PLAUSIBLE IMPACT ON CAPITAL DUE TO CLIMATE CHANGE
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Abstract

Various policy, legal, market, economic and climatic factors can have significant impact on multiple industries. This study evaluates the impact of various climate change factors on the performance of financial institutions that provide credits to various industries.

The Purpose of Analysis

A climate scenario is a reasonable portrayal of future climate that has been constructed for overt use in looking into the significant impacts of anthropogenic (environmental pollution and pollutants originating due to human activity) climate change. Climate scenarios generally make use of climate predictions (details of the systematic response of the climate system to scenarios of greenhouse gas, CO2 emission, temperature, rainfall and gas). Renowned economists infer climate change as one of most well-known market catastrophe in the known past with potentially turbulent consequences on the financial stability, economic well-being, and social inclusion of the present as well as future generations. Traditional approximation shows constant climate disruptions will lead to decrease in global GDP between 5 to 20% every year, now and in future as well.

Consequentially, both public and private administrator and investor around the world face the dual essence of:

- Remarkably and swiftly reducing greenhouse gas (GHG) discharge globally, by de-carbonizing the global economy, consequentially averting the mean worldwide temperature spike from attaining threatening levels.
- Attuning global production and consumption norms, social living, and the fundamental supply-network, to the meteorological, hydrological effects of changing climate that is clearly unstoppable.

The exploratory research has been done to establish relationship between climate change and derivatives like fossil fuel consumption, carbon emission, average rainfall, average temperature, European emission allowances, issuance of green bonds, Norway oil output etc. to some of the balance sheet factors like net interest income, net income, non-performing loans. This is primarily a statistical research that has been done post focused group discussions, data discovery and data profiling from public domain. This paper is first step research showcasing data collection, profiling, establishing relationship on aforementioned parameters.

We acknowledge that climate-change could have significant supposition on the financial institutions. The very first suggests a demand to alter time horizons on the long run along with contemplating measures today observing how the risks from climate change may evolve in the future. The second suggests the urge to maintain the equilibrium. It is anticipated that financial risks are going to be realized in some structure, the question is decreasing their aftermath while firms and society maximize the chances.
Climate Change Presents Financial Risks

Climate change causes financial risks those surfaces from two significant mediums or risk factors: Physical and Transition. Climate and weather related events such as storms, heatwaves, floods, sea level rise and droughts can lead to physical risks. They can consequential cause substantial monetary losses, diminishing asset worth and the credibility of borrowers. Transition risks can rise in the procedure of acquiring a de-carbonized economy. Upgrading policy, technology and belief can trigger a re-assessment of the worth of the holdings and generate credit exposures for financial institutions.

These above said climate related risk factors manifest intensified market, credit and operational risk for banks and financial institutions.

Credit Risks

The financial obligations might fall onto other market partakers if the vandalism from physical risks are not insured which in turn would increase the credit exposures for financial institutions and banks. Homeowners will end up getting severely impacted due to hostile weather events, minimizing their scope to meet their debt obligations and damage the value of their assets. Consequently, it would impact adversely on the credit risk of the loan books as both probability and loss give default increases.

Banks and financial institutions might have some credit exposures with firms having business models that seemingly are not in trend with the switchover to an economy with low carbon usage, and as an impact anticipate a greater chance of minimized corporate income along with business disruptions. Based on our research we have selected firms in the agriculture, property, and transport and energy sectors to be prone to the risk involved, specifically in the case if this transition is triggered late and not systematically.

Market Risks

Commodity prices, energy sector, equities, corporate bonds and certain derivative contract would largely be impacted in this transition on carbon rich sectors. In the coming future if the portfolios are not in line with expected climate protocols the financial risk from sudden transition to a de-carbonized economy may increase. Fundamental factors like inflation, employment and economic growth can be weakened through endured damage to national infrastructure. As a result we can conclude here that macroeconomic conditions would be eventually impacted by increasing frequency of extreme weather events.

Operational Risks

Business continuity like processes, infrastructure, offices, branch networks and staff would be tremendously impacted due to severe weather events. The cost-tariffs of inputs like insurance, water and energy might rise. Due to a strategic shift in sentiments among customers and rising scrutiny and alertness among stakeholders on the banking sectors response to climate change reputational risk may arise as well. As a result monitoring the financial risks from climate change needs a well-planned and strategic methodology, one that is progressive and well balanced in the long term financial interests of the firm.

Traction on Climate

Here, the main focus would be on what the regulatory and banking bodies have to say on the climate ordeal.

PRA: Prudential Regulation Authority - A UK financial services regulatory body formed as a successor to FSA firmly believes that economy is going to take a toll in the areas such as smooth functioning of the financial market, productivity of the work place or impacting total economic activity due to the climate change. Their study also showcases that the global economy too can be impacted by the environmental change. PRA has considered the physical risk that arises from events like droughts, storms and floods. For example, we consider the 2011 Thailand flood which resulted in over $45 billion of economic losses. Moreover, on a different side, the mangrove forests in Mexico bestow protection from storms and provide fisheries support and eco-tourism. These benefits have been estimated at $70 billion in financial terms.

PRA also mentions the transition risk that arises due to change in the policies for e.g., under Paris agreement the economies need to limit their carbon emission and fossil consumption down the line. These are the key concerns that has been taken into account while preparing the outcomes to stabilize the financial system around.

EBA: European Banking Authority has emphasized the aftermath of the climate change and its consequences through the materialization of 3 main risks- Physical Risk (covers direct damage to property or trade disruption, Transition Risk (covers the financial risk that arises from the transformation to a low-carbon economy) and liability risk (stating the responsibilities for the impact that will occur down the line and understanding the impact).

The report also mentions that the transition and physical climate shocks are going to affect credit, market and operational risk in different ways directly or indirectly. Soon EBA will come up with methodology to be implemented by FIs in their jurisdiction. Strong references have been found in EBA websites.
FSB: Financial Stability Board (formed by G20) observes and makes recommendations around the financial system of the globe. In 2015 G20 approached FSB to contemplate climate risk and in 2015 December, FSB initiated the industry-led Task Force on Climate-related Financial Disclosures (TCFD) to develop suggestions on climate-change related financial disclosures. The Task Force published its complete advisory in June 2017.

Declaration of climate-related financial information is now a precondition for financial firms to not only run and price climate risks suitably but also, if they are willing to take lending, investment or insurance underwriting decisions based on their view of transition scenarios.

FSB is currently working on recommendations that will ease habitual, comparable, dependable, clear and systematic climate-related declarations by companies. It is quite clear that FSB is considering climate change as a serious issue.

United Nations Financial Initiatives: UN report stresses on climate change related risks on financial institutions and borrowers. UN has also addressed the current climate change policies in Canada, Europe and the US in order to provide a framework for policy implementation in the future. This study also addressing the impact of future environmental liabilities on specific debt products and review strategies for calibrating the associated risk.

Paris Climate Agreement: As of May 2019, European Union and 194 states have signed the Agreement. EU and 185 states, demonstrating more than 88% of global greenhouse gas emissions, have been ratified or consented to the Agreement, India and China, the countries in top 3 list of largest greenhouse gas emissions of the UNFCCC members total (about 42% together). All 197 members of UNFCCC have either signed or consented to the Paris Agreement. The agreement focus on the below points:

• Need to design a framework for sovereign/country actions on climate change in all of the major economies.
• A robust and transparent process to monitor the implementations.
• A timeline for the nations to review their actions.
• International mechanisms to promote climate friendly finance, carbon trading, technological upgrade and adjustment to climate change impacts.

Kyoto Protocol: The Kyoto Protocol is an international pact that puts out the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that pledges state parties to decrease emissions from greenhouse gas, as established on the scientific consensus that firstly global warming is occurring and secondly it is very likely that CO2 emissions have primarily caused it. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and came in action on 16 February 2005. There are currently 192 parties linked to the protocol.

By Kyoto protocol it is clear that the authorities understood the increasing GHG and carbon content in the atmosphere and planned to limit it by differentiating responsibilities based on the specific capabilities of the individual countries.

Objective of the Analysis

The study is based on considering specific geography (Europe) to evaluate the impact of various climate change factors on performance of financial institutions (banking). First section of the study is based adopting a framework on change in policies, technological changes, market factors, based on key performance metrics like non-performing loans, net interest income and net income. Report then explain the approach adopted to build a regression analysis based on R and perform stress analysis.
Framework for Climate Change Stress Testing & Risk Management

To assess the risks associated with climate change, we have built a Framework to understand and study the climate risk factors and their impact on banks portfolios. The Framework designed by us is as follows:

We have basically divided our Framework in 2 stages:
1) Assessing the Risk Exposure
2) Evaluating the Risk

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**Policy & Legal Factors**

Policy and legal factors consist of changes in local government, national and international regulations and policies that might impact the financial and operational viability of carbon assets. Regulations and policies could enforce restrictions on emissions from GHG on certain kinds of physical assets, or those that negatively affect such assets. Regulatory and policy risks start from action taken by government; it may be at local, state or country level. As an outcome, the nature of these risk types might differ subject to geographical region of assets in question or company.

