

CLIMATE RISK

JUNE, 2022

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Climate Risk Impacts on a Lending Portfolio; Loan-level Analytics

Background

The ongoing discussion and analysis of climate risk and financial system stability has included a number of climate risk trials, case studies, and experimental stress tests. To date, none of these have been comprehensive in terms of the portfolio volumes and industry sectors typically held by mid-market banks, and only a few have attempted to aggregate the financial impacts to show typical bank performance or risk metrics. This analysis does both.

We created a "Synthetic Bank" holding approximately \$20 billion USD in loans that we sampled from Moody's proprietary credit risk database, the DataAlliance. We performed climate impact modeling and compared the results under three primary Network for Greening the Financial System (NGFS) scenarios (Early Policy, Late Policy, and No Policy), against an unadjusted Baseline.¹ For brevity, we summarized results here only for the No Policy and Baseline cases. For relevance, we focused this report on the 10 year time horizon, as we see many commercial loans and even residential loans either run-off or refinance within a 10 year period, allowing institutions to reassess and rebalance their holdings. The 10 year horizon is also long enough that we begin to recognize some of the longer-term climate impacts of the scenarios. Examining the physical and transition climate risk impacts on a large, diverse portfolio of loans and quantifying the potential changes in default rates and expected losses across all credit qualities and industry sectors, provided the basis for assessing the climate risks currently facing this lender. The net impact is measured in terms of increased Expected Loss Reserve Requirements. This set of financial impacts is one example of the metrics now being considered for required disclosure, by the Securities and Exchange Commission and other regulators of public firms and banks in the United States.

While there is no widely accepted standard for how lenders should recognize climate vulnerabilities, this analysis sheds light on how important it is to assess these at the loan level. A loan level analysis is the only way a lender can come to understand both the full portfolio impact and the heterogeneity within its loan portfolios.

¹ Moody's uses Early Policy, Late Policy, and No Policy scenarios to represent the Orderly, Disorderly, and Hot House World NGFS scenarios, respectively.

Summary Portfolio Findings

The portfolio was composed of roughly 43% Commercial Real Estate (CRE), 37% Commercial and Industrial (C&I), and 20% Residential Mortgages (Resi), all of which were located in a seven state region in the Southeastern US.² At the beginning of the forecast period, all loans were performing. That portfolio experienced an increase in the cumulative Expected Loss (EL) of \$312 million USD due to physical and transitional climate risk impacts under a “No Policy” scenario, over a ten-year holding period. This represents cumulative EL rate change from 4.50% to 6.04%, and those translate into annualized EL rates of 45.9 and 62.2 basis points (bps) for an increase of 16.2 bps. Figure 1 summarizes the change in cumulative probability of default or cumulative expected default frequency (CEDF) and EL, and Figure 2 provides some basic descriptive metrics for the Synthetic Bank portfolios.

Figure 1 Summary Portfolio Impacts: CLIMATE VS BASELINE 10- YEAR RESULTS

	CRE	C&I	Resi	Total
CEDF ABSOLUTE CHANGE	5.61%	5.75%	Stable 720 FICO	
EL ABSOLUTE CHANGE	1.68%	1.22%	1.88%	1.55%
EL INCREASE (\$ USD)	145,684,167	91,241,414	74,595,747	311,521,328

Figure 2 Portfolio Overview

	CRE	C&I	Resi	Total
LOAN COUNT	2,163	1,215	13,300	16,678
STARTING BALANCE (\$ USD)	8,695,438,021	7,478,810,260	3,967,858,893	20,142,107,174
WTD AVERAGE INTEREST RATE	3.07%	3.21%	4.26%	3.40%
INTEREST INCOME YEAR 1 (\$ USD)	266,949,947	240,320,407	178,496,768	685,767,122

