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A SIMPLE FRAMEWORK FOR ASSESSING THE CROSS-BORDER TRANSMISSION OF CLIMATE TRANSITION RISK BASED ON GLOBAL SYNDICATED LOAN DATA

Key points:

- *Assessing the cross-border transmission of climate-related risks, particularly transition risk, is an important focus for policymakers globally. However, partly due to data gaps and the lack of an internationally comparable analytical framework, conducting such an assessment on a global scale is challenging. To address this challenge, this study proposes a simple framework that facilitates a systemic assessment of the cross-border transmission of climate transition risk across banking sectors.*

- *Using data on global syndicated loans, we demonstrate that our framework is capable of estimating the impact of future unpriced carbon costs for syndicated loan borrowers on the probability of default and expected losses of syndicated loans in various climate transition scenarios. The framework is also sufficiently flexible to adopt the projections of future carbon prices from other sources, such as those provided by the Network for Greening the Financial System. Finally, the mapping of banks' exposure to these firms further enables us to assess the impact of credit risk on banks' cross-border loans.*

- *Our initial assessment, based on S&P's 2°C-aligned scenario up to 2030, yields three key findings: First, approximately one third of the syndicated loans are extended to transition risk-exposed borrowers (defined as firms with unpriced carbon costs greater than 10% of their earnings). As only approximately 10% of these loans are extended to borrowers facing significant transition risk, where unpriced carbon costs account for at least half of their earnings, the estimated credit loss associated with future unpriced carbon costs by the end of 2030 is found to be relatively low.*

- *Second, despite the relatively small estimated credit risk impact, cross-border spillover effects are possible. Of the syndicated loans granted to transition risk-exposed borrowers, over half of them are cross-border loans (i.e. 17% of all syndicated loans). Notably, such spillover may occur primarily within the same regions as the banks, particularly for banks in the Asia–Pacific region and*

Western Europe. For banks in these regions, a large share – approximately 40% – of their cross-border exposure is to transition risk-exposed borrowers within their respective regions. These patterns indicate that the regional spillover of transition risk may warrant close monitoring.

- *Finally, the exposure of globally systemically important banks (G-SIBs) may deserve closer attention, as their cross-border exposure to transition risk-exposed borrowers is widespread across regions. Specifically, G-SIBs account for over two thirds of total cross-regional exposure to transition risk-exposed borrowers. In addition, these G-SIBs have significant common exposure to the borrowers most vulnerable to transition risk. Together, these findings suggest that G-SIBs may play a crucial role in transmitting and amplifying the global spillover of transition risk.*

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I. INTRODUCTION

Assessing and managing the cross-border transmission of climate-related risks (particularly transition risk) are key areas of focus for policymakers and regulators worldwide (FSB, 2020; FSB, 2023). Specifically, the transition to a low-carbon economy, especially if the transition is disorderly, may lead to an abrupt increase in the credit risk premium for high-risk borrowers and have crucial credit risk implications for banks due to their loan exposure. Such risks are not confined to domestic economies but can be transmitted globally through banks' cross-border exposure.

However, systemically assessing the cross-border transmission of transition risk in the global banking system remains challenging. One key challenge arises from the fact that access to detailed information on banks' cross-border corporate loan exposure is often restricted to regulators within individual jurisdictions. Such restriction prevents regulators and supervisors from comprehensively assessing the impacts of transition risk, particularly that on banks' cross-border lending and the related common exposure to high transition risk borrowers, on a global scale. In addition, the absence of an internationally comparable analytical framework makes it challenging for policymakers to systemically quantify and compare the extent of cross-border exposure to transition risk across jurisdictions.

Against this background, this study proposes a simple framework that helps facilitates the systemic assessment of cross-border climate transition risk exposure across various banking sectors based on global syndicated loan data. The proposed framework utilises readily accessible data, including environmental data provided by S&P Global Trucost and global syndicated loan data from LSEG Loan Connector. While syndicated loan data account for only a subset of banks' total lending, their standardised nature and data granularity provide a good starting point for developing an internationally applicable framework to systemically assess the transition risk arising from banks' cross-border lending. Cerutti, Hale, and Minoiu (2015) showed that global syndicated loan exposure accounted for almost one third of total cross-border loan exposure between 1995 and 2012. Therefore, by examining the global syndicated lending market, this study could shed light on the implications of climate transition risk for broader cross-border bank lending to corporate sectors.

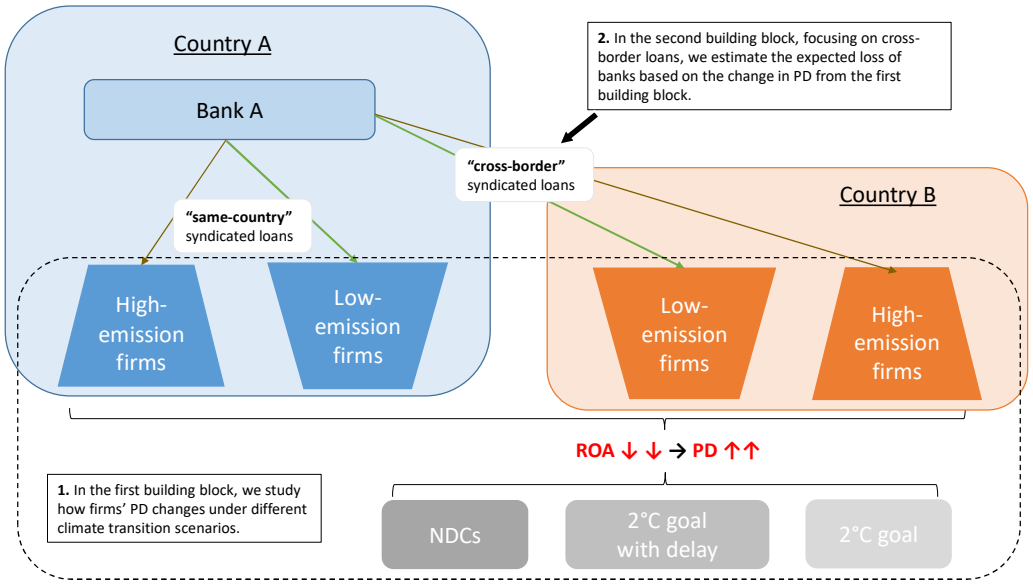
The remainder of this paper is structured as follows. Section II outlines the methodological framework employed. Section III presents our initial assessment of the credit risk impacts of transition risk on banks' cross-border loan exposure in an adverse

climate scenario for 2030, based on the proposed framework and global syndicated loan data. Finally, Section IV discusses the policy implications of our findings.

II. OVERVIEW OF THE METHODOLOGICAL FRAMEWORK

In this section, we present a high-level overview of the analytical framework (see Chart 1), which has two main blocks. The first block is a simple credit risk model that estimates the extent to which corporate default risk is affected by climate transition risk. The second block derives the potential credit losses for banks by mapping increases in the probability of default (PD) of borrowers to banks' exposure to these borrowers, focusing on cross-border exposure. A more detailed discussion is provided below.

Chart 1: Schematic of the simple framework



2.1 Simple model of corporate borrower credit risk

As mentioned, the first block translates the financial impact of transition risk into the change in the PD of individual firms. In principle, climate transition risk can influence firms' financial fundamentals through various channels; however, to maintain the simplicity and clarity of our analysis, we focus on the impact on profitability due to

future unpriced carbon costs.[1] In this context, we assume that authorities impose a certain carbon price depending on the climate transition scenario considered. This imposition generates additional unpriced carbon costs that affect firms' business activities and thus reduce their profitability (measured as return on assets (ROA)). The decline in ROA leads to a rise in PD for the firms.

To quantify the effect of the resulting ROA decline on firms' PD, we employ a simple linear credit risk model. The model regresses 1 year ahead PD on a set of firm-level financial fundamentals, with ROA among the explanatory variables. Detailed information on the sample data, regression specification, and estimation results can be found in the Appendix. Our results suggest that a 1 percentage point drop in ROA is associated with a 2.9-basis point (bp) increase in 1-year ahead PD or a 7.5-bp increase in 5-year ahead PD.