**Technology Factors**

These risk factors would affect the carbon assets & companies in various ways. Technological factors consist of new and innovative technological developments either in design, cost or both — and that lead to quick change of outdated technologies. Existing technologies largely face threat of replacement by latest technical alternatives that have greater function, reliability, efficiency, or lesser cost profile, and, with relation to carbon, lesser GHG emissions. Technological changes that lead to enhanced energy productivity can decrease the overall energy demand, therefore reducing the necessity for production from current technology assets.

**Market & Economic Factors**

These factors involve risks that derive from changes in the economic and market parameters that might be related to the operational feasibility or financial value of the physically used asset or institution. Such economic and markets changes can be due to changes in consumer’s behavior. One contemporary example of how changes in market can negatively influence assets related to energy and other related companies is the current drastic slump in the oil prices. Lower demand for oil is correlated to lower growth rates in economy in many parts of the world and the ever-increasing efficiency, and moreover solid oil supply in some markets. It has been difficult for energy companies, for example, in the USA, where supplies have been tremendously increased by the exploration of new reserves made possible to access by the technology of hydraulic fracturing and horizontal drilling and other disruptive technologies which were developed recently in the field of oil explorations. There is a scenario where companies dealing in oil and gas business would go for higher cost development projects when there is low price environment and demand for disruptive tech advancements, energy, and even sovereign policies or political events.

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*Fig.1: Framework for Climate Change Stress Testing & Risk Management*
**Fig. 2: Risk Factors**

**Physical climate change risks**, refer to the risks pertaining to the physical impacts that may affect the operating companies and their assets. These risks can affect and contain physical impairment and along with that, capital expenses too in response to changes in weather scenarios (such as floods, severe drought and storms) and “slow onset” impacts such as sudden increase in the level of sea.

**Transitional change risks**, are the risks pertaining to the non-physical (i.e. intangible) climate change-related parameters being subjected on the assets of the companies. This includes technology, policy and legal, economic and market related risks — depending upon their type and magnitude of impact to the financial institutions. Based on the above factors, we have tried to identify the other variable, which would drive major changes in future.

**Policy and Legal Factors**: We have identified following changes which might be implemented by different countries to reduce temperature.

a) Policies to reduce fossil fuel consumption  
b) Policies to reduce carbon emission  
c) Increased focus on fuel efficiency standard  
d) Increased investment on renewable energy  
e) Other local government regulations  
f) Norway oil production

**Market and Economic Factors**

- Changes in Crude prices
- Annual Gross Issuance of Green Bond
- European Emission Allowances Spot price [emissions trading systems]

**Technology Factors**

- Consumption of Renewable Energies
- Fossil Fuel Consumption
- Sell of Hybrid Electric Vehicle
- Sell of Conventional Fuel Vehicle

**Climatic Factors**

- Temperature
- Rainfall
- Wind Speed
- Water Level rise
- Polar ice Cap melt

**Technology Factors**

- Increased demand of alternative energies
  - Increased consumption of renewable energy  
  - Reduced consumption of fossil fuel  
- Advancement renewable energy technologies
  - Increased and demand in electric vehicle  
  - Reduced demand of conventional Fuel vehicles
Methodology

Selecting Dependent Variable

In order to select the key performance indicators for the predictive modelling, it was imperative to decide the geography from which the bank or financial institute is selected. Here in the study, the selected geography is Norway. Below is reason why Norway is considered for the study.

1. Norway has a history of environmental concern, much before other cities jumped on the eco bandwagon. The government outgrows on the populace by promoting sustainability. The Norwegian city Oslo replaced heating oil in city buildings with renewable energy sources, which is bold considering the amount of energy the metropolis uses. The government also provides incentives for new buildings to promote energy efficiency. All buses running on fossil fuels are converted to biofuels. The Oslo city has less CO2 emission as compared to all European metropolises. Most of school children walk, cycle to school or use public transportation (the rail system is run on hydroelectric power). Ninety-four percent of household waste is recycled.

   Above mentioned facts are factored as part of Paris Agreement which has been addressed by Norwegian Government to save environment. This has led to policy implementation around the transition risk.

2. Further, The BEVs and PHEV’s will capture 100% of the automobile market by 2025. Govt. of Norway plans to get rid of fossil based vehicles completely post 2025. Plan to impose heavy carbon tax is being contemplated to curb the CO2 emission industry wise. Below is the plan to curb fossil fuel vehicle usage:
   - 100% by 2025
   - 50% by Dec’20

3. Govt. of Norway plans to limit the fossil fuel consumption completely by 2030 and shift to renewables.

   From the above Framework we have extracted the Independent and dependent variables for climate change scenarios. Once variables are identified, then historical data for a specific timeframe were collected and a multiple variable linear regression analysis was performed to assess the relation between dependent and independent variables. Secondly, a transitive hypothetical stress testing study is performed on banks’ variables to evaluate the effect of changes on variables which are Net Interest Income, Non-Performing Loans and Net Income of banks. Below is the pictographic depiction of the methodology followed.

Data Collection

For the identified variables, which were identified based on their special mentions in the various green agreements like Kyoto Agreement and Paris Agreement etc., data were collected from 2009 to 2018 from different sources.

Data Cleansing

Data collected were of annual basis, therefore data were broken down to get the data of quarterly basis. Data for temperature and rainfall were seasonally adjusted and later transformed for better analysis. For regression all the data were used as rate of change by using natural log.

Multiple Linear Regression

Data were used to get a multiple linear regression equation in order to predict the key performance indicators like NII, NPL and Net Income etc.

Model Validation

Regression equation which was achieved in the analysis is validated by using test set of data to check the accuracy of the prediction.

Scenario Analysis

Scenario Analysis Hypothetical transitive stress testing is used to understand scenario analysis, to evaluate the effect of the dependent variable on net income of bank.

As per the most widely used industry standards, there are following ways to proceed for a stress-testing model.

- Portfolio P&L analysis
- Historical event analysis & replication
- Transitive analysis & forecast

Here we have measured transitive stress testing, which includes finest practices for generating forward-looking scenarios so as to identify parametric correlation. We have also added random methodology to forecast future values or projection and then the Stressed values. This is the enhanced or dynamic version of our stress test, where it uses models which allows the test to discreetly select the accurate upper and lower range of Independent Parameters. Based on the several hypotheses, Government/Policy guidelines given to control the independent parameters (i.e. CO2 emission) which are dynamically adjusting to foresee future impact and monitoring the subsequent Asset classes or Incomes of Bank.
Steps Followed for Stress Testing

1. Historical data of last ten years has been collected quarter wise streamlined for the regression analysis.
2. Using linear regression, we have derived an equation for dependent variable (net income) with all the independent variable.
3. Each of the independent variable are grouped, within a risk factor/stress parameter.
4. By stimulating a set of independent variable, which falls under one particular risk factor (i.e. market factor) we can stress that particular factor.
5. We have used forecasting methodology for predicting the future values for coming ten years to derive the upper and lower range of variables within which the independent variables are going to move.
6. Several hypotheses are used and in some case government policies or regulatory, guidelines are used to decide the future path or transition of each of the independent variable.
7. We have used the upper and lower range along with the mean of last ten years' values of the parameter to derive the percentage value of “Upper Bound” and “Lower Bound” of change.
8. Using those bound values, we have randomized the parameter to derive the basic values of coming ten years of the future values of those independent parameters as per our hypothesis. These define the baseline scenario (1X).
9. Further, we have stimulated the upper and lower bound of each parameter to arrive at the stressed values of each independent variable. Summation of stressed position of all the variable under one risk factor gives a stress output (i.e. 2X Market Factor).
10. We have arrived to approximately 8 stress scenarios where on the combination of multiple Stressed risk factor derives the change on dependent variable (i.e. delta net income).
11. Regression equation is used where the coefficient is multiplied with the stressed changes of each independent variable (not all are stressed in each scenario) will return the stress output of dependent variable (i.e. bank’s net income).
Logic for Designing the Stress Scenarios

As per the most widely used industry standards, there are following ways to proceed for a stress-testing model.

