds' portfolios are potentially exposed to transition risk arising from a disruptive transition that affects ICE producers, as the companies in their portfolios are not decreasing their ICE's production in a magnitude that is consistent with a <2°C scenario. Both the listed equity and corporate bond portfolios of insurers and pension funds are in a trajectory that is compatible with a 2°C – 2.7°C scenario. However, the assets at risk of pension funds are around 5 times the assets at risk of insurance companies, thus the absolute losses from the materialization of transition risks in the pension funds' portfolios are potentially higher than for insurers.

Electric Vehicles. Insurers and pension funds corporate bond portfolio trajectory is compatible with a 1.75°C – 2°C scenario (see Figure 26). In the case of listed equity portfolios only pension funds are following this same trajectory, while insurers are under a 2°C-2.7°C scenario trajectory. Those portfolios that are compatible with a <2°C are therefore investing in companies that are adapting their strategies to seize the opportunities of the energy transition.

Hybrid vehicles production. Insurers and pension funds are not seizing the opportunities the energy transition will bring with hybrid vehicles, as companies in their portfolios are not increasing its hybrid production as much as it is required in a <2°C scenario. Both corporate bonds and listed equity portfolios trajectories are compatible with a 2.7°C – 3.2°C scenario.

Figure 26: Alignment of electric vehicle production in the corporate bond portfolios of insurers and pensions funds relative to the IEA transition scenarios (Source: 2DII, based on AFS, Bloomberg, and IEA)



5. The scenario analysis results are driven by the investment and production plans of a few local companies. Transition risks affecting these companies' financial drivers will have a major impact in the return of the pension funds' and insurers' portfolios. This situation therefore calls for a timely identification of the available avenues for the mitigation of transition risks arising from these companies.

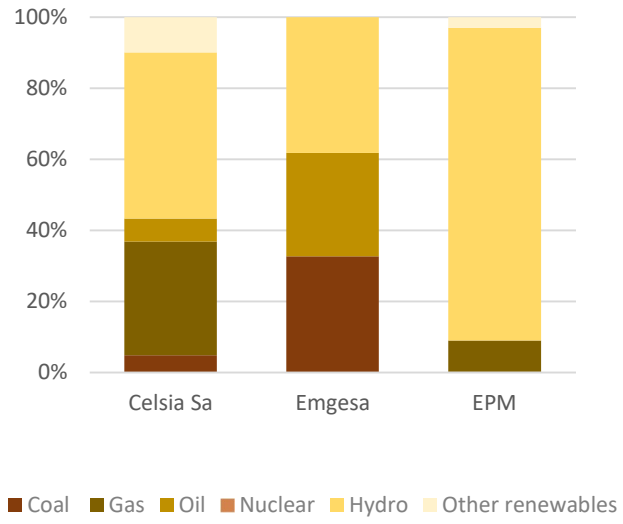
The sectors in which this situation is more present are oil & gas, power, cement, and aviation. The results shown here focus on the oil & gas, power, and cement sector as these are the sectors with the highest weight in the portfolio.

Oil & Gas sector. Investments in the listed equity and corporate bond portfolios of both investors are similar. Around 5.9% of the corporate bonds and

7.3% of the listed equity investments of the pension funds are in Ecopetrol. Ecopetrol is the only oil & gas producer in the corporate bond portfolio. In the case of insurers, Ecopetrol represents around 4.2% of the corporate bond portfolios and 7.2% of the listed equity investments. Both investors are exposed to other oil & gas companies, but their weight in the portfolios is negligible (<0.5%) when compared to Ecopetrol.

The results of the scenario analysis are therefore driven by Ecopetrol's investment plans (see Figure 27). However, analysis made by Carbon Tracker Initiative in 2019 showed that 10 to 20% of Ecopetrol's upstream capital expenditures might be outside of the SDS scenario[86] This is therefore an important point to investors as it means that some of Ecopetrol's assets might become stranded in the long-term [87]. This becomes even more relevant as Ecopetrol announces that its 2020 investment plans will involve capital expenditures between $3.3 billion and $4.3 billion[88].