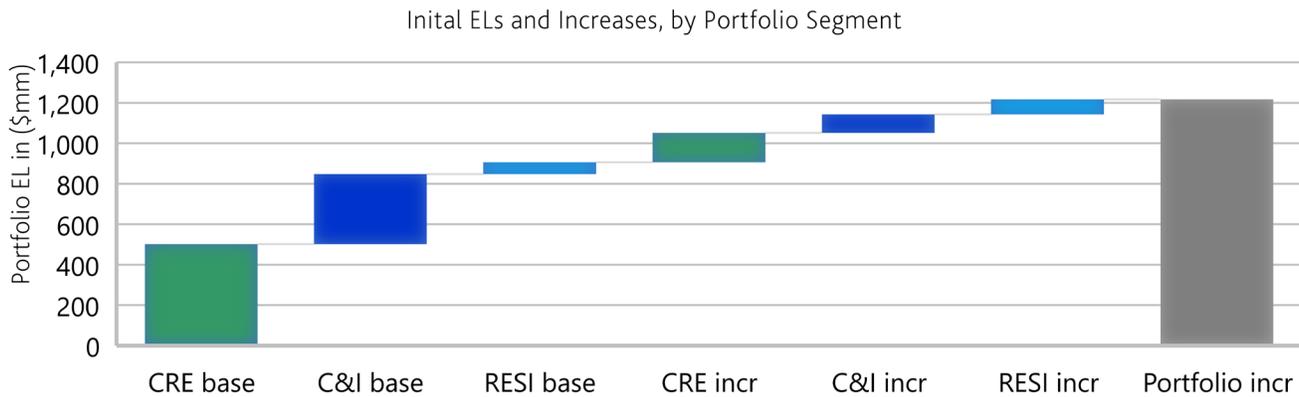
The portfolio segment descriptions in Figure 1 provide a sense of the overall composition and balance, as well as of the annual interest income streams. The climate risk impacts on CEDF and cumulative EL were material for all three of these portfolios. Note that the cumulative EL dollar figures also reflect the assumption that any CRE or C&I loan that matured within the 10-year horizon was replaced.

The Resi portfolio demonstrated resilience to climate related EL due in no small part to the role of insurance covering potential climate damages. Furthermore, the relatively lower balances, relatively greater geographic diversity, and the ability of homeowners to more easily relocate to climate safe havens provided some insulation from climate impacts for borrowers and for lenders.

These general results were all reflected to greater or lesser degrees in the other NGFS scenarios and over 5, 20, and 30 year horizons, as expected. All impacts were magnified with longer horizons, and the differences across scenarios were very slight at horizons of 10 years or less. The relative contributions to overall cumulative portfolio EL at 10 years are shown in Figure 2.

² Actual anonymized loan data was used to construct these portfolios, supplemented in the Resi portfolio by some sampled and simulated data. Private firms comprise 98% of the C&I portfolio.

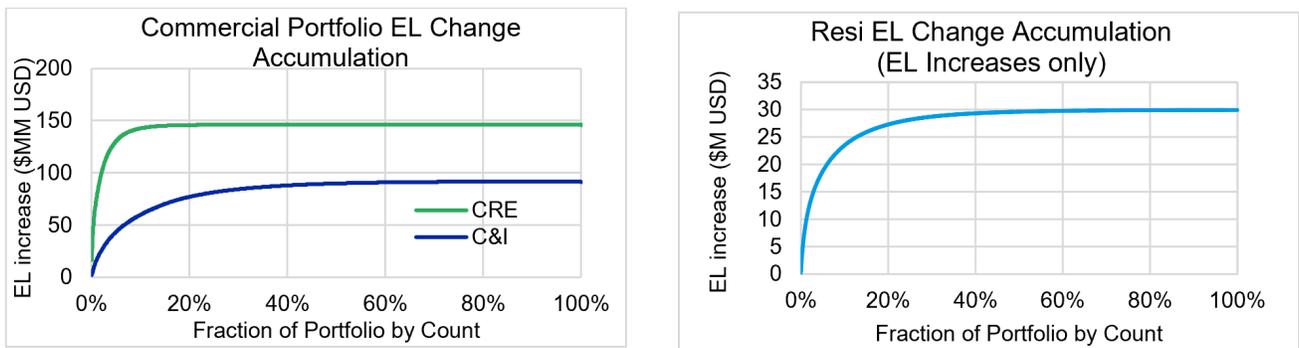
Figure 3 Portfolio Expected Loss contributions



On a single year basis, the 16.2 bps EL increase will have a negative impact on Net Interest Income of about \$33 million USD, and the CECL allowance would increase by roughly \$312 million USD. But these aggregate statistics obscure the heterogeneity in the levels of EL change across all portfolio segments, which is critical for the lender to identify and address the highly vulnerable loans.

In addition, it is not possible to begin to understand the critical drivers without looking at individual exposures. One indicator of differing loan sensitivity to climate risk is the concentration of Cumulative EL increases by loan. The diagrams below in Figure 3 show the accumulation of Cumulative EL dollars for the C&I and CRE portfolio segments and the Resi segment, beginning with the largest EL increases.