1. Portfolio P&L analysis
2. Historical event analysis & replication
3. Transitive analysis & forecast

- Here we have considered transitive (or predictive) stress testing, which includes best practices for creating forward-looking scenarios in order to identify parameters correlation.
- We have also added random methodology to forecast future values or projection and then the stressed values.
- There are two separate stress scenarios where we stress the rate of change of climatic factors which are categorized under physical stress scenarios.
- There are other stress scenarios where we stress the rate of change of other risk factors i.e. Market Factor, Policy Factor, Technology Factor and these are transitional stress scenario

<table>
<thead>
<tr>
<th>SN</th>
<th>Scenario</th>
<th>Equation</th>
<th>Logic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scenario 1A Climate Stress</td>
<td>Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 2x Climate Factor (Temperature Upper Bound 2X, Rainfall Upper Bound 2X)</td>
<td>Physical stress scenario where, climatic factors are stressed keeping other constant. Temperature rises and so does the rainfall providing adverse climatic condition for few industries i.e. logistics, transport etc.</td>
</tr>
<tr>
<td>2</td>
<td>Scenario 1B Climate Stress</td>
<td>Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 2x Climate Factor (Temperature Upper Bound 2X, Rainfall Lower Bound 2X)</td>
<td>Physical stress scenario where climatic factors are stressed keeping other constant. Temperature rises but the rainfall goes down, providing adverse climatic condition for few industries i.e. agriculture.</td>
</tr>
<tr>
<td>3</td>
<td>Scenario 2A Policy Stress</td>
<td>Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Lower Bound 2X) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress over policy factor keeping other constant. Policy enables all emissions and consumptions going down including oil production rate.</td>
</tr>
<tr>
<td>4</td>
<td>Scenario 2B Policy Stress</td>
<td>Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X &amp; Lower Bound 0) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress over policy factor keeping other constant. Policy enables all emissions and consumptions going down but due to invention of oil across norway the oil production rate goes up.</td>
</tr>
<tr>
<td>5</td>
<td>Scenario 2C Policy Stress</td>
<td>Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Upper Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X &amp; Lower Bound 0) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress over policy factor keeping other constant. Policy enables all emissions going down including oil production rate.</td>
</tr>
<tr>
<td>6</td>
<td>Scenario 3 Market Stress</td>
<td>Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 2x Market Factor (EU Emission Spot price upper Bound 2X, Green Bond Investments Upper Bound 2X) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress over market factor keeping other constant. Market prices enables issuance and investment of green bond and the price for eu emission allowance spot going up.</td>
</tr>
<tr>
<td>7</td>
<td>Scenario 4 Technology Stress</td>
<td>Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 2x Technology Factor (Renewable Consumption Upper Bound 2X) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress over technology factor keeping other constant. Technology enables renewable energy consumption and hybrid vehicle sales going up.</td>
</tr>
<tr>
<td>8</td>
<td>Scenario 5 Combined Stress</td>
<td>Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Lower Bound 2X) + 2x Market Factor (EU Emission Spot price upper Bound 2X, Green Bond Investments Upper Bound 2X) + 2x Technology Factor (Renewable Consumption Upper Bound 2X) + 1x Climate Factor (Baseline of Temperature, Rainfall)</td>
<td>Transitional stress scenario with stress across all transitional scenarios apart from climate. It decreases consumption, emission, and oil production under policy, increases green bond investment and EU emission spot price under market and increases investment and consumption of renewables under technology impact.</td>
</tr>
</tbody>
</table>

Fig 4 : Stress Scenarios Logic
Defining Types of Climate Change Risks and Risk Factors

While defining risks associated with climate change, it is important to distinguish between:

Physical climate change risks, are the risks related to tangible impacts that could negatively affect the operating companies and carbon assets. These risks effect may comprise physical impairment and/or capital expenses that might be required to deal with the variations in weather patterns (i.e. extreme storms, certain floods, and long-lasting drought) and “slow onset” consequences like rising sea level, situation leading to desertification etc.

Transitional change risks, are the risks such as non-physical (i.e. intangible) climate change-related parameters subjected on the assets of companies. This includes technology, policy and legal, economic and market related risks — depending upon their type and magnitude of impact to the financial institutions.

Climate Change Risk Factors

In addition to reputation related risk, these frameworks emphasize on three risk factors that occur in current scenario, and also numerous other factors that may become significant in the future. These risk factors are:

1. Policy and Legal Factors
2. Technology Factors
3. Economic and Market Factors

Primary categories of Climate Change-related Risk Factors

<table>
<thead>
<tr>
<th>Category of Risk</th>
<th>Definition</th>
<th>Nature of Impact</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy and Legal</td>
<td>Policies or rules and regulations which would impact the financial and operational viability of carbon related assets.</td>
<td>Affects physical carbon assets and firms which deal in such assets.</td>
<td>Fuel-efficiency standards for private vehicles; emissions trading systems; EPA regulations (USA) on air pollution &amp; GHGs from power plants.</td>
</tr>
<tr>
<td>Technology</td>
<td>Developments in the commercial accessibility and reduced cost of substitute and low carbon technologies.</td>
<td>Impact on the choice and deployment of technology, and the costs and demand profiles.</td>
<td>Energy storage technologies; changes in technologies related to renewable energy, carbon consumption and storage; alternative fuels.</td>
</tr>
<tr>
<td>Market and Economic</td>
<td>Changes in economic or market condition which would adversely affect carbon assets.</td>
<td>Impact on physical carbon assets and companies which deal in such assets.</td>
<td>Changes in fossil fuel prices; changes in the preferences of consumer.</td>
</tr>
</tbody>
</table>
horizontal drilling and other disruptive technologies (that were developed recently in the field of oil explorations). Fourteen gas and oil companies in USA found it more difficult to go for higher cost projects in a demand that is in lower-price environment for energy; and amidst tech advancements, and even policies or political events that are administered by government.

Based on the above factors we have tried to identify the other variable which would drive major changes in future.

Policy and Legal Changes:
We have identified following changes, which might be implemented by different countries to reduce temperature.

- Policies to reduce fossil fuel consumption
- Policies to reduce carbon emission
- Increased focus on fuel efficiency standard
- Increased investment on renewable energy
- Other local government regulations

Market and Economic Factors:
- Changes in fuel/crude prices
- Changes in consumer preferences
- European emission allowances spot prices
Technology Changes:
- Increased demand for alternative fuel
- Reduced demand for fossil fuel
- Advancement and demand in renewable energy technologies
- Reduced demand of conventional fuel vehicles

Apart from the above variables, we are trying to assess the impact of these changes on macroeconomic variables such as countries GDP and unemployment rate etc.

### Risk Factor Identification

<table>
<thead>
<tr>
<th>GDP growth rate</th>
<th>Market and Economic Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>Changes in fossil fuel prices</td>
</tr>
<tr>
<td>Policy Changes &amp; Legal Factors</td>
<td>Changes in consumer preferences</td>
</tr>
<tr>
<td>Fossil Fuel Consumption</td>
<td>European Emission Allowances spot price [emissions trading systems]</td>
</tr>
<tr>
<td>Carbon Emission</td>
<td>Technology</td>
</tr>
<tr>
<td>Consumption of Renewable energy</td>
<td>Alternative fuels</td>
</tr>
<tr>
<td>Fuel-efficiency standards</td>
<td>Advances in Renewable Energy Technologies</td>
</tr>
<tr>
<td>EPA regulations on air pollution &amp; GHGs from power plants</td>
<td></td>
</tr>
</tbody>
</table>

**Fig 7: Climate Change Risk Factors**

**Description of Para & Variables**

**Case 1: Non-performing loans dependent variable**: Non-performing loans of a bank (based out of Norway). Data is gathered from its annual reports from 2008 to 2018. Data were annual and these are broken down to quarterly interval depending upon the rate of change annual and assuming equal change in quarterly interval.