Figure 27: Technology mix of selected Colombian utility companies (Source: 2DII, based on Global data)



Coal Mining. Investments in coal mining companies are mainly done through funds. Part of the exposure in coal mining comes from investments in companies that are not listed in Colombia, but which have production in the country (e.g. Glencore, BPH Billiton), as no coal company operating in Colombia has issued financial instruments.

Power utilities. Investments in this sector are concentrated in three companies. Empresas Publicas de Medellin (EPM) and Emgesa in the corporate bonds' portfolio, and Celsia in the listed equity portfolio. 16.5% of the corporate bonds' investments are in EPM and Emgesa (equivalent to 79% of the total investments in power utilities), while 2.52% are in Celsia (equivalent to 73% of the total investments in power utilities). In the case of the insurers corporate bond portfolio 9.9% of the investments are in EPM and EMGSA, while 5.1% of investments in the listed equity portfolio are in Celsia.

Any change in the investment plans of these companies or lack of it has therefore an impact on the alignment of the pension fund's portfolio. As of end 2018, EPM was the only company planning to increase its capacity generation in the next five years, focusing on hydropower generation. This therefore means that none of these companies are supporting the non-conventional renewables capacity additions the portfolio requires for it to be aligned with a <2°C scenario (see Figure 23 for the case of listed equity) and that close attention needs to be paid to any increase in gas capacity additions by Celsia as any increase would potentially lead to portfolio misalignment (see Figure 21).

Cement. Cement producer Argos and its parent company Grupo Argos make up 100% of the investments in cement producers of the corporate bond portfolios and around 90% of the listed equity portfolio. Any reduction or increase in the emissions intensity of their manufacturing process will therefore have a significant impact in the pension funds and insurers portfolio alignment.

Section IV

STRATEGIES FOR TRANSITION RISKS MITIGATION BY LATIN AMERICAN FINANCIAL INSTITUTIONS

4.1. Strategies for climate-risk mitigation

Once financial institutions have identified and measured their exposure to climate-related risk, the next intuitive step is to identify the avenues to mitigate such risks. There are different strategies that can be put in place, with the most common including:

- **Divestment:** selling instruments from issuers that are not mitigating their exposure to climate risks or that represent a potential source of climate risks. Several NGO movements support this strategy, in particular divestment from fossil fuel companies[89]. This strategy can also come as a result of setting exclusion criteria (see below).
- **Investment:** buying instruments issued by companies whose business will represent an opportunity in the energy transition (i.e. providing low-carbon solutions). It is generally associated with green, low-carbon or climate-friendly products or companies.
- **Exclusion:** systematically excluding issuers based on a set of criteria which defines companies that are a potential source of climate-related risks. The criteria can come in the form of thresholds (e.g. BNP Paribas asset management excludes companies that derive more than 10% of their revenue from mining thermal coal and/or account for 1% or more of total global production[90]), a theme (e.g. destruction of high conservation value areas[91]) or an industry.
- **Engagement:** using financial institutions' power to influence corporate behavior on climate-related topics. There are different forms of engagement including direct corporate engagement (e.g. communication with company boards), proxy voting, and filing or co-filing shareholder proposals.
- **Setting climate-related conditions:** including climate-related factors as part of the contractual conditions of a financial instrument. These conditions seek to influence and increase the climate performance of issuers so as to reduce potential risk exposure.

De-risking the portfolio vs. de-risking the economy. Although all the strategies mentioned have for objective to mitigate risk from financial portfolios, some of them can go further by helping to mitigate risks in the real economy. This is for example the case of engagement and the set-up climate-related conditions. By requiring

companies to improve their environmental or climate performance to mitigate potential climate-related risks, financial institutions can induce behavioral change in these companies which in turn can result in a lower impact in the environment and the climate. There is no evidence that capital reallocation strategies (i.e. invest, divest, exclude) have an impact on the company activities[92].

4.2 Factors driving the selection of mitigation strategies

The choice of the strategy is going to be largely driven by the financial market structure and the level of influence the financial institution has in the investee company(ies) identified as a potential source of risks.