2.2 Mapping firms' PD estimates to banks' syndicated loan exposure

After obtaining the PD estimates for each firm in the climate scenario, we derive the associated increase in banks' expected losses (EL) by mapping the changes in firms' PD to banks' exposure to such firms on a loan-by-loan basis. Specifically, we calculate the change in banks' EL with the following equation:

$$\Delta Expected\ Loss_{b,f,l} = \Delta PD_f \times LGD_{b,f,l} \times Outstanding\ Loan_{b,f,l} \qquad (1)$$

where the EL of loan l that bank b extends to firm f equals the change in PD of firm f (given a particular climate scenario), multiplied by the loss given default (LGD) of loan l and the size of outstanding loan l. While LGD can theoretically be determined on a loan-by-loan basis, for simplicity, we assume it to be 1.[2]

To further explore the financial impact of transition risk on banks' cross-border exposure, we distinguish cross-border and domestic loans in our sample. Specifically, a loan is classified as a cross-border loan if the lender parent's operating country differs from the borrower's operating country.[3] Summing the rise in the EL from a bank's cross-border loan exposure returns the expected credit losses of the bank resulting from the climate transition risk scenario.

[1] Given the flexibility of the framework, additional channels can be integrated as appropriate.
[2] This assumption implies that banks bear all losses should a firm default on its loan.
[3] Alternatively, the classification of cross-border and domestic loans could be based on the residence of the lenders and borrowers, which is akin to a 'residence' basis. However, because global banks typically manage their lending on a consolidated basis and the risks associated with the loans are ultimately borne by the parent banking group, we deem our classification based on the ultimate parent bank's operating country (akin to a consolidated basis) more appropriate.

III. INITIAL ASSESSMENT BASED ON GLOBAL SYNDICATED LOANS AT THE END OF 2022

In this section, to illustrate the feasibility of our simple analytical framework, we use global syndicated loan data to assess the impact of transition risk on banks' loans exposure in an adverse transition scenario projected through 2030.

3.1.1 Overview of the syndicated loan data

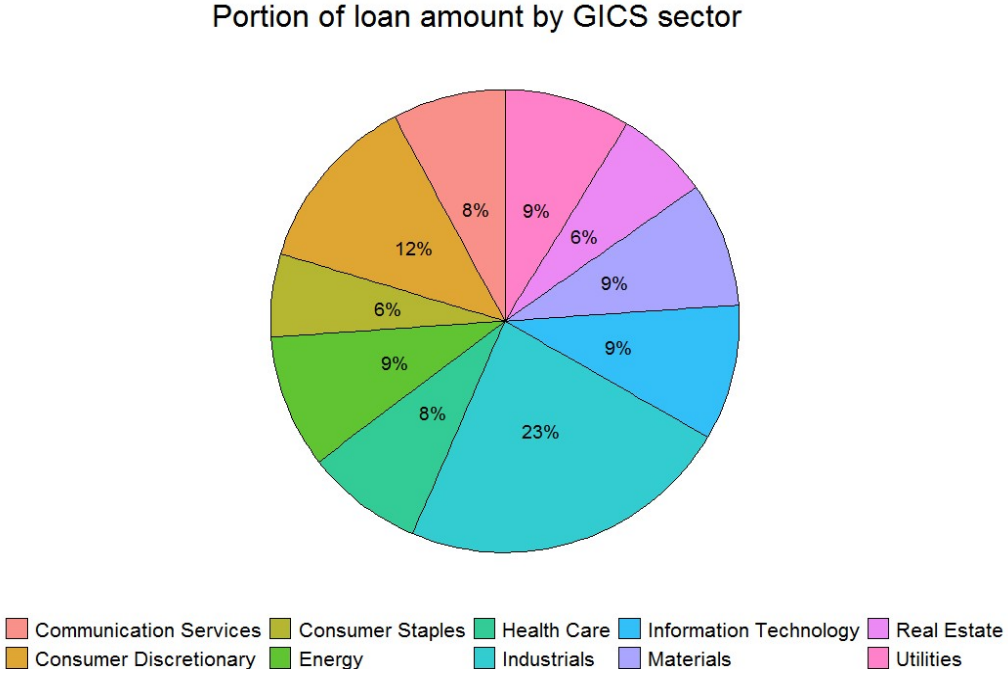
In this study, we use the complete syndicated loan dataset from LSEG Loan Connector (also known as LPC Dealscan in the literature), covering period from 2004 to 2022. The dataset includes both tranche-level and tranche–bank-level data. Because our analysis focuses on the transition risk associated with banks' loan exposure at the end of 2022, we retain only those loans outstanding at that time, based on their reported tranche maturity dates.[4] For outstanding syndicated loans set to mature before 2030, we assume that the borrowers roll over the loans with the same lenders until at least 2030. Further, we exclude loans extended to the government or financial sector, because our analysis focuses on the impact of transition risk on banks' nonfinancial corporate exposure.[5] Finally, we exclude loans extended by nonbank lenders.[6]

Next, we obtain financial and environmental data on the borrowers by matching their identities with those in the S&P Capital IQ and S&P Trucost databases.[7] If we cannot find a match for any borrower in the S&P Capital IQ database or no environmental data are available for a matched borrower, the borrower's primary industry information is used as a proxy. Specifically, we used the industry median transition risk impact calculated based on all firms within that industry in 2022 from the S&P Trucost database. Chart A.1 presents the high-level statistics of the proportions and average loan amounts in the syndicated lending data, both with and without successful borrower name matching with the S&P Trucost database.[8]

[4] We also exclude loan tranches without a reported maturity date.
[5] As only partial information on the lender shares of each tranche is available, we follow practices in the literature (Giannetti and Laeven, 2012; Cerutti, Hale and Minoiu, 2015) by splitting the remaining unassigned loan amounts among those lenders without reported lender shares for each tranche.
[6] A lender is considered a nonbank lender if neither it nor its ultimate controlling parent is a banking entity.
[7] We base matching on name, industry, location, ultimate parent name, and ticker information.
[8] We can successfully match approximately 44% of total outstanding syndicated loans to borrowers with carbon earnings at risk data available in the S&P Trucost database. On average, loans to borrowers with such data available are on average larger than other loans.

After the above data cleaning procedure, our final sample for analysis contains 75,067 loan tranches and 23,675 unique borrowers.[9] The total outstanding syndicated loan exposure at the end of December 2022 in this analysis is approximately US$16.3 trillion, constituting a preponderant financial market segment. The distribution of loan amounts by sector is presented in Chart 2. In general, loan amounts are evenly distributed across sectors, with the exception of loans to the industrial sector, which account for a considerably larger share.

Chart 2: Distribution of syndicated loan amounts by GICS sector



Note: Borrower sector information is sourced from S&P Capital IQ Pro.

3.1.2 Using carbon earnings at risk to predict the impact of future unpriced carbon costs on firms' earnings

To estimate the impact of future unpriced carbon costs on firms' earnings, we use the carbon earnings at risk (CEaR) dataset developed by S&P Trucost. CEaR is a metric that assesses a firm's ability to absorb future carbon costs. It is defined as the difference between the current carbon costs a firm incurs today and the carbon costs projected at a future date, considering the firm's sector, operations, and specific carbon price policy scenarios. The CEaR database provides various financial metrics, such as unpriced carbon costs, unpriced carbon cost-adjusted earnings before interest and taxes (EBIT), and the reduction in EBIT margin, for selected future time horizons (2025,

[9] To determine the loan amount contributed by each bank, we first utilise the reported lender share whenever possible. For loan tranches lacking such information, we adopt a common practice in the literature to assume that the loan is evenly distributed among all lenders within the syndicate.