**Assumptions**

1. NPL for 2008 = 3192.6
2. Annual Rate = -2.43%
3. Quarterly rate = -0.61%
4. Annual data of NPL are reported on or after Q4

*Detailed calculations are mentioned in the embedded spreadsheet (Accessible on google drive)*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Year</th>
<th>NPL(NOK,MM)</th>
<th>Annual Rate</th>
<th>Quarterly Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009</td>
<td>3115</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2010</td>
<td>4724</td>
<td>51.65%</td>
<td>10.97%</td>
</tr>
<tr>
<td>3</td>
<td>2011</td>
<td>2313</td>
<td>-51.04%</td>
<td>-16.35%</td>
</tr>
<tr>
<td>4</td>
<td>2012</td>
<td>3422</td>
<td>47.95%</td>
<td>10.29%</td>
</tr>
<tr>
<td>5</td>
<td>2013</td>
<td>2228</td>
<td>-34.89%</td>
<td>-10.17%</td>
</tr>
<tr>
<td>6</td>
<td>2014</td>
<td>3179</td>
<td>42.68%</td>
<td>9.29%</td>
</tr>
<tr>
<td>7</td>
<td>2015</td>
<td>3318</td>
<td>4.37%</td>
<td>1.08%</td>
</tr>
<tr>
<td>8</td>
<td>2016</td>
<td>2463</td>
<td>-25.77%</td>
<td>-7.18%</td>
</tr>
<tr>
<td>9</td>
<td>2017</td>
<td>4322</td>
<td>75.48%</td>
<td>15.09%</td>
</tr>
<tr>
<td>10</td>
<td>2018</td>
<td>2842</td>
<td>-34.24%</td>
<td>-9.95%</td>
</tr>
</tbody>
</table>

**Fig 8: Annual Non-Performing Loans**
Logic for calculation of Annual & Quarterly Rate

Rate of change for annual interval:  \( Ra = (p2/p1)-1 \), where \( p2 \) is final value and \( p1 \) is initial value

Rate of change for quarterly interval:  \( Rq = (1+Ra)(.25)-1 \), where \( Ra \) is annual rate of change

Above calculation has been used for breaking the annual data (both dependent and independent) into quarterly interval and for projecting the data wherever required. After projecting the data, random data is also generated between the actual historical data which were taken from the sources in annual terms. Then average of the projected data and random data is taken for each variables for the analysis. Below is the screenshot of data as discussed above from 2009-11 only for reference.

In the table, the last column i.e. Rate_of_change is calculated as continuous rate of change, by using the formula \( \ln(p2/p1) \), here \( p2 \) is final data value and \( p1 \) is initial data value.

This same calculation is used for all variables in order to prepare data for analysis.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Year</th>
<th>Quarter</th>
<th>Projected Value</th>
<th>Random Value</th>
<th>NPL Value</th>
<th>Rate of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009</td>
<td>Q1</td>
<td>3173</td>
<td>3173</td>
<td>3173</td>
<td>-0.39%</td>
</tr>
<tr>
<td>2</td>
<td>2009</td>
<td>Q2</td>
<td>3154</td>
<td>3168</td>
<td>3116</td>
<td>-0.53%</td>
</tr>
<tr>
<td>3</td>
<td>2009</td>
<td>Q3</td>
<td>3134</td>
<td>3154</td>
<td>3144</td>
<td>-0.93%</td>
</tr>
<tr>
<td>4</td>
<td>2009</td>
<td>Q4</td>
<td>3115</td>
<td>3115</td>
<td>3115</td>
<td>-0.93%</td>
</tr>
<tr>
<td>5</td>
<td>2010</td>
<td>Q1</td>
<td>3457</td>
<td>3457</td>
<td>3457</td>
<td>10.41%</td>
</tr>
<tr>
<td>6</td>
<td>2010</td>
<td>Q2</td>
<td>3836</td>
<td>3842</td>
<td>3839</td>
<td>10.49%</td>
</tr>
<tr>
<td>7</td>
<td>2010</td>
<td>Q3</td>
<td>4257</td>
<td>4257</td>
<td>4257</td>
<td>10.33%</td>
</tr>
<tr>
<td>8</td>
<td>2010</td>
<td>Q4</td>
<td>4724</td>
<td>4724</td>
<td>4724</td>
<td>10.41%</td>
</tr>
<tr>
<td>9</td>
<td>2011</td>
<td>Q1</td>
<td>3952</td>
<td>3952</td>
<td>3952</td>
<td>-17.85%</td>
</tr>
<tr>
<td>10</td>
<td>2011</td>
<td>Q2</td>
<td>3306</td>
<td>3604</td>
<td>3455</td>
<td>-13.44%</td>
</tr>
<tr>
<td>11</td>
<td>2011</td>
<td>Q3</td>
<td>2765</td>
<td>2674</td>
<td>2720</td>
<td>-23.93%</td>
</tr>
<tr>
<td>12</td>
<td>2011</td>
<td>Q4</td>
<td>2313</td>
<td>2313</td>
<td>2313</td>
<td>-16.19%</td>
</tr>
</tbody>
</table>

Case 2: Net interest income

Dependent variable: - Net interest income of a bank (based out of Norway). Data is gathered from its annual reports from 2008 to 2018. Data were annual and these are broken down to quarterly interval depending upon the rate of change annual and assuming equal change in quarterly intervals. Below is the screenshot of data as discussed above from 2009-11 only for reference. Same calculation method is used as discussed in case 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter</th>
<th>Projected</th>
<th>Random</th>
<th>NII_NOK_MM</th>
<th>Rate of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Q1</td>
<td>22089</td>
<td>22089</td>
<td>22089</td>
<td>0.62%</td>
</tr>
<tr>
<td>2009</td>
<td>Q2</td>
<td>22269</td>
<td>22184</td>
<td>22226</td>
<td>0.62%</td>
</tr>
<tr>
<td>2009</td>
<td>Q3</td>
<td>22450</td>
<td>22327</td>
<td>22389</td>
<td>0.73%</td>
</tr>
<tr>
<td>2009</td>
<td>Q4</td>
<td>22633</td>
<td>22633</td>
<td>22633</td>
<td>1.09%</td>
</tr>
<tr>
<td>2010</td>
<td>Q1</td>
<td>22831</td>
<td>23089</td>
<td>22960</td>
<td>1.43%</td>
</tr>
<tr>
<td>2010</td>
<td>Q2</td>
<td>23031</td>
<td>22915</td>
<td>22973</td>
<td>0.06%</td>
</tr>
<tr>
<td>2010</td>
<td>Q3</td>
<td>23233</td>
<td>23434</td>
<td>23333</td>
<td>1.56%</td>
</tr>
<tr>
<td>2010</td>
<td>Q4</td>
<td>23436</td>
<td>23436</td>
<td>23436</td>
<td>0.44%</td>
</tr>
<tr>
<td>2011</td>
<td>Q1</td>
<td>23877</td>
<td>23792</td>
<td>23835</td>
<td>1.69%</td>
</tr>
</tbody>
</table>

Fig.9: Quarterly Non Performing Loans

Fig.10: Quarterly Net Interest Income
Case 3: Net income
Dependent variable: Net income of a bank (based out of Norway). Data is gathered from its annual reports from 2008 to 2018. Data were annual and these are broken down to quarterly interval depending upon the rate of change annual and assuming equal change in quarterly intervals. Below is the screenshot of data as discussed above from 2009-11 only for reference. Same calculation method is used as discussed in case 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter</th>
<th>Projected</th>
<th>Random</th>
<th>NII_NOK,MM</th>
<th>Rate of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Q1</td>
<td>8918</td>
<td>8918</td>
<td>8918</td>
<td>-8.57%</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>8402</td>
<td>7969</td>
<td>8185</td>
<td>-5.32%</td>
</tr>
<tr>
<td></td>
<td>Q3</td>
<td>7916</td>
<td>7607</td>
<td>7761</td>
<td>-9.95%</td>
</tr>
<tr>
<td>2010</td>
<td>Q4</td>
<td>7026</td>
<td>7026</td>
<td>7026</td>
<td>-10.46%</td>
</tr>
<tr>
<td>Q1</td>
<td>9940</td>
<td>8800</td>
<td>9370</td>
<td>-10.46%</td>
<td></td>
</tr>
<tr>
<td>Q3</td>
<td>11823</td>
<td>9758</td>
<td>10790</td>
<td>14.11%</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>14062</td>
<td>14062</td>
<td>14062</td>
<td>26.48%</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Q1</td>
<td>13783</td>
<td>13907</td>
<td>13845</td>
<td>-1.55%</td>
</tr>
</tbody>
</table>

**Fig.11: Quarterly Net Income**

Independent Variables
1. Temperature: Average temperature is considered as factor as abrupt variation in temperature can indirectly signal for potential physical risk due to natural calamities.

**Geography: Oslo, Norway**

**Fig.12: Average Temperature**

*Source: World Weather Online*
Seasonal Adjustment of Temperature Data:
As we collected data on quarterly basis, so it calls for adjusting the seasonality in the data. Below mentioned graph explain the smoothening which is achieved after seasonality adjustment. SA series (seasonal adjusted series) is used post squared transformation of the analysis. SA series is squared because few data of temp were negative and to calculate continuous rate of change by natural log we need positive data.

![Seasonal Adjustment of Temperature Data](image)

Fig.13: Seasonally Adjusted Temperature Series.

2. Rainfall: Average rainfall is one of the factor in the analysis as it is also one of the barometer to check how climatic condition of a geography is changing.

Geography: Oslo, Norway

![Average Rainfall](image)

Fig14: Average Rainfall

*Source: World Weather Online*
Seasonal Adjustment of Rainfall Data: As we collected data on quarterly basis, so it calls for adjusting the seasonality in the data. Below mentioned graph explain the smoothening which is achieved after seasonality adjustment.