The financial market structure mainly relates to:

i. **The market's diversification** in terms of sector and number of companies operating either in the capital markets or in the local/regional economy. In markets that are concentrated in a few sectors and companies, invest/divest or exclusion strategies are not considered the most appropriate choice due to the limited amount of companies. The application of these strategies can even be hindered by investment or lending mandates.

ii. **The regulatory framework** defining the levers of influence an investor has on its investees. Depending on the jurisdiction, these frameworks can define voting rights thresholds at general assemblies, the process to submit shareholder resolutions in these assemblies, among others. Understanding the regulatory framework is particularly relevant in the case of shareholder engagement strategies.

The level of influence the financial institution has in the investee company mainly relates to the governance relationship between the financial institution and the investee company. It needs to be considered that this relationship:

i. may change depending on the type of financial instrument. For example, in the case of shareholders the level of influence can be defined by the proportion of shares the investor holds as minority shareholder, while in the case of bondholders it can be defined by the contractual obligations set forth as part of the covenants, and in the case of banks it can be defined through the short and/or long-term debt share the bank is providing;

ii. does not necessarily need to be contractual for it to have an influence on the investee, it can equally be relational; and

iii. can be established as a single financial institution or by representing a group of financial institutions.

4.3. Risk mitigation strategies in the Latin American context

The financial market structure in Latin America is more suitable for mitigation strategies that support de-risking the economy than purely portfolio de-risking strategies. The main factors contributing to this are the high sectoral concentration and the low liquidity. The market structure thus provides a framework for the development of climate-risk mitigation strategies that position the financial institution as a key agent in the mitigation of risks in the real economy. However, some countries have a regulatory framework that can be limiting.

Market concentration and liquidity. The International Monetary Fund (IMF) Financial Markets Depth Index serves as proxy indicator to understand the concentration of financial markets. This index considers different factors such as the ratio of stock market capitalization to GDP and the total debt securities of non-financial corporations to GDP to measure size and liquidity of markets[93]. The index shows that there has been little progress in the largest Latin American capital markets in the past 10 years. Chile is the only country that has considerably increased its position in the index (from #39 in 2000 to #32 in 2017), Brazil (#40) and Mexico (#50) have moved up one position,

Colombia (#57) has dropped 4 positions and Argentina (#92) has remain stable.

In addition, in some jurisdictions, investors diversification is hindered by national regulation that restricts investments to high-quality domestic assets for prudential reasons and to support the expansion of domestic markets. High concentration on domestic issuers can be equally driven by a low risk tolerance. In the case of pension funds, around 70% of the listed equity assets and 93% of fixed income assets are invested domestically[94].

This, coupled with the results of the analyses in section 3, allow us to infer that invest/divest and exclusion strategies are not necessarily the most suitable strategies to follow due to the markets' heavy concentration in few companies within a sector, their low liquidity and size. The application of such strategies for the mitigation of climate-related risks at portfolio level might be quite limited if not inexistent.

It is therefore more relevant to carry out strategies that push for behavioral change at companies, such as engagement. Engagement strategies can be applied as shareholder, bondholder, and in the case of credit providers, directly with corporate clients. While bondholders and credit providers can establish contractual arrangements that include climate-related criteria by financial instrument, shareholders can make use of the stablished regulatory framework that sets the requirements associated to their voting rights.

The regulatory framework on shareholder voting rights of Latin American largest capital markets differ considerably. Table 2 identifies the requirements to follow to exercise the voting rights that are most used by shareholders aiming to include climate on companies' agenda :

- **Selection or change of Boards of Directors (BOD).** This allows investors to have a board with diversified backgrounds, including individual experts on climate and other non-financial issues. While in Mexico and Brazil there are minimum capital thresholds to access to voting rights, Chile and Colombia allow shareholders to vote proportionally to their voting capital.
- **Propose resolutions.** This allows investors to scale their engagement when dialogue with companies stalls or is unproductive. All countries provide some mechanism for shareholders to raise their topics of concern, however, all countries except Mexico establish minimum voting capital thresholds that ensure that concerns from a significant portion of shareholders are formally addressed by the board.
- **Opposing the decisions of the BOD.** Investors use this mechanism more rarely as it is often accompanied by legal action, which is very resource intensive. Brazil is the only country in which the regulation is silent, while Mexico, Colombia and Chile have different mechanisms.