2030, 2040, and 2050) in a given carbon price pathway scenario defined by S&P Trucost.[10]

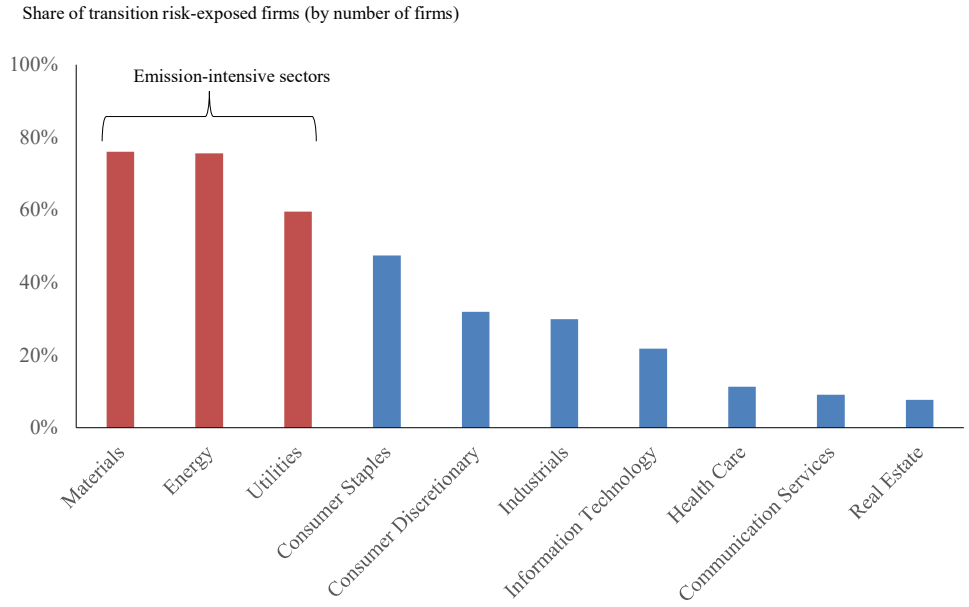
S&P Trucost provides three carbon price scenarios: i) nationally determined contributions, ii) 2°C-aligned with a delay in the short term, and iii) 2°C-aligned. We focus on the CEaR estimates for the 2°C-aligned scenario, as this scenario is expected to yield the highest unpriced carbon costs. The associated metrics in the CEaR dataset can be used to capture the impact on firms' earnings and repayment ability through the derivation of standard financial ratios, such as the interest coverage ratio or ROA, to estimate impacts on firms' creditworthiness. For instance, we can scale the reduction in EBIT margin obtained directly from the CEaR dataset by firms' revenue-to-assets ratio (sourced from S&P Capital IQ) in the base year to derive the related impacts on firms' ROA. Our translation of the reduction in EBIT margin metric into the decline in firms' ROA is explained in simple terms in the Appendix.

Within the CEaR dataset, S&P Trucost also reports which firms' earnings would be at risk if unpriced carbon costs are considered. S&P Trucost does not provide a precise explanation of its classification, but most such firms would face unpriced carbon costs of at least 10% over their EBITs in the base year or at least a 2-percentage point reduction in their EBIT margin[11] in each respective climate scenario. As this type of firm is more susceptible to the impacts of higher carbon prices, we denote such firms as "transition risk-exposed borrowers".

Chart 3 shows the share of high transition risk borrowers by Global Industry Classification Standard (GICS) sector within the S&P Trucost dataset for calendar year 2022. Consistent with the findings of Kong et al. (2024), high transition risk borrowers are not only those in emission-intensive sectors. While over 60% of firms in emission-intensive sectors are classified as having high transition risk, a notable percentage of high transition risk borrowers are observed in other sectors, such as the consumer staple and consumer discretionary sectors.

[10] Overview of the three carbon price pathways provided by S&P Trucost (https://www.spglobal.com/en/Perspectives/IIF-2019/Trucost-Carbon-Earnings-at-Risk.pdf).
[11] EBIT margin is calculated as EBIT divided by total revenue.

Chart 3: Share transition risk-exposed borrowers by GICS sector (number of firms)

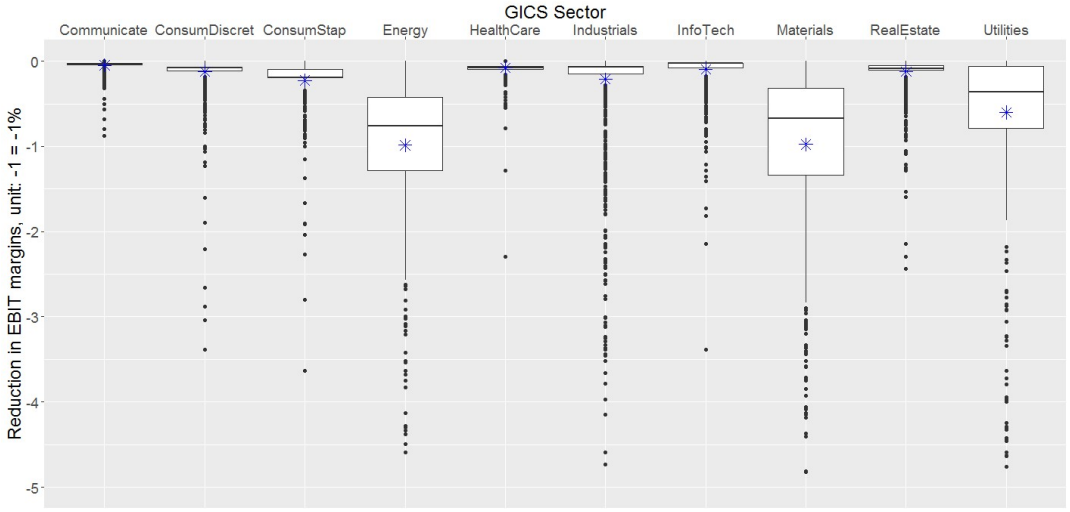


Source: HKMA staff estimates based on S&P Trucost.

3.1.3 Estimated change in PD for sample syndicated borrowers in the 2°C-aligned scenario

Based on the CEaR estimates for the 2°C-aligned scenario through 2030, Chart 4 presents the estimated decline in EBIT for borrowers in our syndicated loan sample after we account for unpriced carbon costs. Two key observations are worth highlighting. First, while firms from emission-intensive sectors generally see a larger average decline in EBIT margin (i.e. the median impact) than those from other sectors, the cross-sectional variation in the impact on firms from these sectors is large. Second, some firms from non-emission-intensive sectors (particularly at the tail) may also experience a notable decrease in earnings, with the size of the decrease being equivalent to that experienced by firms in emission-intensive sectors. These two observations suggest that sector-level estimates may not be reliable for gauging the impact of transition risk on individual firms. These observations also underscore the importance of using more granular, firm-level information to more comprehensively assess the impact of climate transition risk on banks' loan exposure.

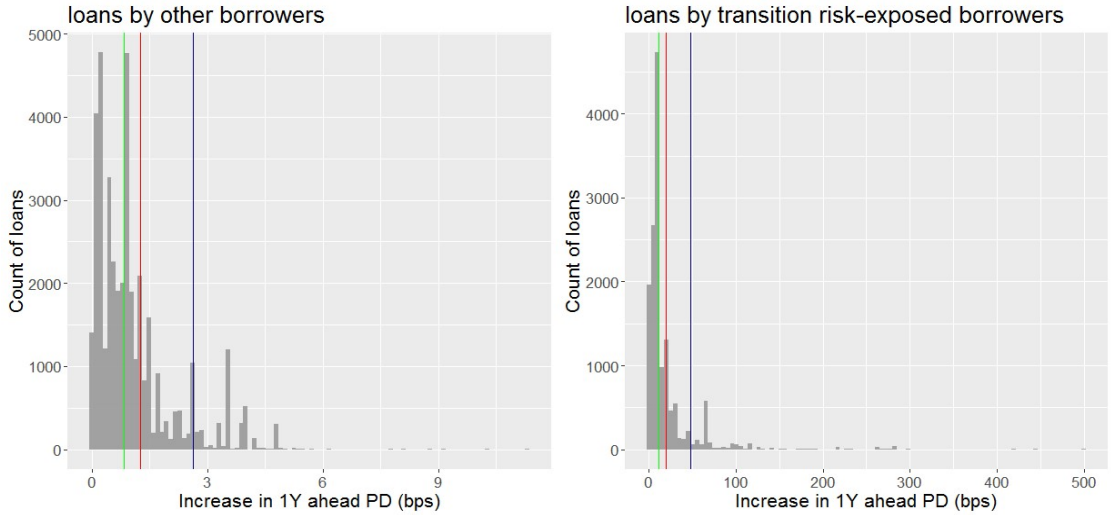
Chart 4: Reduction in EBIT margin resulting from unpriced carbon costs by GICS sector in the 2°C-aligned climate scenario



Note: The reduction in EBIT margin for unique nonfinancial syndicated borrowers are presented. The boxplots, whiskers, and blue asterisks for each sector present the median value and interquartile range, data points within 1.5 times the interquartile range, and the average value, respectively.