SA series (Seasonal Adjusted series) is used for the analysis.

Global Fossil Fuel Consumption: As agreement related to going green taking center stage, it become imperative to study how is the trend of fossil fuel consumption globally changing and kind of relation it has with the overall banking performance.

Source: ourworldindata.org/fossil-fuels
Data collected from 2008-18 and projected for quarterly interval as discussed in case 1. Rate of change of fossil fuel consumption on quarterly basis is used for analysis.

3. **Global CO2 Emission**: As agreement related to going green is taking center stage, it becomes imperative to study how is the trend of global CO2 emission changing and what kind of relation it bears with the performance of the banks. Data for the period 2008-18 has been extracted from the graph of the trends published by the author Kelly Levin (December 05, 2018) on World Resource Institute. Data in analysis is used as rate of change on quarter to quarter. Please find the screenshot of the graph.

4. **CO2 European Emission Allowances (EUA) Trading**: Objective was to capture any relevant behavior and sentiment of the traders who trade EUA, and also to capture the interplay between supply and demand for EUA units in the exchange which would influence the spot price of the EUA and later on to study if it bears any relation with the performance. Alongside is the graph showing the spot price of the EUA.

5. **Global Consumption of Renewal Energy**: As due to green policies in place, the demand of renewal energy should increase drastically, it also gives a new venture for banks to invest in or transition their investment from fossil fuel to renewal energy. So, this factor becomes important to study its impact on banks’ performance. Alongside is the graphical representation of the global renewal energy consumption.

---

*Fig. 17: Global CO2 Emission*

*Source: Global Carbon Project*

*Fig. 18: EUA Spot Price*

*Source: Markets Insider*

*Fig. 19: Global Renewable energy consumption*


+Rate of change in renewable consumption is used for regression analysis.
6. **Value of Issuance of Green Bond ($, Bn):**
As green bond issuance is increasing exponentially year on year, it indicates how investment portfolio of different financial investor shifting toward financing green energy. It becomes important to study the impact of green bond issuance on banks’ performance. Data for green bond was not directly available, so it has been extracted from the graph, which is as shown alongside.

![Global Annual Issuance of Green Bond](source: Climate Bond Initiative. Data as of Sep. 29, 2017 [Data for 2018 is projected])

7. **Norway Oil Output:** As subject bank is based out of Norway, it become imperative to see how is the trend of Norway oil production output and study its impact on banks’ performance. It was also noted that crude oil production in Norway decreased to 1.420 BBL/D in February from 1.488 BBL/D in January of 2019. Crude oil production in Norway averaged 1.674 BBL/D from 1973 until 2019, reaching an all-time high of 3.417 BBL/D in July of 2000 and a record low of 0.002 BBL/D in January of 1974. Data were extracted from the graph below and rate of change in Norway’s oil production was calculated on quarterly interval. Below is the screen shot of the graph showing oil output for Norway.

![Norway Oil Output](source: Tradingeconomics.com)
Regression Procedure: Multiple Variable Linear Regression

**Case 1:** Dependent variable is Non-Performing Loans

**Objective:** To analyze the impact of climate-related factors i.e. temperature, rainfall, CO2 emission on non-performing loans (NPL) of the bank of a particular geography (Norway).

**Methods:** Multiple variable linear regression

**Tool:** MS Excel and R Studio

**Time Period:** 2009-2018, data used is of quarterly interval.

**Descriptive Analysis of the Variable**

**R code:**

```r
> summary(Climate_Data2)
```

![Descriptive Analysis of the Variable](image)
Creating Correlation Matrix

Using Rstudio

Running linear regression in Rstudio for test dataset

R Code:

```r
> model<-lm(Npl~Temp+Rain+FF_consumption+CO2+EUA+RE_Consumption+GB_Value+Nor_oil,data=train)
```

Results: Output of the linear regression

```
Call: lm(formula = Npl ~ Temp + Rain + FF_consumption + CO2 + EUA + RE_Consumption + GB_Value + Nor_oil, data = train)

Residuals:
     Min      1Q  Median      3Q     Max
-0.215960 -0.075303  0.003584  0.076279  0.195599

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)    -0.028888   0.028277  -1.022   0.3163
Temp            0.017589   0.012921   1.361   0.1852
Rain            0.034130   0.030929   1.127   0.2700
FF_consumption  3.546929   4.696724   0.755   0.4569
CO2             0.613088   3.383471   0.181   0.8576
EUA             0.107021   0.098933   1.082   0.2893
RE_Consumption  -1.995481   1.182064  -1.688   0.0933
GB_Value        0.158732   0.070242   2.260   0.0324 *
Nor_oil         0.738000   0.996411   0.741   0.4655
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 1

Residual standard error: 0.1137 on 26 degrees of freedom
Multiple R-squared:  0.3326,  Adjusted R-squared:  0.1272
F-statistic: 1.619 on 8 and 26 DF,  p-value: 0.1676
```
Interpretations of the Above Result

1. Looking at P-value i.e. last column of the table above chart, it can be said that not a single coefficient of the considered variable is significant except the GB_Value. All the P-Values are greater than 5% (if level of confidence is considered 5%) except for GB_Value.

2. Due to the value of P-Value in the above table, null hypothesis is fail to reject for all but GB_value. Ha (Alternate Hypothesis): Coefficient of variable(β)≠0 H0 (Null Hypothesis): Coefficient of variable(β)=0 As from above table H0 is not rejected for the most of the variable, this means that coefficient of these variables are not statistically indifferent from zero. Therefore, these variable are not major in the analysis.

3. Coming to value of R-squared, which is very low i.e. 33.26%, it means that model is able to clarify a very sample portion of variability of the response data around its mean. Given the variables which are considered.

4. Coming to overall p-value of the model which is 0.1676(>0.05), again this value is very high, which is an indication of the inability of the model with the given set of the variable to be robust.

Result

As per the above analysis, the impact of the climatic factors is not significantly felt on the rate of change in NPL. One of the important reasons is that most of the risk factors are not climatic but are the results of disruptive policies. These policies are becoming more important and disruptive in recent times like after Paris Agreement of 2016 and data which is used under analysis is from 2009-18. This is the period when the banking business was “Business as Usual” irrespective of green policies or climatic factors. So it is difficult to conclude that the above considered climatic factor play any significant role in explaining the NPL level of the bank. Most probably, the impact would be felt once policies disruptions become a reality in near future.

As we could not find any significant relation between the climatic variables and NPL, we decided to change our dependent variable to net interest income and study further to understand if these variables are having its impact on other dependent variable of banks' balance sheet.

Predicted Vs. Actual values

R code:

```R
> fitted.results <- predict(model,newdata = subset(test,select = c(2,3,4,5,6,7,8,9)),type='response')
> print(fitted.results)
> predicted_and_Actual<-cbind(test,fitted.results)
> View(predicted_and_Actual)
> predicted_vs._Actual<-predicted_and_Actual[,-(2:9)]
> View(predicted_vs._Actual)
```

As we can observe, in the above predicted value which are just four in number confines the analysis to conclude anything, as few predicted values are close to actual value.
### Case 2: Dependent Variable is Net Interest Income

**Case 1: Dependent variable is Non-Performing Loans**

**Objective:** To analyze the impact of climatic factor on net interest income.

**Methods:** Multiple variable linear regression

**Tool:** MS Excel and R Studio

**Time Period:** 2009-2018, data used is of quarterly interval.

Data is collected considering their climatic significance and also considering their special mention in different “Green Agreements” like Kyoto Protocol (1997), Paris Agreement (2016), etc. Below is the detail of the dataset used.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Variable Masked_name_Variable</th>
<th>Rate of change of variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NII data of DNB Bank(Dependent Row)</td>
<td>NII</td>
</tr>
<tr>
<td>2.</td>
<td>Average Temp. for Oslo(Norway)</td>
<td>Temp</td>
</tr>
<tr>
<td>3.</td>
<td>Average Rain for Oslo(Norway)</td>
<td>Rain</td>
</tr>
<tr>
<td>4.</td>
<td>Global_Total_Consumption(terawatt-hours)</td>
<td>FF_consumption</td>
</tr>
<tr>
<td>5.</td>
<td>CO₂ Emission in gigatonnes</td>
<td>CO₂</td>
</tr>
<tr>
<td>6.</td>
<td>EUA_Spot Price</td>
<td>EUA</td>
</tr>
<tr>
<td>7.</td>
<td>Consumption_of_Renewable_Energy(terawatt-hours)</td>
<td>RE_Consumption</td>
</tr>
<tr>
<td>8.</td>
<td>Green Bond Issuance</td>
<td>GB_Value</td>
</tr>
<tr>
<td>9.</td>
<td>Norway_oil_output_Oil output(million bpd)</td>
<td>Nor_oil</td>
</tr>
</tbody>
</table>

---

**Descriptive Analysis of the Variable**

**R Code:**

```r
> summary(model_data)
```

**Creating Correlation Matrix**

```r
> cor(model_data)
```
Running Regression on the Dataset

R Code:

```r
> model4<-lm(Nii~Temp+Rain+FF_consumption+CO2+EUA+RE_Consumption + GB_Value+Nor_oil,data=model_data)
> summary(model4)
```

Result

AR-squared of the regression analysis is 33.13%, which is very low and p-value of the regression model is 0.1049 which is more than expected level of significance of 0.05 (i.e. confidence interval of 95%).