More research on shareholder engagement in the region needs to be done to better define the engagement mitigation options of financial institutions and their probability of success. Understanding success as the likelihood that engagement actions result in a behavioral change, understood through changes in the investee strategy that support climate goals and mitigate climate-related risk in the real economy.

There is no evidence of Latin American financial institutions carrying out strategies for climate-risk mitigation nor of the existence of a framework or process to mitigate climate-related risks at portfolio level. This is not surprising, considering the results of the different surveys run in Latin American markets (see section 2). The lack of public evidence does not mean that strategies are not taking place, as some of these strategies can be confidential or at an early stage. This is for example the case of Bancolombia, which joined the Climate Action 100+ initiative in 2019 and so far, has not disclosed any information about its engagement strategy nor its relations with its overall risk management strategy[95].

Most of the information available on climate-related issues focuses on actions related to credit lines for low-carbon technologies or green bonds investments. The rationale driving these actions,

as presented by financial institutions, is to contribute to the transition to a low-carbon economy rather than risk mitigation.

There is however evidence that some financial institutions are carrying out some of these strategies for broader environmental and social topics. A survey from GovernArt and Vigeo Eiris on SRI uptake in Latin America shows that a few Colombian and Brazilian investors carry out exclusion strategies and some form of engagement[96]. The survey run by the Financial Superintendence of Colombia shows that few financial institutions are carrying out some form of engagement on environmental issues: 22% of the asset managers, 9% of insurers, 35% of banks and no pension fund.

Table 2: Regulatory framework of shareholder voting rights in selected Latin American countries.

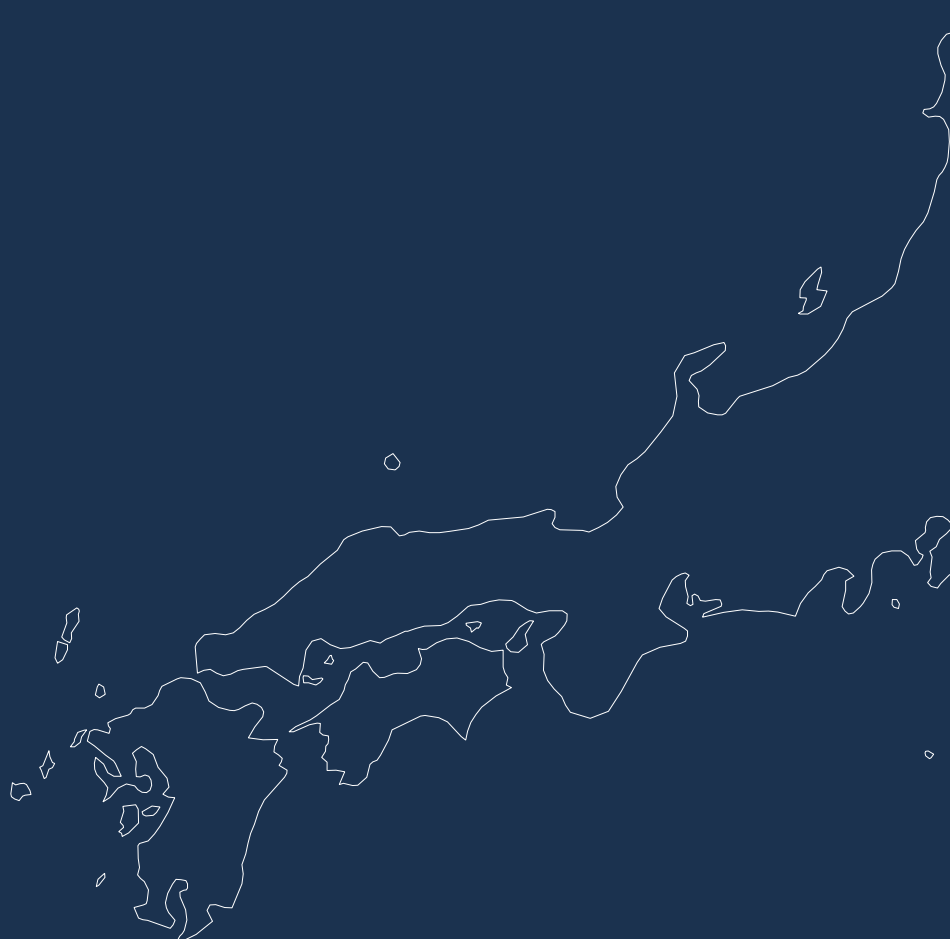
Shareholders Right	Mexico	Colombia	Chile	Brazil
Selection or change of members of the BOD	10% of voting capital is needed [97]. As an individual or group of shareholders.	Defined by the company statutes[98]. However, most companies allow for a vote that is proportional to the voting capital.	Any shareholder can vote. The weight of the vote is proportional to the % of voting capital[99].	15% of the voting capital, or 10% of non-voting shares have the right to elect one of the board members[100].
Propose resolutions [101] in the general assembly or to the BOD	The law is silent[102]. It mentions that the board of directors is responsible to include the discussion points but mentions that shareholders can include other topics for discussion as part of "general subjects".	5% of voting capital can make proposals to the BOD in order for it to be considered in the general assembly.[103] The board of directors is required to respond to the resolution in written.	10% of voting capital can propose a resolution to the BOD in order for it to be included in the annual memory of the company. The law is silent about the process to discuss the resolution in the general assembly[104].	Any shareholder can require an issue to be included and voted on at a general meeting. If the company does not attend to the request, only the shareholders that hold at least 5% of the capital can call a general meeting directly[105].
Oppose to the decisions of the general assembly of shareholders or to the BOD	20% of voting capital is needed to object any general assembly resolution through judicial procedures[106].	20% of voting capital can call for an assembly to oppose any decision taken by the BOD that goes against the value of the company[107].	The statutes of the company can define the process of arbitration between the shareholders and the company. If the statutes do not specify it, the differences will be resolved through an arbitration process[108].	The law is silent.