Figure 4 Concentration of EL Change within Portfolio Segments



C&I and CRE. The C&I portfolio segment displays some concentration, nearly conforming to the "80:20" rule of thumb. Here, 80% of the \$91 million USD in cumulative EL is \$73 million USD, and those expected losses are concentrated in 16.8% of the loans in that portfolio (204 loans). The Synthetic Bank's CRE portfolio segment is, on the other hand, much more concentrated. Within CRE, 90% of the cumulative EL increases are driven by only 5.2% of the loans. Looking for concentration by conditioning on initial EDF, or on loan balance, revealed very little in either case. Thus, the major EL increases are not coming from loans with poor initial EDFs or large balances. These larger EL increases appear to be driven by a combination of industry segment, firm size, and location within the C&I segment, and by property address and facility type within the CRE segment.

The specific C&I segment distributions of cumulative EL increases across states, industry segments, firm type (public v.s. private), or firm sizes also do not show significant concentrations, hinting that it is the combination of these drivers within the climate risk modeling suite that underlies the larger impacts.

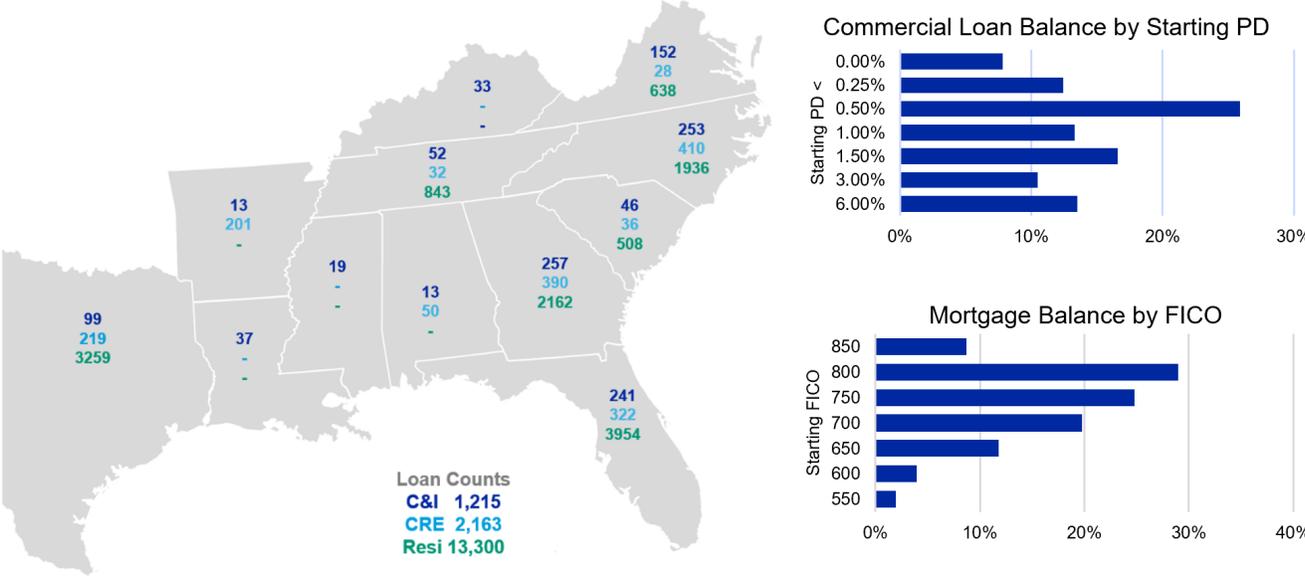
Resi. Within the Resi portfolio segment the climate risk impacts were more subtle, as shown in Figure 3 above. The distribution of EL changes was nearly symmetric in this portfolio, with 5,656 mortgages showing increases in EL and 7,644 showing either zero changes or decreases in EL. The large majority of these were very small, but there was notable concentration in both the positive and negatively impacted mortgages. For example, approximately 50% of the total EL positive changes were attributable to only 210 mortgages, or 1.6% of the Resi segment.

There is no common geographic indicator, industry marker, or other smoking gun to help lenders identify climate vulnerability (or resilience) at a portfolio level for any of these three segments. As a result, loan-level analytics are critical to identifying where climate risk will impact loan portfolios.