As we could not find any significant relation between the climatic variables and net interest income also, we lastly tried to change our dependent variable to net income.

Case 3: Multiple Variable Regression: Climatic Risk Analysis on Bank's net income

Objective: To study the impact of climatic factor on net income.

Dependent Variable: Net Income of the institute

Independent Variables:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Variable</th>
<th>Masked_name_Variable (Rate of change of variable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Net income data of DNB Bank (dependent variable)</td>
<td>Net_income</td>
</tr>
<tr>
<td>2.</td>
<td>Average temp. for Oslo (Norway)</td>
<td>Temp</td>
</tr>
<tr>
<td>3.</td>
<td>Average rain for Oslo (Norway)</td>
<td>Rain</td>
</tr>
<tr>
<td>4.</td>
<td>Global_Total_Consumption (terawatt-hours)</td>
<td>FF_consumption</td>
</tr>
<tr>
<td>5.</td>
<td>CO2 emission in gigatonnes</td>
<td>CO2</td>
</tr>
<tr>
<td>6.</td>
<td>EUA_Spot Price</td>
<td>EUA</td>
</tr>
<tr>
<td>7.</td>
<td>Consumption_of_Renewale_Energy (terawatt-hours)</td>
<td>RE_Consumption</td>
</tr>
<tr>
<td>8.</td>
<td>Green bond issuance</td>
<td>GB_Value</td>
</tr>
<tr>
<td>9.</td>
<td>Norway_oil_output_Oil output(million bpd)</td>
<td>Nor_oil</td>
</tr>
</tbody>
</table>

Fig 24. Net Income Vs. Independent Variable
Descriptive Analysis of the data

```r
> summary(net_income_data)
X1  Net_Income  Temp  Rain
Min. : 2.0  Min. :-0.116888  Min. :-6.024523  Min. :-1.702671
1st Qu.:11.5  1st Qu.: -0.022616  1st Qu.: -0.588972  1st Qu.: -0.593033
Median :21.0  Median : 0.006499  Median : 0.072297  Median : 0.006994
Mean :21.0  Mean : 0.025684  Mean : 0.007492  Mean : 0.017318
3rd Qu.:30.5  3rd Qu.: 0.052265  3rd Qu.: 0.536657  3rd Qu.: 0.621157
Max. :40.0  Max. : 0.392518  Max. : 4.136026  Max. : 1.666469

FF_consumption  CO2  RE_Consumption
Min. :-0.0074098  Min. : -0.0106934  Min. : -0.63587
1st Qu.: 0.0009284  1st Qu.: 0.0009683  1st Qu.: -0.09600
Median :0.0025815  Median : 0.0021544  Median : 0.04288
Mean :0.0033303  Mean : 0.0037047  Mean : 0.01406
3rd Qu.: 0.0054996  3rd Qu.: 0.0056274  3rd Qu.: 0.14301
Max. :0.0273879  Max. : 0.0214713  Max. : 0.54618

GB_Value  Nor_oil
Min. :-0.65302  Min. : -0.065193
1st Qu.: 0.05744  1st Qu.: 0.022239
Median :0.18573  Median : 0.002929
Mean :0.17946  Mean : 0.009173
3rd Qu.: 0.29169  3rd Qu.: 0.005728
Max. : 1.27609  Max. : 0.026206
```

Correlation Matrix

```r
> cor(Model_data)
     Net_Income       Temp       Rain FF_consumption     CO2
Net_Income  1.000000000  0.003173848 -0.03037497 0.68855656 0.10010361
Temp        0.003173848  1.000000000 -0.15681238 -0.04932425 0.03381770
Rain        -0.03037497  0.156812383  1.00000000  0.04932425 0.03381770
FF_consumption 0.68855656 -0.04932425  0.68855656 1.00000000 0.03572886
CO2         0.10010361 -0.04932425  0.68855656 0.03572886 1.00000000
EUA         0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
RE_Consumption 0.04127920 -0.02078209 -0.05671130 -0.05671130 0.16575748
GB_Value    -0.669574169 -0.357912807 -0.02078209 -0.02078209 0.28533344
Nor_oil      0.083004847  0.041279206  0.15896365 -0.669574169 0.28533344
EUA_RE_Consumption 0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
Net_Income -0.03579173  0.003173848  0.15681238 -0.04932425 0.03381770
Temp        0.003173848  1.000000000 -0.15681238 -0.04932425 0.03381770
Rain        -0.15681238 -0.156812383  1.00000000  0.04932425 0.03381770
FF_consumption 0.15681238 -0.156812383  0.68855656 1.00000000 0.03572886
CO2         0.10010361 -0.04932425  0.68855656 0.03572886 1.00000000
EUA         0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
RE_Consumption 0.04127920 -0.02078209 -0.05671130 -0.05671130 0.16575748
GB_Value    -0.669574169 -0.357912807 -0.02078209 -0.02078209 0.28533344
Nor_oil      0.083004847  0.041279206  0.15896365 -0.669574169 0.28533344
EUA_RE_Consumption 0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
Net_Income -0.03579173  0.003173848  0.15681238 -0.04932425 0.03381770
Temp        0.003173848  1.000000000 -0.15681238 -0.04932425 0.03381770
Rain        -0.15681238 -0.156812383  1.00000000  0.04932425 0.03381770
FF_consumption 0.15681238 -0.156812383  0.68855656 1.00000000 0.03572886
CO2         0.10010361 -0.04932425  0.68855656 0.03572886 1.00000000
EUA         0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
RE_Consumption 0.04127920 -0.02078209 -0.05671130 -0.05671130 0.16575748
GB_Value    -0.669574169 -0.357912807 -0.02078209 -0.02078209 0.28533344
Nor_oil      0.083004847  0.041279206  0.15896365 -0.669574169 0.28533344
EUA_RE_Consumption 0.083004847 -0.03579173 -0.12631938 -0.05671130 0.32983742
```

Dividing Dataset into Test and Train

**R Code:**

```r
> #dividing dataset into test, train and scenario_1x
> reg_train<-data_scenario_model[1:35,]
> reg_test<-data_scenario_model[36:39,]
```

Regression Analysis

**R Code:**

```r
> #running regression on reg_train
> model_reg<-lm(Net_income~Temp+FF_consumption+GB_Value+Nor_oil, data=reg_train)
> summary(model_reg)
```
Interpretation of Above Regression: Here we can see that all the three variable has once again have become significant but one important observation is that adjusted R-squared value has dropped from 0.599 to 0.585. This indicate the previous regression result is better than considering only three variables.

Result
Three variables i.e. fossil fuel consumption, CO2 emission and Norway oil consumption are significantly contributing in explaining the net income of the DNB bank.

R-Square = 69.37%, P-value = 9.774e-06 (which is very less than 0.05), this explains the significance of the model. Model is robust as far as statistical analysis is concerned. This can be used for scenario analysis and stress testing. Equation for predictive rate of change of net income is as below:

\[
\text{Rate of change of net income} = -0.021484 + 0.003109(\text{Temp}) + 0.015165(\text{Rainfall}) + 11.0138(\text{Global Fossil Fuel consumption}) - 4.40426(\text{Global CO2 Emission}) + 0.074810(\text{EUA}) + 0.040562(\text{Global Renewal Energy Consumption}) + 0.061843(\text{Green bond issuance value}) - 1.498499(\text{Norway oil output}).
\]
Scenario Analysis for Climatic Factors on Net Income of the Bank

Objective: To stress test various independent factors to analyze its impact on the net income of the bank by creating various scenario.

Tool: MS excel and R studio

Pre-requisite: Multiple variable linear regression equation

Rate of change of Net Income:

0.02148394 + 0.00310907*(Temp) + 0.0151651*(Rainfall) + 11.013859*(Global Fossil Fuel consumption) -4.404259*(Global CO2 Emission) + 0.07481*(EUA) + 0.040652*(Global Renewal Energy Consumption) + 0.061843*(Green bond issuance value) -1.4984994669371*(Norway oil output)

Case 1: Baseline Scenario

In baseline scenario, it is considered that all the independent variables would change w.r.t rate which is calculated from the historical data from 2009-18. As shown in below equation.

Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) +1x Technology Factor (Baseline of Renewable Consumption) + 1XClimate Factor (Temperature Upper Bound, Rainfall Upper Bound).

R Code used:

```r
# predicting for the given scenario
scenario_1x_results <- predict(model_reg,newdata=scenario_1x)
print(scenario_1x_results)
scenario_1x_predictbind(scenario_1x,scenario_1x_results)
```

Predicted Output for Net Income from 2019-25 on Quarterly Basis

Graphical Representation of the Predicted Net Income

Result: As it is evident from the above graph that even if business remains as usual and no precaution is taken by bank, net income of the bank would take a massive downward hit on its bottom line.
Case 2: Scenario 1A Climate Stress
Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) +1x Technology Factor (Baseline of Renewable Consumption) + 2 X Climate Factor (Temperature Upper Bound, Rainfall Upper Bound)

In this scenario, climatic factors i.e. temperature and rainfall are stress as shown in aforementioned equation and all other factors remain as baseline.

R Code:
```r
# predicting for the given scenario_1xA
scenario_1A_Climate_Stress<- predict(model_reg,newdata=scenario_1xA)
print(scenario_1A_Climate_Stress)
scenario_1A_pred<-cbind(scenario_1xA,scenario_1A_Climate_Stress)
```

Predicted Output for Net Income:

Graphical Representation of Predicted Net Income

Result: As it is evident from the above graph that, even if business remains as usual and no precaution is taken by the bank, net income of the bank would take a massive downward hit on its bottom line.
Case 3: Scenario 1B Climate Stress
Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 2x Climate Factor (Temperature Upper Bound 2X, Rainfall Lower Bound 2X).

In this scenario, climatic factors i.e. temperature and rainfall are stressed as shown in the above equation and all other factors remain as baseline.

R Code:
```R
# predicting for the given scenario_1xB
Scenario_1B_Climate_Stress <- predict(model_reg, newdata=scenario_1xB)
print(Scenario_1B_Climate_Stress)
Scenario_1xB_pred <- cbind(Scenario_1xB, Scenario_1B_Climate_Stress)
```

Predicted Output for Net Income:

Graphical Representation of Predicted Net Income

![Graph showing the predicted net income over quarters for Scenario 1B Climate Stress](image)

Result: In case 3, where we have stressed only climatic factors (2x Climate Factor (Temperature Upper Bound 2X, Rainfall Lower Bound 2X) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.

Fig 27: Scenario 1B Climate Stress
**Case 4: Scenario 2A Policy Stress**

Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Lower Bound 2X) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall).

in this scenario, policy factors i.e. Fossil Fuel Consumption, CO2 Emission and Norway oil output were stressed taking into consideration that growth trend for this variable would follow a negative one. All other factors remain as baseline.

**R Code:**

```
# predicting for the given scenario_2A
Scenario_2A_Climate_Stress <- predict(model_reg,newdata=scenario_2A)
Scenario_2A_pred <- cbind(Scenario_2A,Scenario_2A_Climate_Stress)
```

**Predicted Output for Net Income:**

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.16921105</td>
</tr>
<tr>
<td>2</td>
<td>-0.30671857</td>
</tr>
<tr>
<td>3</td>
<td>-0.09281606</td>
</tr>
<tr>
<td>4</td>
<td>0.26406241</td>
</tr>
<tr>
<td>5</td>
<td>-0.32011096</td>
</tr>
<tr>
<td>6</td>
<td>-0.16926602</td>
</tr>
<tr>
<td>7</td>
<td>-0.01076658</td>
</tr>
<tr>
<td>8</td>
<td>-0.40461378</td>
</tr>
<tr>
<td>9</td>
<td>-0.19580364</td>
</tr>
<tr>
<td>10</td>
<td>-0.10035515</td>
</tr>
<tr>
<td>11</td>
<td>-0.34523128</td>
</tr>
<tr>
<td>12</td>
<td>-0.05379974</td>
</tr>
<tr>
<td>13</td>
<td>-0.11903041</td>
</tr>
<tr>
<td>14</td>
<td>-0.17284789</td>
</tr>
<tr>
<td>15</td>
<td>-0.11424297</td>
</tr>
<tr>
<td>16</td>
<td>0.02370816</td>
</tr>
<tr>
<td>17</td>
<td>-0.16299770</td>
</tr>
<tr>
<td>18</td>
<td>-0.07161661</td>
</tr>
<tr>
<td>19</td>
<td>-0.05994953</td>
</tr>
<tr>
<td>20</td>
<td>-0.17662986</td>
</tr>
<tr>
<td>21</td>
<td>0.03682239</td>
</tr>
<tr>
<td>22</td>
<td>-0.14528128</td>
</tr>
<tr>
<td>23</td>
<td>-0.32818458</td>
</tr>
<tr>
<td>24</td>
<td>-0.22836219</td>
</tr>
<tr>
<td>25</td>
<td>-0.25047413</td>
</tr>
<tr>
<td>26</td>
<td>-0.39046900</td>
</tr>
<tr>
<td>27</td>
<td>-0.28608574</td>
</tr>
<tr>
<td>28</td>
<td>-0.26240182</td>
</tr>
</tbody>
</table>

**Graphical Representation of Predicted Net Income**

**Result:** In case 4, where we have stressed only policy factors 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Lower Bound 2X) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the graph above.
Case 5: Scenario 2B Policy Stress
Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X & Lower Bound 0) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall)

In this scenario, policy factors i.e. Fossil Fuel Consumption, CO2 Emission and Norway oil output were stressed taking into consideration that growth trend for these variables i.e. fossil fuel and CO2 emission would follow a negative one and whereas Norway oil output would follow a positive trend. All other factors remain as baseline.

R Code:
```
# predicting for the given scenario_2B
Scenario_2B_Climate_Stress <- predict(model_reg_newdata=scenario_2B)
print(Scenario_2B_Climate_Stress)
Scenario_2B_pred <- cbind(Scenario_2A,Scenario_2B_Climate_Stress)
```

Predicted Output for Net Income:

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Net_Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30000</td>
</tr>
<tr>
<td>2</td>
<td>25000</td>
</tr>
<tr>
<td>3</td>
<td>20000</td>
</tr>
<tr>
<td>4</td>
<td>15000</td>
</tr>
<tr>
<td>5</td>
<td>10000</td>
</tr>
<tr>
<td>6</td>
<td>5000</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

Graphical Representation of Predicted Net Income

![Graph 29: Scenario 2B Policy Stress](image)

Result: In case 5, where we have stressed only policy factors 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X & Lower Bound 0) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.
Case 6: Scenario 2C Policy Stress
Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Upper Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X & Lower Bound 0) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature, Rainfall). In this scenario, policy factors i.e. Fossil Fuel Consumption, CO2 Emission and Norway oil output were stressed taking into consideration that growth trend for these variables would be positive one. All other factors remain as baseline.

R Code:
```
# predicting for the given scenario_2C
scenario_2c_climate_stress <- predict(model_reg,newdata=scenario_2c)
print(scenario_2c_climate_stress)
scenario_2c_pred <- cbind(scenario_2c,scenario_2c_climate_stress)
```

Predicted Output for Net Income:

![R Code Output](image)

Graphical Representation of Predicted Net Income

![Graph](image)

**Result:** In case 6, where we have stressed only policy factors 2x Policy (Fossil Fuel Consumption Upper Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Upper Bound 2X & Lower Bound 0) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.
**Case 7: Scenario 3 Market Stress**  
Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO2 Emission, Norway Oil Output) + 2x Market Factor (EU Emission Spot price upper Bound 2X, Green Bond Investments Upper Bound 2X) + 1x Technology Factor (Baseline of Renewable Consumption) + 1x Climate Factor (Baseline of Temperature,

Rainfall).

In this scenario, market factors i.e. EUA spot price and Green bond investment are stressed as shown in above equation and all other factors remains as baseline.