There is evidence that Latin American companies are becoming aware of some of these strategies due to action from foreign institutional investors. This is for example the case of asset manager Hermes, which engaged with the state-owned oil & gas producer Petroleos Mexicanos (PEMEX) due to identified ESG factors that could potentially have had a negative impact on credit risk and therefore prevented Hermes from increasing its position on the company. Different ESG topics were discussed, including PEMEX's commitment to reduce carbon emissions by 25% during the execution of the company's 2017-2021 plan and its plan to achieve the target[109].

Latin American companies and financial institutions will become more familiar with these strategies as international initiatives such as Climate Action 100+ and the TCFD gain momentum in the region. Climate Action 100+ currently targets four Latin American companies[110], and the results of this initiative will set precedent in the way of carring out shareholder engagement on non-financial topics in the region. The TCFD recommendations will help to share practices on engagement actions carried out with investee companies or clients to manage climate-related risks. Currently, there are five Latin American financial institutions (2 banks and 3 asset managers) supporters of the initiative. None of these companies have disclosed on this aspect yet and only one of them has already reported their progress on applying the TCFD recommendations.

Implications of the lack of evidence on climate-risk mitigations strategies. The lack of evidence points at three conditions that need to be met in order to ensure the uptake of climate-risk mitigation strategies. Financial institutions need to:

- Identify the different sources of climate-related risks their portfolios could be exposed. This requires first building capacities around methodologies and frameworks that allow one to measure portfolio risks but also the identification of hotspots at different levels of granularity including sector, subsector, and company level;
- Improve their understanding of existing mitigation strategies and define parameters that will allow them to decide among their use. For example, considering their position in the portfolio and the weight in the company, Colombian pension funds could prefer to divest from the funds that are negatively exposed to the auto sector and invest in funds with a lower exposure, than to engage directly with the companies;
- Share their experience with peers and opt for collective strategies whenever relevant. Investor coalitions in the region such as the Principles for Responsible Investment (PRI) and the United Nations Environmental Programme Finance Initiative (UNEP FI) can be an excellent forum for this; and
- Improve dialogue with their investee companies to increase visibility on investees' strategy on climate and ensure any information is considered when deciding upon the climate strategies to take.



Conclusions

The use of methodologies for the assessment of climate-related risks by Latin American financial institutions is at its infancy. This is due to different factors, including: (1) the novelty and complexity of the topic; (2) the relatively low awareness on the interlinkages between climate-related issues and financial performance; and (3) the relatively low, but growing attention that governments, regulators, supervisory authorities, and sectors associations are paying to the topic.