The right and left panels of Chart 5 present the estimated impacts on individual firms' PD of the 2°C-aligned scenario by the end of 2030 for the high transition risk borrowers and for the other firms, respectively. The green, red, and blue lines respectively represent the 50th, 75th, and 90th percentile of 1-year ahead PD impact. In general, the estimated impact is relatively modest for non-high transition risk borrowers, with the rise in PD ranging from <1 bps (median) to approximately 3 bps (90th percentile) (see the left panel of Chart 5). The impact is more pronounced for the group of transition risk-exposed borrowers, with the impact ranging from 11 bps (median) to approximately 48 bps (90th percentile) (see right panel of Chart 5).

Chart 5: Change in 1-year ahead PD in the 2°C-aligned climate scenario by the end of 2030



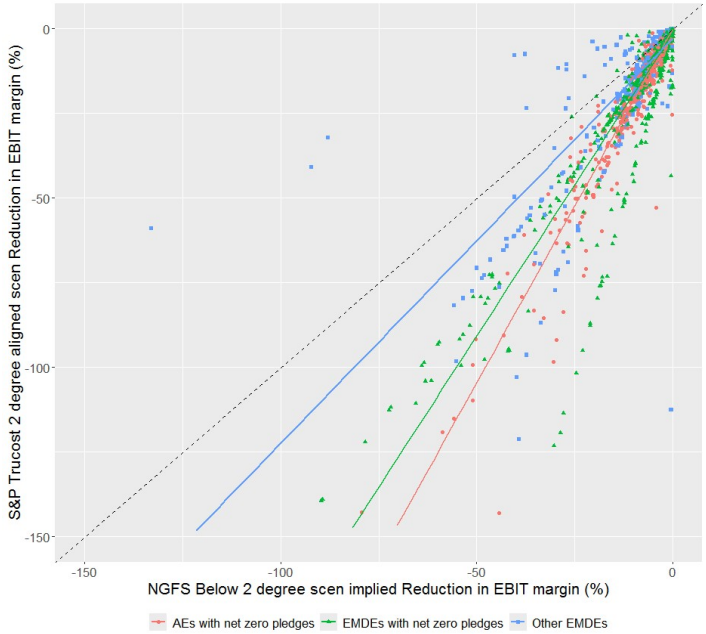
3.1.4 Comparison with alternative unpriced carbon costs based on Network for Greening the Financial System scenarios

While the analysis above employs a climate transition scenario provided by S&P Trucost, our framework is sufficiently flexible to adapt other scenario pathways, such as those provided by the Network for Greening the Financial System (NGFS). In principle, we can easily calculate the reduction in EBIT margin for firms due to unpriced carbon costs by multiplying firms' emission amounts by the increase in carbon prices in the NGFS scenarios applicable to the firms' headquarters countries.

Chart 6 presents a scatterplot comparing the reduction in EBIT margin for the high transition risk borrowers in 2030 in the S&P Trucost 2°C-aligned scenario with the corresponding estimates for the NGFS below-2°C scenario.[12] These two sets of estimates are strongly correlated, suggesting one can consider alternative unpriced carbon cost assumptions that align with its specific scenario narratives when assessing the firms' default risk impact.

[12] A majority of the estimated declines in firms' EBIT margins in the NGFS below-2°C scenario are below the 45° line, implying that the projected increase in carbon prices from 2022 to 2030 is smaller than that outlined in the 2°C-aligned scenario by S&P Trucost. This difference may be attributable to various factors, including differences in the modelling and narrative settings of the two sources' scenarios.

Chart 6: Scatterplot of estimated EBIT margin reduction based on S&P Trucost and NGFS scenario projections of carbon prices

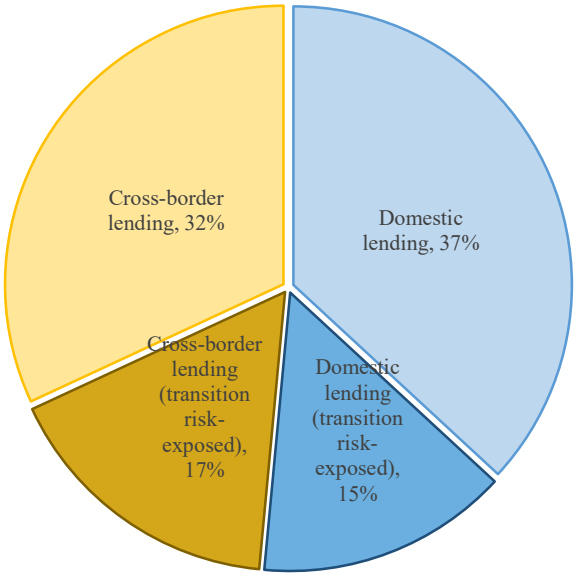


Source: Estimates based on data from S&P Trucost and the REMIND model of the NGFS Phase IV Scenario.

3.2 To what extent are global cross-border syndicated lenders exposed to transition risk-exposed borrowers?

After mapping the above borrower-level estimates to banks' syndicated loan exposure, we evaluate the extent to which banks' cross-border lending is exposed transition risk-exposed borrowers. Chart 7 presents the share of loan exposure to high transition risk borrowers. Approximately 32% of the value of global syndicated loans outstanding at the end of 2022 is extended to transition risk-exposed borrowers. Among this exposure, more than half is accounted for by cross-border loans (i.e. 17% of syndicated loans).

Chart 7: Distribution of syndicated loan value outstanding by type at the end of 2022



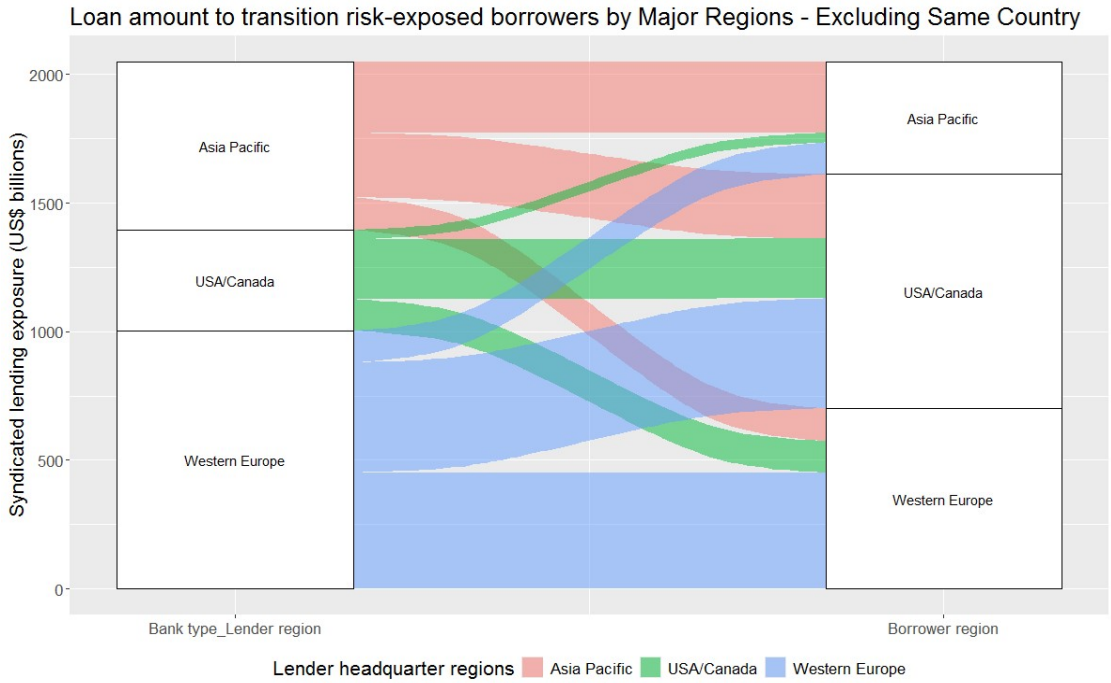
Source: Estimates based on data from S&P Trucost and LSEG Loan Connector.