**R Code:**

```r
# predicting for the given scenario_3
Scenario_3_Climate_Stress <- predict(model_reg,newdata=scenario_3)
print(Scenario_3_Climate_Stress)
Scenario_3_pred <- cbind(Scenario_3,Scenario_3_Climate_Stress)
```

**Predicted Output for Net Income:**

```
> print(Scenario_3_Climate_Stress)
          1          2          3          4          5          6          7          8
-0.34217078 -0.16095144 -0.17517205 -0.06924529 -0.10063096 -0.27749574 -0.35825759 -0.4432921
 -0.30368140 -0.30446689 -0.2675704 -0.05163248 -0.15726924 -0.40360840 -0.16441078 -0.24063114
 -0.27228450 -0.39662150 -0.33903524 -0.29042368 -0.38508093 -0.23237117 -0.16807951 -0.37653335
 -0.19175846 -0.11744655 -0.21742786 -0.34082623
```

**Graphical Representation of Predicted Net Income**

![Graphical Representation of Predicted Net Income](image)

**Result:** In case 7, where we have stressed only market factors 2x Market Factor (EU Emission Spot price upper Bound 2X, Green Bond Investments Upper Bound 2X) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.
Case 8: Scenario 4 Technology Stress
Delta Net Income = 1x Policy Factor (Baseline of Fossil Fuel Consumption, CO₂ Emission, Norway Oil Output) + 1x Market Factor (Baseline of EU Emission Spot price, Green Bond Investments) + 2x Technology Factor (Renewable Consumption Upper Bound 2X) + 1x Climate Factor (Baseline of Temperature, Rainfall).

in this scenario, technology factor i.e. renewable energy consumption is stressed as shown in above equation and all other factors remains as baseline.

R Code:
```r
# predicting for the given scenario_4
Scenario_4_Climate_Stress <- predict(model_reg,newdata=scenario_4)
print(Scenario_4_Climate_Stress)
Scenario_4_pred <- cbind(Scenario_4,Scenario_4_Climate_Stress)
```

Predicted output for net income:

Graphical Representation of Predicted Net Income

Result: In case 8, where we have stressed only technology factors i.e. 2x Technology Factor (Renewable Consumption Upper Bound 2X) and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.
Case 9: Scenario 5 Combined Stress
Delta Net Income = 2x Policy Factor (Fossil Fuel Consumption Lower Bound 2X, CO2 Emission Lower Bound 2X, Norway Oil Output Lower Bound 2X) + 2x Market Factor (EU Emission Spot price upper Bound 2X, Green Bond Investments Upper Bound 2X) +2x Technology Factor (Renewable Consumption Upper Bound 2X) +1x Climate Factor (Baseline of Temperature, Rainfall)

In this scenario, combined factors are stressed as shown in above equation and all other factors remains as baseline.

R Code:
```r
# predicting for the given scenario_5

scenario_5_climate_stress <- predict(model_reg,newdata=scenario_5)
print(scenario_5_climate_stress)
scenario_5 pred<-cbind(scenario_5,scenario_5_climate_stress)
```

Predicted output for net income:

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Net_Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.153746333</td>
</tr>
<tr>
<td>2</td>
<td>-0.121080474</td>
</tr>
<tr>
<td>3</td>
<td>-0.147359348</td>
</tr>
<tr>
<td>4</td>
<td>-0.514072657</td>
</tr>
<tr>
<td>5</td>
<td>-0.495297721</td>
</tr>
<tr>
<td>6</td>
<td>-0.405734359</td>
</tr>
<tr>
<td>7</td>
<td>-0.469402483</td>
</tr>
<tr>
<td>8</td>
<td>-0.466208947</td>
</tr>
<tr>
<td>9</td>
<td>-0.266044847</td>
</tr>
<tr>
<td>10</td>
<td>-0.250599196</td>
</tr>
<tr>
<td>11</td>
<td>-0.503449699</td>
</tr>
<tr>
<td>12</td>
<td>-0.30159126</td>
</tr>
<tr>
<td>13</td>
<td>-0.599321564</td>
</tr>
<tr>
<td>14</td>
<td>-0.215741785</td>
</tr>
<tr>
<td>15</td>
<td>-0.300699750</td>
</tr>
<tr>
<td>16</td>
<td>-0.543861954</td>
</tr>
<tr>
<td>17</td>
<td>0.008925687</td>
</tr>
<tr>
<td>18</td>
<td>0.079808598</td>
</tr>
<tr>
<td>19</td>
<td>-0.677237348</td>
</tr>
<tr>
<td>20</td>
<td>-0.608336112</td>
</tr>
<tr>
<td>21</td>
<td>-0.596136834</td>
</tr>
<tr>
<td>22</td>
<td>-0.207949707</td>
</tr>
<tr>
<td>23</td>
<td>-0.250586532</td>
</tr>
<tr>
<td>24</td>
<td>-0.505507671</td>
</tr>
<tr>
<td>25</td>
<td>-0.060749684</td>
</tr>
<tr>
<td>26</td>
<td>-0.178070147</td>
</tr>
<tr>
<td>27</td>
<td>-0.555666986</td>
</tr>
<tr>
<td>28</td>
<td>0.018358618</td>
</tr>
</tbody>
</table>

Graphical Representation of Predicted Net Income

Result: In case 9, where we have stressed combined factors and the remaining independent factors remain as baseline, this also gives us almost the same trend of net income as going downwards. Same can be seen in the above graph.

Fig 33: Scenario 5 Combined Stress
Conclusion Drawn from Scenario Analysis

It is evident from the above graph, that when the different scenarios are taken under consideration, there is adverse impact on the net income of bank depending upon the policies that come into play and the climatic factors becoming unpredictable.

Multiple Variable Regression: Climatic Risk Analysis on Bank’s Non-Performing Loans (NPL)

Based on the collected data for each of the variables, we have performed a Regression Analysis to understand the effect of these independent variables on the dependent variable NPL.

Fig 35: Regression Model
In the initial study conducted by us we have performed a regression analysis on independent variable such as average temperature, average rainfall, carbon emission to ascertain its impact non-performing loans.

Based on the all the 3 regression analysis performed by us we could identify some correlation between variables like fossil fuel consumption, CO₂ emission and Norway oil consumption has significant correlation with banks’ net income. However, we have also observed that there is no correlation between other variables and banks portfolio in the time frame from 2009-2018.

So based on the historical trend we can also conclude that there is going to be significant impact on banks net income due to the changing patterns in the fossil fuel consumption and CO₂ emissions.

However, we would also like to bring it to notice that the historical data may not represent the correct picture of future changes. As in history we have not seen any major events or changes related to climate. So there are high chances that the banks will be highly exposed to the policies and technological change which would be driven by their local and global bodies to reduce the temperature. If the countries come up with aggressive policies and legal frameworks it might have significant impact on banks. As they need to adopt to those policies and act fast to perform a quick transition from consumption of non-renewable to renewable source of energy.
Conclusion
In the analysis performed by us, it has been observed that most of the key performance indicators like NPL, NII etc. do not bear any statistical significant relationship with climatic factors considered in the study, though one of the KPI i.e. Net Income of the bank does have significant relation with three climatic factors, especially with rate of change of global Fossil Fuel Consumption, rate of Change of Global CO2 emission and Rate of Change of Oil Output of Norway. On the basis of the regression analysis between Net Income of the bank with climatic factors, a valid predictive regression equation is created, and same equation is used in scenario analysis. In scenario analysis, it was evident from the stress test results that Net Income of the bank would have negative impact and capital need to be allocated against the probable loss.

This study is based on few KPI factors and limited climatic related data, results can be more prominent if sectoral data is available for analysis.
Appendix

| Data set used for studying the impact of climate variables on NPL | https://drive.google.com/open?id=1rz2EQxwXnbnv7a0Y40tzKMdKEKx9i6kd |
| Data set used for studying the impact of climate variables on net interest income | https://drive.google.com/open?id=1JEUf5t375BJZAIYkDldW8lxcm6hlLXqE |
| Data set used for studying the impact of climate variables on net income | https://drive.google.com/open?id=1583jayeCB5MdWSPF-w7_CJ-KeVJxcXR |
| Net Income | https://drive.google.com/open?id=1Fy5rvX8X0kJaElIQ-UpezRiXW0n4P_qf |
| Net interest income | https://drive.google.com/open?id=15CLVHkk2aGghdPPX5_uAqP3p_W3J6n9 |
| NPL data | https://drive.google.com/open?id=1bmpYmCdO7Y2cWq3UDqj9y8y--EVwqis2 |

References

Literature study on climate change impacts on Credit risk, Market risk and Operational Risk factors are studied from

Various other regulatory documents are studied for literature review to understand the climate change initiatives includes: https://www.bankofengland.co.uk/knowledgebank/climate-change-why-it-matters-to-the-bank-of-england
To understand the literature on carbon asset risk and adopt a generic risk framework for our study

Traction on Climate-
https://www.britannica.com/event/Kyoto-Protocol
https://www.fsb.org/work-of-the-fsb/policy-development/additional-policy-areas/climate-related-financial-disclosures/

Sources of data used:
https://tradingeconomics.com/norway/crude-oil-production
https://ourworldindata.org/renewable-energy
https://ourworldindata.org/fossil-fuels
https://www.worldweatheronline.com/oslo-weather-history/oslo/no.aspx
https://www.worldweatheronline.com/oslo-weather-history/oslo/no.aspx
Fayyaz Memon, Principal Consultant with Risk & Computational Finance Practice at Infosys

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