To provide evidence on the relevance of climate-related risk for financial institutions (both investors and banks) in Latin America, this report takes a closer look at how and which transition risks could affect the economy, local capital markets, and consequently financial portfolios in the largest financial markets in Latin America, namely Brazil, Chile, Colombia, Mexico and Argentina. In order to do so, the data analysis covered in this paper combines three types of data: physical asset-level data, financial data, and investors' portfolio data.

The physical asset level data is sourced from market intelligence databases in seven sectors, namely, fossil fuels, power utilities, automotive, aviation, shipping, cement, and steel. These sectors account for more than 60% of CO_2 emissions in the real economy and up to 90% of CO_2 emissions in financial portfolios. The financial data is sourced from Bloomberg and the investor portfolio data from the Colombia supervisory authority.

The report finds that the banking sector might be potentially exposed to transition risks arising from power, fossil fuel and automotive companies. To analyze the exposure to transition risks of banks, we use as proxy country level production data. It is therefore assumed that banks finance their local economy. Forward-looking country level data shows that power and fossil fuel companies are not reducing their exposure to coal and oil assets at the pace required in the transition. The data equally shows banks might be equally exposed to transition risks impacting the automotive industry as most countries either do not have or are not increasing electric and hybrid vehicles production in the levels required.

To analyze the exposure to transition risks of investors, we use as proxy financial markets data. We analyzed the sectoral exposure of listed equity and corporate bonds capital markets. Given that most Latin American investors have most of their investments either invested locally or in the region, we focused the analysis on local issuers or

instruments domiciled in the local market. We find that the most carbon intensive sectors (i.e. fossil fuels, materials and buildings, transport and power) cover from 21% to up to 53% of the market capitalization of listed equity issuers and from 20% to 45% of total amount of assets outstanding of corporate bond issuers. The estimated exposure levels are not negligible as the four sectors examined cover more than 70% of the CO_2 emissions in the real economy. If these issuers are not starting to mitigate their exposure to climate-related risks, the portfolios of investor might be exposed to a future financial loss.

Therefore, to understand if this exposure could actually translate into risk, we examined the share of low-carbon and high-carbon technologies of issuers in Latin American equity market. We find that the share of low-carbon technologies is of around 3%, mainly driven by its share of hydropower, while the share of high-carbon technologies is of around 11% driven mainly by oil production. This therefore confirms that there is a potential risk exposure.

To provide evidence that financial institutions can effectively assess their exposure to climate-related risk we applied the scenario analysis methodology PACTA to the Colombian insurers and pension funds listed equity and corporate bond portfolios.

The analysis finds that Colombian insurers and pension funds listed equity portfolio might be potentially exposed to transition risks arising from investments in coal mining, coal power, oil power and ICEs production companies. These technologies cover around 1% of the pension funds and insurers listed equity portfolio, and from 2% to 4% of their corporate bond portfolio. The high weight of hydropower in the corporate bond portfolio could potentially offset part of these risks, as this technology covers 11% of the insurers and 14% of the pension fund's portfolio. However, to fully seize the opportunities the transition will bring with low carbon alternatives, the companies in the portfolios of both investors need to significantly increase their investments in non-conventional renewable energy sources.

Other industries in which portfolio decarbonization is required are cement, steel, and aviation. These three sectors cover around 14% pension funds and insurers listed equity portfolios, and around 5% of their corporate bond portfolio.

Although there are similarities in the scenario analysis results, some differences were identified. For example, in the case of coal power, the insurers' listed equity portfolio is not investing in companies which are planning to increase their coal power capacity, the portfolio trajectory is therefore slightly above a 2ºC scenario trajectory. For the portfolio to be in a 2ºC scenario, the coal power capacity should decrease. In the case of pension funds, the portfolio is compatible with a >3.2ºC scenario as the companies in the portfolio are planning to increase their coal power capacity. For the portfolio to be aligned with a 2ºC scenario it would need decrease the coal power exposure by up to 15% by 2024. The results of the corporate bonds portfolio are however the opposite. The study finds that the pension funds' portfolio is aligned with a 2ºC scenario, while the insurers' portfolio is following a trajectory that is slightly above a 2ºC scenario trajectory. From a macro perspective, there might not be substantial differences in the financial losses because the 'assets at risk' of both investors are quite similar.