Chart 8 shows that when banks extend cross-border loans to transition risk-exposed borrowers, these borrowers tend to be within the same geographical region. For instance, approximately 45% of Western European banks' cross-border exposure to transition risk-exposed borrowers is directed towards entities within their own region. Similarly, 42% of the cross-border exposure of banks in the Asia–Pacific region to transition risk-exposed borrowers is within the same region. These patterns suggest that the regional spillover of transition risk should be monitored.

In addition, some large global banks – especially global systemically important banks (G-SIBs) – have significant cross-border exposure to transition risk-exposed borrowers in other regions (e.g. European banks lending to Asian borrowers). Chart A.2 in the Appendix shows that G-SIBs account for over two thirds of such cross-regional exposure to transition risk-exposed borrowers. This pattern suggests that banks, particularly internationally active global banks, are exposed to transition risk spillover both within and across regions.

Chart 8: Origin and flow of cross-border transition risk by selected major region[13]

[13] For simplicity, we present only three major regions, namely the Asia–Pacific, USA and Canada, and Western Europe, for illustration in Chart 9.

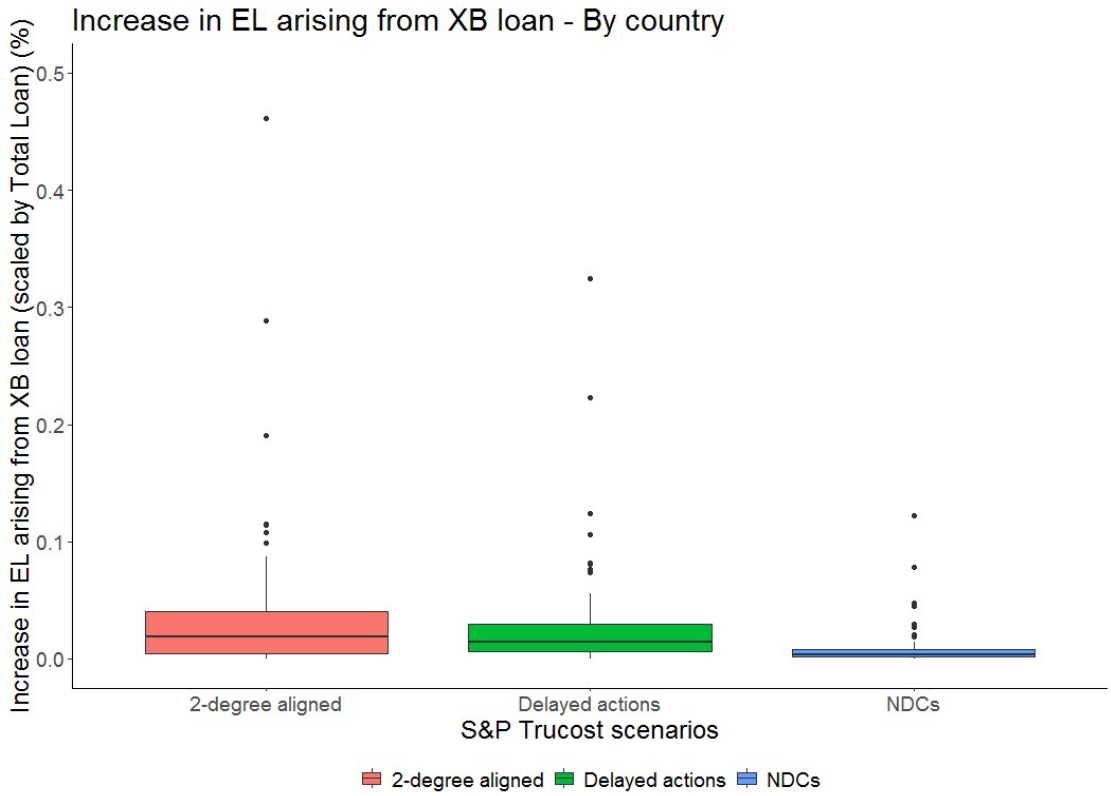


Note: The chart presents the source of cross-border transmission of transition risk to different banks by borrowers' geographic region.

3.3 Estimated increase in credit risk for banks with cross-border exposure at the end of 2030

By mapping the impact of credit risk on borrowers to banks' exposure, we obtain the distribution of estimated credit losses for cross-border syndicated loans in the 2°C-aligned scenario by bank jurisdiction, as presented in Chart 9. We include the results for the two additional scenarios provided by S&P Trucost for reference (i.e. the second and third boxplots in the chart). Overall, the increase in expected credit losses for different banking sectors is estimated to be mild, indicating that only a small proportion of the total amount of these cross-border loans (less than 2% of total syndicated loans) is extended to borrowers facing significant transition risk, where unpriced carbon costs account for at least half of their earnings. For instance, the median impact indicates that the estimated increase in EL would account for approximately 0.02% of the banking sector's total syndicated loans at the end of 2030. Even at the 95th percentile, the estimated increase in EL remains small, representing around 0.1% of the banking sector's total syndicated loans.

Chart 9: Boxplot of the estimated increase in EL resulting from cross-border exposure across lender jurisdictions



Note: The boxplot, whiskers, and points indicate the median value and interquartile range, 1.5 times the interquartile range, and other data points more than 1.5 times the interquartile range from the median.

However, the estimated increase in EL reflects only the impact of declining earnings due to unpriced carbon costs in the adverse climate scenario. As various other channels (especially the second-round effect of the pass-through of carbon taxes to other sectors) are not captured by our analysis, the total impact of transition risk on the credit risk of banks with cross-border exposure could be significantly higher than the current estimates suggest. Therefore, the credit risk estimates provided above should be viewed as demonstrative of the usefulness of the analytical framework for quantifying the potential financial impact of transition risk on banks' cross-border exposure. As such, caution should be exercised in the interpretation of these results.

3.4 To what extent are banks exposed to climate transition risk spillovers due to their common exposure?

In the final part of our analysis, we examine the extent of spillover risk due to banks' common exposure to the borrowers most vulnerable to transition risk. A better understanding of this issue is important, as increased interconnectedness among banks could amplify systemic risk through contagion effects (Cai et al., 2018). Moreover, a significant degree of common exposure to such vulnerable firms may imply that any sudden realisation of transition risk for such firms would simultaneously harm the balance sheet resilience of multiple banks worldwide. This contagion effect could be