Methodology

Moody's Analytics maintains one of the world's largest pools of anonymized loan data, and that pool spans CRE loans, C&I loans, and Resi Mortgages, all from a wide variety of borrower types. From that pool, samples were drawn to create a synthetic bank portfolio totaling \$19.4 billion USD in outstanding balances – a typical mid-market US bank size. The samples were drawn across 11 states to emulate a regional bank footprint and to include a variety of economic and climate conditions. The resulting portfolio of the Synthetic Bank was described in Figure 1, and the physical footprint is shown below in Figure 4.

Figure 5 Synthetic Bank Loan Map and Starting Risk Metrics



Each of the three portfolio segments required somewhat different quantification approaches to capture the unique aspects of the exposure types and to leverage the best available methods and data. All the climate risk impact modeling was performed using Moody's Analytics' proprietary data and methodologies, guided by widely accepted climate scenarios/pathways. Moody's Analytics' proprietary macroeconomic scenarios align with NGFS scenarios, and reflect many of the chronic physical and transition risk impacts with variables including productivity metrics, energy demand, commodity, and carbon prices, as well as classic macroeconomic measures like government spending, employment by industry, incomes, and output.

C&I. The C&I analysis estimated the individual and combined impacts of physical and transition risk on each individual borrower's probability of default. Both physical and transition risks were estimated leveraging an Integrated Assessment Model (IAM), which predicts economic and climate outcomes for the underlying scenarios. For transition risk, the IAM was augmented to incorporate an oligopoly-based model of firm competition, customized by individual firm's carbon emission intensity and energy emission intensity. For climate risk, granular data that reflect exposure to physical risk based on the geographical location(s) were leveraged. The results were then extrapolated into asset volatility, and equity and liability impacts to determine a Climate-adjusted Expected Default Frequency (EDF). Where obligor-specific data was lacking, proxy-based estimates were utilized.

CRE. The CRE Climate-adjusted EDF models also source proprietary physical climate risk data at a very precise spatial granularity, focusing only on wildfire, hurricane, and flooding impacts in this analysis. Those physical risk impacts were calibrated to historical losses for similar building types and locations. The remaining inputs are typical of any CRE credit model, principally including loan origination and maturity dates, loan rate and outstanding balance, property type, address, value, and net operating income.

Resi. The Resi portfolio models used here were largely driven by Housing Price Index, Unemployment, Interest Rates, and local GDP; all variables captured in the macroeconomic scenarios. Moody's leveraged historical physical climate risk and loss data to create spatial differences in the risk factors across the geographic portfolio footprint.

Conclusions

Some previous climate impact evaluations of large loan portfolios have utilized industry sub-segment proxies or averages. That approach certainly could produce very similar results in terms of average EDF changes or EL impacts. A loan-level approach was utilized for the Synthetic Bank loan portfolio specifically to explore the heterogeneity within the industry or credit quality concentrations of the portfolio. This revealed that very similar looking loans could have extremely different sensitivities to climate change. That understanding is vital for a bank to act on the results of an analysis and identify the specific obligors or properties that are most at risk. Furthermore, as we continue to acquire and integrate the latest climate data into our models, we expect to find additional granularity in our modeling approaches to better forecast climate impacts.

To institute a framework similar to this report, lenders need C&I PDs and LGDs, CRE property information including zip code, property type (retail, multifamily, etc.), loan-to-value ratio, and debt service coverage ratio, Resi property state location. Less granular information limits lenders to a higher-level assessment that may be useful for determining allowance adjustments but not for managing the risk in the portfolio. To facilitate the detailed analyses that support rigorous portfolio management, analysts benefit from more granular details such as, C&I geographic markets for products and services, CRE environmental certifications (e.g., LEED) and energy sources, and Resi addresses and insurance coverages. The more granular data allow lenders to better price both new and refinancing loans and advise clients on how to manage their operations to achieve better resilience.

Any analysis of climate risk impacts on a financial institution entails significant assumptions and uncertainty. This exercise, while based on actual loan data, will certainly not be representative of any specific bank's loan portfolio for many reasons. One of the primary findings of this analysis is that individual loan characteristics matter greatly, so extending specific numerical findings to a particular bank or portfolio is unfounded. There is also some level of conservatism in the loss estimates since the methodology excludes some transition impacts, possible migrations, loss of insurance products (a trend of particular interest in the real estate space), and other secondary affects.

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