The scenario analysis results show that insurers and pension funds should monitor changes in the production plans of those companies that have an important weight in their portfolios, even when the results show that portfolios are potentially not exposed to transition risks, as any change in these companies production plans can impact significantly their portfolios. This is for example the case in the oil & gas and power sector. In the case of oil & gas, the portfolios of insurers and pension funds are aligned with a <1.75ºC scenario. Ecopetrol is the main company in that sector covering from 4.1% up to 7.3% of a corporate bond portfolio, any changes in Ecopetrol's investment plans will have a major impact on the exposure to transition risks of both investors. This is particularly relevant in the context of their recent capital expenditures announcement for 2020 which consider between $3.3 billion and $4.3

billion of investments. A similar case occurs in the gas power capacity scenario analysis results of pension funds listed equity portfolio. The investments in that portfolio are concentrated in three companies[111], which make up to 16.7% of the portfolio. The portfolio is aligned with a 2ºC scenario, however, any additional investments from the issuers will result in a portfolio compatible with a 2ºC-2.7ºC scenario and thus a potential exposure to transition risks.

The analysis additionally finds that pension funds and insurers are not seizing the opportunities the low-carbon economy could bring with non-conventional renewable energy sources as the power capacity additions of the companies in the portfolios are lower than the ones required in a 2ºC scenario. However, this is not necessarily the case of all low-carbon technologies and portfolios. The scenario analysis results show that the corporate bond portfolios trajectory of both investors is compatible with a 2ºC scenario in the case of electric vehicles and hydropower.

The report finds that the most suitable climate-risk mitigation strategies financial institutions could opt for, are does that aim at a behavioral change from investee companies and clients. This is the recommended strategy given the high level of concentration of most markets, their low liquidity, and the low risk tolerance of some investors represent a barrier for the implementation of mitigation strategies focused on asset allocation (e.g. divest/invest, exclude).

The report mentions the most relevant shareholder voting rights included in the local regulation, however, more research on the topic needs to be done to better define the engagement mitigation options of financial institutions and their probability of success. Understanding success as the likelihood that the engagement actions will result in changes in the investee strategy that support climate goals and mitigate climate-related risk in the real economy.

The findings of this report provide a set of recommendations to all participants in the financial sector:

- Financial institutions should start assessing the exposure to transition risks of their portfolios and identify the avenues for their mitigation. They now have evidence showing that their portfolios might be exposed these transition risks and guidance on which are the strategies for mitigation they should consider. Investors should equally look at how their bank investees are managing their exposure to climate related risks as an impact in banks corporate lending portfolios could potentially impact banks value drivers and consequently the market prices of their issuances.
- Supervisory authorities and regulators now have evidence of the sector's potential exposure to transition risks, which could potentially have an impact on financial stability. They are therefore called to join initiatives such as the NGFS to build their capacities on the topic in a view to ultimately understand i. how to improve transparency on the integration of climate change by banks and investors at portfolio level; ii. how regulatory stress tests can integrate climate-related risks considering different scenarios to test the resilience of the financial system; and iii. how to better shape regulation or local initiatives that foster the integration of climate-related risks in the decision making of financial institutions.
- Governments have now evidence of the potential mismatch between the alignment of financial institutions portfolios and the Art.2.1.c objective, they are therefore encouraged to join initiatives such as PACTA 2020, to set up their own initiatives on the topic and to assess how regulation could be an instrument that drives the consideration of climate change as a driver of financial and economic performance.

Annex A

Estimating sectoral profits in a deleyed transition.