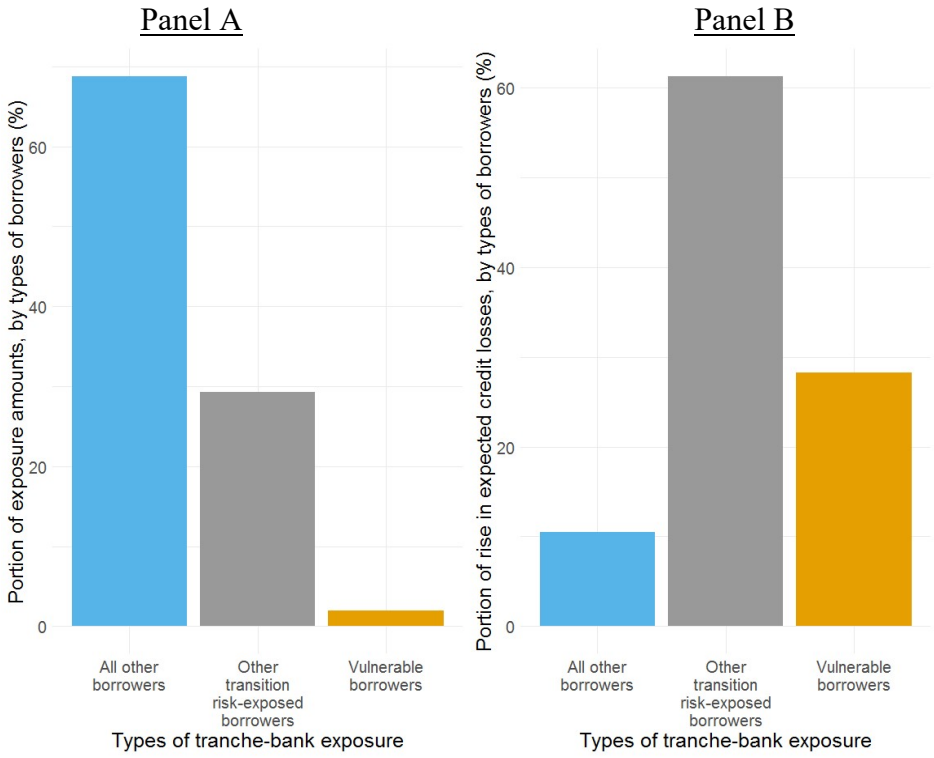
geographically widespread if such exposure to high transition risk is not confined to the domestic region but extends to cross-border lending.

3.4.1 Degree and importance of exposure to vulnerable borrowers

To quantify banks' common exposure to borrowers especially vulnerable to transition risk, we focus on a subsample of the 300 borrowers that would be most adversely affected by unpriced carbon costs in the 2°C-aligned scenario in 2030 (hereafter 'vulnerable borrowers').

According to the S&P Trucost CEaR dataset, such vulnerable borrowers could experience a substantial decline in their profitability, with projected reductions of at least 35 percentage points in their EBIT margins by 2030. While this group of borrowers accounts for merely approximately 2% of the total syndicated loan exposure of banks (as indicated by the orange bar in Panel A of Chart 10), they account for approximately 30% of the total increase in banks' EL (as indicated by the orange bar in Panel B). This finding underscores the importance of examining the extent of banks' common exposure to the most vulnerable borrowers.

Chart 10: Share of loan exposure at the end of 2022 and estimated EL by the end of 2030 (by borrower type)

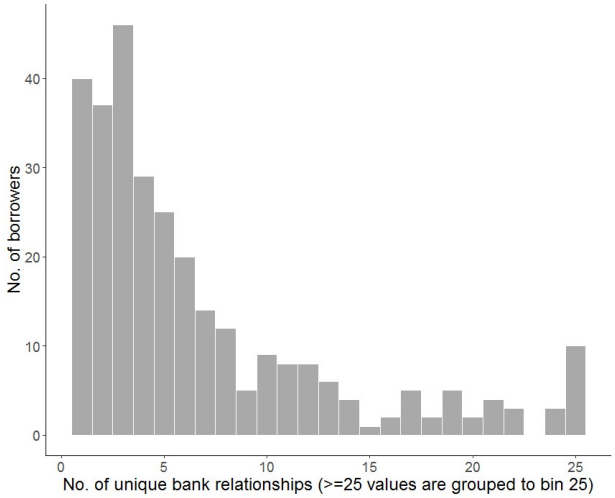


Note: Vulnerable borrowers', 'Other transition risk-exposed borrowers', and 'all other borrowers' indicate the 300 borrowers most adversely affected by unpriced carbon costs, other transition risk-exposed borrowers, and all remaining borrowers, respectively.

3.4.2 Banks' common exposure to vulnerable borrowers

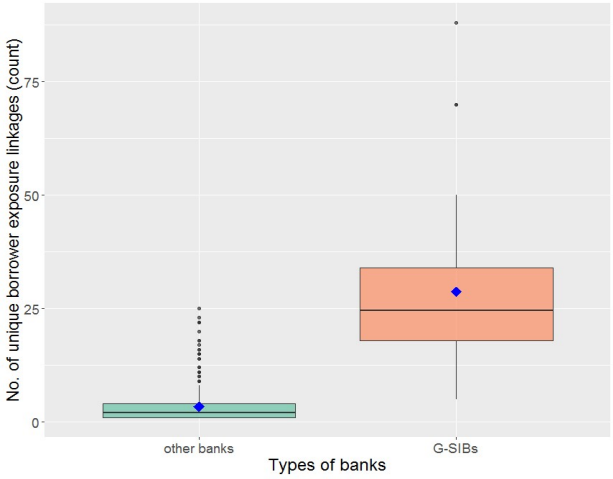
Many of these vulnerable borrowers have multiple banking relationships. As shown in Chart 11, approximately 50% of these borrowers have up to four unique banking relationships, while approximately 20% have more than 10. The prevalence of multiple banking relationships highlights a potential source of common exposure in the global syndicated loan market.

Chart 11: Distribution of unique bank relationships for the 300 most vulnerable borrowers (by counts)



Note: Distinct borrower–bank lender pair data are presented for the 300 most vulnerable borrowers.

Chart 12: Distribution of the number of unique lending relationships with the 300 most vulnerable borrowers by type of bank



Note: The list of G-SIBs includes all banks currently or previously classified as such by the Financial Stability Board.

Chart 12 displays the average number of lending relationships between G-SIBs and other banks, respectively, with the 300 most vulnerable borrowers. G-SIBs tend to have more lending relationships with these most vulnerable borrowers than do their non-G-SIB counterparts, as reflected by both higher average values and a broader distribution in the boxplot in Chart 12. This finding suggests that G-SIBs tend to have greater common exposure to these vulnerable firms, compared with other banks.

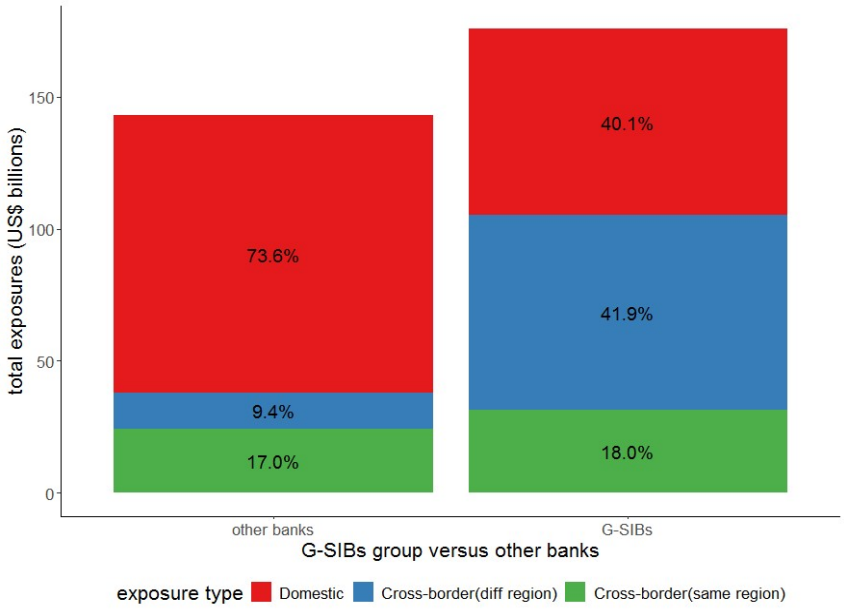
3.4.3 To what extent does common exposure to vulnerable borrowers take the form of cross-border loans?

Whether this common exposure is more prevalent for cross-border loans or domestic loans is important. If exposure is more concentrated in banks' cross-border portfolios, any realisation of transition risk affecting such vulnerable borrowers could negatively impact banks across multiple jurisdictions simultaneously, creating an additional channel for the cross-border propagation of climate transition risk. Furthermore, abrupt changes in national climate policy in a jurisdiction could be more disruptive for foreign banks with cross-border loan exposure in the region, as they may be less familiar with the economic and political development of the region and therefore less able to accurately assess the magnitude of adverse impacts on the associated borrowers.

Our findings in Chart 13 show notable differences between G-SIBs and other banks in the types of exposure to these 300 vulnerable borrowers. Specifically, G-SIBs tend to have a much higher share of their exposure in cross-border loans to vulnerable borrowers, as indicated by the blue and green sections of Chart 13, which together account for 60%. In contrast, other banks are primarily exposed to these vulnerable borrowers through domestic lending, as suggested by the red sections of Chart 13.

This notable difference between the exposure of these two groups of banks may be attributable to the fact that G-SIBs are generally more active in foreign lending. Overall, these findings suggest that the extent of cross-border spillover arising from common exposure to the most vulnerable borrowers varies between G-SIBs and other banks, with G-SIBs being more susceptible to this type of risk.

Chart 13: Syndicated loan exposure to the 300 most vulnerable borrowers, by type of exposure



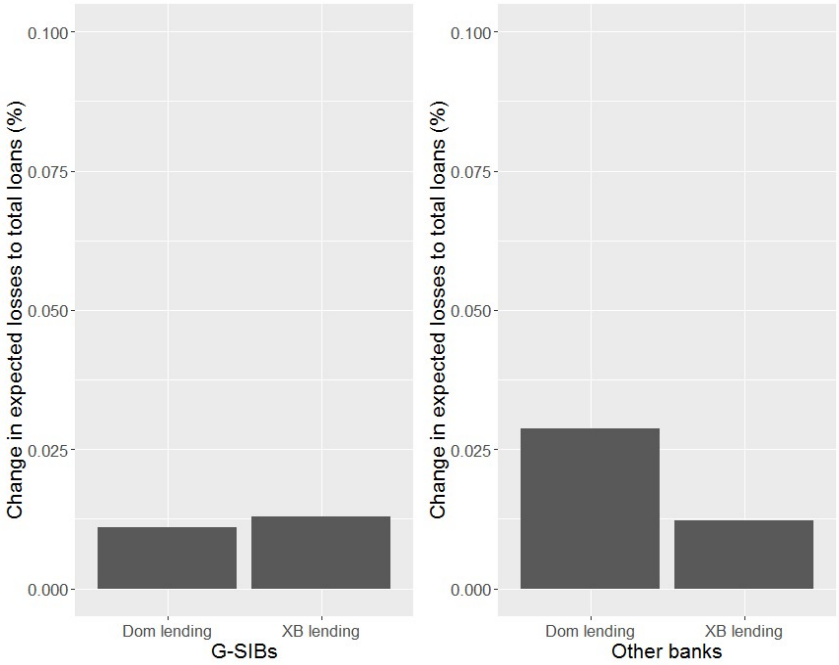
Note: The proportions (%) of the three types of exposure within each group of banks' total syndicated lending portfolios are reported within the blocks.

3.4.4 Magnitude of credit risk impacts on banks from their common exposure to vulnerable borrowers

The significant common exposure to vulnerable borrowers notwithstanding, the estimated increase in EL remains moderate for both G-SIBs and other banks in the 2°C-aligned scenario (i.e. totalling less than 0.1% of their domestic and cross-border

syndicated loan portfolios, as shown in all four columns in Chart 14).[14] The relatively small impact may be partly attributable to the fact that the syndicated lending portfolios of both groups of banks are generally well diversified and that the total amount of exposure of banks to these vulnerable borrowers is small. It should also be reminded that the estimated expected losses capture only the direct impact on profitability of unpriced carbon costs (i.e. only Scope 1 and Scope 2 emissions) on borrowers. If we consider the broader economic impacts of carbon pricing policies on the entire value chain of high-emission economic activities, the impacts of the materiality of credit risk on banks could be significantly greater.

Chart 14: Changes in EL in loans to vulnerable borrowers over total syndicated loan exposure



Note: 'Dom lending' and 'XB lending' denote the domestic and cross-border syndicated lending portfolios, respectively.

IV. CONCLUDING REMARKS

Using data on global syndicated loans, we illustrate the feasibility of our proposed framework for assessing the cross-border transmission of transition risk and the related credit risk implications for the global banking sector. In particular, the framework can be used to estimate the impact of the future unpriced carbon costs faced by syndicated loan borrowers on the PD and EL of syndicated loans in various climate

[14] Furthermore, the final impact would probably be even lower, as approximately 24% and 33% of the outstanding domestic and cross-border syndicated loan exposure to these vulnerable borrowers is secured lending based on information from LSEG Loan Connector.

transition scenarios. It is also sufficiently flexible to adapt to future carbon price estimates from other sources, such as those provided by the NGFS. Finally, the mapping of banks' exposure to these firms further enables us to assess the impact of credit risk on banks' cross-border loans.

Our initial assessment based on S&P Trucost's 2°C-aligned scenario for 2030 shows that approximately one third of banks' total syndicated loan outstanding amounts are extended to transition risk-exposed borrowers (defined as firms with unpriced carbon costs greater than 10% of their earnings). As only approximately 10% of these loans are extended to borrowers facing significant transition risk, where unpriced carbon costs account for at least half of their earnings, the estimated credit loss associated with future unpriced carbon costs by the end of 2030 is found to be relatively mild.

Despite the relatively small estimated credit risk impact, cross-border spillover effects are possible. Among the syndicated loan exposure to transition risk-exposed borrowers, over half is attributable to cross-border lending (i.e. 17% of total syndicated loan amounts). Notably, spillover may primarily stem from banks' own regions, particularly for those in Asia and Western Europe. Banks in these regions have a large share – approximately 40% – of their cross-border exposure to transition risk-exposed borrowers within their respective regions. These patterns indicate that regional transition risk spillover may warrant close monitoring.

Furthermore, our analysis suggests that the exposure of G-SIBs warrants closer attention, as their cross-border exposure to transition risk-exposed borrowers is more widespread across regions. Specifically, G-SIBs account for over two thirds of cross-regional exposure to transition risk-exposed borrowers. In addition, G-SIBs have significant common exposure to the borrowers most vulnerable to transition risk. Together, these findings suggest that G-SIBs may play a crucial role in transmitting and amplifying the global spillover of transition risk.

Using the lens of bank exposure in the global syndicated loan market, this study broadens understanding of the potential extent of the cross-border transmission of climate transition risk, which may be useful for policymakers in relevant prudential and supervisory considerations. For instance, as banks – especially G-SIBs – are exposed to cross-border transition risk spillover from both within and outside the regions where they are headquartered, policymakers should continuously monitor developments in climate policies in various regions. Additionally, our common exposure analysis highlights how banks' common exposure can serve as an important channel for transmitting transition risk across different banking sectors. Such transmission could

have negative implications for the resilience of the global banking sector if a severe transition risk shock hits such borrowers with common lenders, underscoring the importance of improving the monitoring of the common exposure of banks to borrowers that are highly susceptible to climate-related risks.

Finally, our proposed framework currently considers only the impact of future unpriced carbon costs on borrowers' profitability. While these costs are a critical factor through which climate transition risk can affect the credit risk of firms, future climate risks can impact firms and banks through many other potential channels (BCBS, 2021). Given the complex and multifaceted nature of climate-related risks, further analysis is necessary to explore such additional channels and evaluate their credit risk implications for banks. In principle, such additional channels can be incorporated into our proposed framework to allow for a more comprehensive assessment of the implications of climate risk on banks. Therefore, this study can be viewed as a useful starting point for regulators and practitioners to develop and enhance their tools for analysing the cross-border transmission of transition risk in the global syndicated lending market over time.