The general principles of the estimatation are:

- For each sector, the additional emissions occurring before 2025 under a delayed action scenario compared to a smooth transition scenario (date at which the transition starts) have to be offset by 2040, assuming a climate lag of 60 years (the temperature of 2100 is determined by the GHG emitted 60 years before).
- Additional emissions occurring before 2025 can be offset through either a drop in production or a surge in energy efficiency, depending on the sector considered. For example, cement being an essential material to build the infrastructures needed for the 10 billion humans expected by 2050, assuming a major drop in production wouldn't make sense (as confirmed by the IEA in ETP 2017), a surge in energy efficiency due to sudden R&D efforts seems more realistic.
- Fossil fuel prices under a delayed transition scenario evolve proportionally to demand; prices for other sectors slowly reach the levels of a "smooth" transition once the "late & sudden" transition starts.
- No impact on gross or operating margins is assumed for building material industries (Steel & Cement), as the authors didn't find any reasonable way to estimate this under a delayed transition scenario.
- In line with literature, Carbon prices are assumed to be 1.5 times higher in 2040 under a "too late, too sudden" scenario compared to a "smooth" transition scenario, to foster quicker energy efficiency improvements once the late & sudden transition has started (See Advance_2020_Med2C ("smooth" transition scenario) and Advance_2030_Med2C (slightly delayed transition scenario) on IAMC's 1.5° online scenario database).

Although the approach developed above represents a valuable first step in the development of a "too late, too sudden" transition scenario including all the indicators needed for financial analysis, there are several caveats to bear in mind. First, the approach overlooks possible interactions between sectors (in reality, emissions may decrease less than needed in an industry and more than needed in another) – although it takes into account risk propagation across industries (e.g. an increase in oil prices impacts airlines expenses). Second, in the absence of alternative solutions, it features a very simplistic price dynamic. Finally, in the absence of alternative solutions, it neglects changes in net margins for some sectors.

The table below details the sectors covered in our analysis, as well as the indicators used to estimate the change in profits under transition scenarios. The evolution of Net Profits is then estimated from these indicators using the following formula:

Net profits = (Production volume x Prices) (4) – Costs of Goods Sold (2) – OPex (3) – (Taxes + Interests) (1)

The following table, illustrates how transition risks, will impact sectoral profits by affecting each of the independent variables to calculate companies net profits.

	How could transition risks impact sectoral profits?	Indicators needed to quantify the impact
1	**Increased cost of emitting CO2**: Under a transition scenario, the implementation of a carbon tax will cut the margin of carbon intensive industries proportionally to their emissions. Under a "too late, too sudden" scenario, carbon prices would need to be higher than under a "smooth" transition scenario, in order to foster a quick decrease in emissions.	- Production - Carbon intensity of production - Carbon tax
2	**Increased cost of production inputs**: During a low carbon transition, carbon intensive goods will increase in prices due to pass-through of direct emissions costs. Industries using such carbon intensive goods as production inputs will thus be impacted.	- Prices of production inputs
3	**Additional depreciation costs and R&D expenditures**: Under a transition scenario, significant capital expenditures in low-carbon technologies will increase companies' annual depreciation costs (included in Operating Expenses). Under a "too late, too sudden" scenario, the depreciation costs of "brown" capital stocks build up before the transition starts add up to these green expenses. R&D expenditures will also likely increase.	- CAPEX - R&D expenditures - All other OPEX
4	**Changes in revenues**: Companies' revenues will be affected through a change in prices and consumer demand: As they become increasingly costly to produce, prices of carbon intensive goods will likely increase, and consumers will, in turn, decrease their demand for such goods. A delayed transition, as it would increase the costs bared by carbon-intensive industries, would likely deepen this effect.	- Production - Prices

The table below details the sectors covered in our analysis, as well as the indicators used to estimate the change in profits under transition scenarios. The evolution of Net Profits is then estimated from these indicators using the formula above.

Sector	Target companies	Geography	Indicators used for profits calculation
Oil	Upstream oil	Europe, North America, South & Central America, Middle East, Africa, Asia Pacific, Eurasia	Production, Prices
Coal	Coal mining		
Natural gas	Upstream natural gas		
Power	Power generators (Coal, Gas, Solar, Wind)	Europe, USA, Latin America	Production, Prices, Levelized Cost of Electricity, Subsidies
Steel	Crude steel producers	Brazil, USA, Mexico, France, Germany, Italy	Production, Prices, Carbon prices, Carbon intensity
Cement	Cement producers		
Automotive	Car producers	World average	Production, Net margin by powertrain type
Aviation	Airlines (international)		Demand, Fuel efficiency, Fuel prices

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