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Appendix

Table A.1: Sources of different variables

Variable	Sources
1 year (or 5 year) ahead PD for listed nonfinancial firms	NUS-Credit Research Initiative
Borrowers' geographic and industry classification and key financial statement variables	S&P Capital IQ Pro
Borrowers' reduction in EBIT margin	S&P Capital IQ Pro – Trucost
Sample period	1993–2022 (annual frequency)
No. of firms (nonfinancial)	Approximately 59,000

Equation 1: A simple credit risk model for linking borrower's ROA and its PD

$$PD_{f,t} = \beta_1 ROA_{f,t} + \beta_2 Size_{f,t} + \beta_3 debt/asset_{f,t} + \beta_4 cash/asset_{f,t} + \beta_5 \frac{CurrentAsset}{CurrentLIA}_{f,t} + firm\ FE_f + DomicileCtry\_Year_t + \varepsilon_{f,t} \quad (1)$$

where *f* and *t* denote firm *f* and year *t*, respectively. Other balance sheet control variables are relevant explanatory variables commonly employed to assess firms' financial resilience.

Table A.2: Estimation results of equation (1)

Columns	(1)	(2)
Dependent variable:	1Y-ahead PD (0.01=1ppt)	5Y-ahead PD (0.01=1ppt)
ROA (0.01 = 1ppt)	-0.043891***	-0.114497***
	(0.000731)	(0.001624)
Size (ln(asset in US$))	0.000138**	0.002361***
	(0.000065)	(0.000159)
Debt/asset (0.01 = 1ppt)	0.019588***	0.052425***
	(0.000335)	(0.000744)
Cash/asset (0.01 = 1ppt)	-0.003517***	-0.006022***
	(0.000260)	(0.000607)
CurrentAsset/CurrentLIA (1 = 100ppt coverage)	-0.000491***	-0.001622***
	(0.000017)	(0.000043)
No. of observations	675,346	675,346
Firm fixed effects	Yes	Yes
Domicile_Country#Year fixed effects	Yes	Yes
Within R2	0.080	0.116
R2	0.509	0.662

Independent variables are winsorised at the 5% and 95% levels. Standard errors clustered by firm are reported in parentheses. *** represents statistical significance at the 0.1% level.

Equation 2: Deriving change in ROA from CEaR data

$$\Delta ROA = \frac{\Delta EBIT}{Asset} = \frac{EBIT_{S1} - EBIT_{base}}{Asset_{base}}$$

$$= \frac{Unpriced\ carbon\ cost\ adj\ EBIT_{S1} - original\ EBIT_{base}}{Asset_{base}}$$

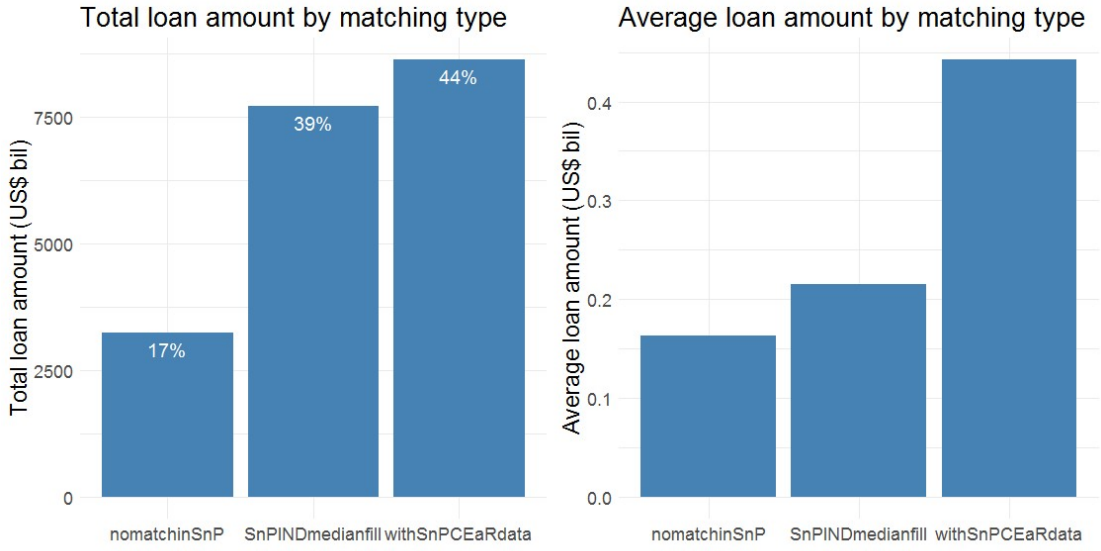
$$= \frac{change\ in\ EBIT\ due\ to\ unpriced\ carbon\ cost}{Asset_{base}}$$

$$= \frac{change\ in\ EBIT\ due\ to\ unpriced\ carbon\ cost}{Revenue_{base}} * \frac{Revenue_{base}}{Asset_{base}}$$

$$= Change\ in\ EBIT\ margin_{S1} * \frac{Revenue_{base}}{Asset_{base}}$$

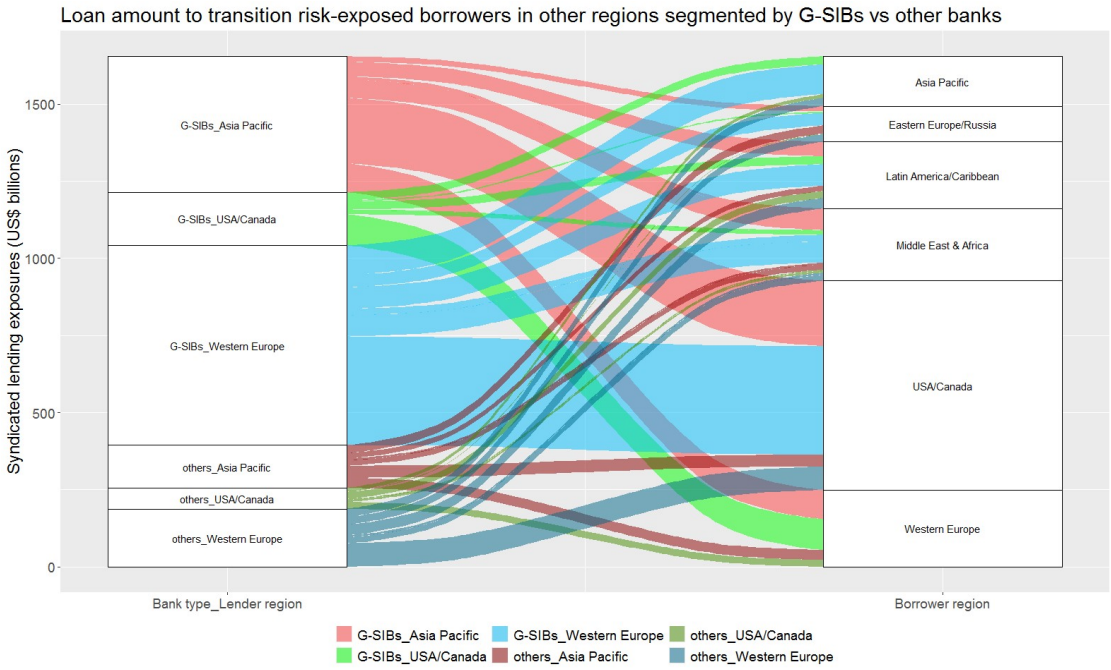
where $Change\ in\ EBIT\ margin_{S1}$ (reduction in EBIT margin) is obtained directly from Trucost for the high, medium, and low scenarios. $Revenue_{base}$ and $Asset_{base}$ can be obtained from the 'financials' tab directly.

Chart A.1: Aggregate and average syndicated loan amounts after matching syndicated loan data from Loan Connector with S&P Trucost



Note: 'NomatchinSnP', 'SnPINDmedianfill', and 'withSnPCEaRdata' respectively denote loans to borrowers i) with no true match in the S&P database, ii) with a true match in the S&P database but without CEaR data, and iii) with a true match in the S&P database and available CEaR data available after the matching process. The aggregate and average loan amounts for each group of loans are reported in the left and right panels, respectively.

Chart A.2: Origins and cross-region flows of transition risk for G-SIBs and other banks



Note: The 2030 high scenario and consolidated basis for classifying the regions of bank lenders are adopted for chart compilation.