

# Causal Relationship Between Climate and Financial Sector: A Systematic Literature Review and Policy Recommendations

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**Abstract:** The purpose of this article is to give a brief overview of what economists have attempted to study concerning climate change. Climate change and the financial system must be understood holistically. Our awareness of the immediate effects of climate disasters is also crucial, even though most studies focus on distant effects. We will examine the climate change relationship with financial system, and will discuss strategies that the financial sector could possibly implement for addressing climate change. This study identifies the causal relationships between the financial system and climate change, including adaptation and mitigation in the short period and concentrates on three specific areas, including bank behavior, asset prices, and insurance and, thus, it is found that both climate change and the financial sector are deeply entwined. As a result, this study aims to investigate the interactions and to make recommendations for policy makers.

**Keywords:** Climate Change, Greenhouse Gases, Financial Market, Stocks, Asset Price, Insurance

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## 1. Introduction

Climate change is a reality that increases with time, and greenhouse gases are largely responsible for its cause. Human involvement since the start of the industrial revolution has substantially increased the concentration of these gases in the atmosphere and they are now far above pre-industrial levels. Carbon dioxide is mainly produced by fossil fuel combustion, carbon-dioxide emission, and land use conversion primarily, deforestation and agriculture. Despite the curtailing or ceasing of emissions, global temperatures are expected to remain warm for decades to come. As a result, environmental changes are likely to become more significant and sustained, resulting in increased natural disaster risk. More and more evidence has indicated that global warming is closely linked with climate change, resulting in an increase in floods and wildfires which is shown through figure 1. Climate policy failure and deteriorating weather are recognized as the biggest long-term challenges facing nations around the globe

[140].

To counteract these trends, financial institutions in various countries, including Central Banks and international organizations, are also taking an active interest in climate change and have enacted a variety of measures. A mitigation strategy for climate change is to reduce emissions of greenhouse gases, whereas adaptation means lessening the severity of climate change. Few factors may hinder climate change mitigation efforts by the financial system. In other words, if market valuations fail to distinguish between businesses that emit high and low levels of carbon, reduced efforts to cut emissions could be discouraged which is depicted by figure 2.

Climate change and the financial system must be understood holistically. Our awareness of the immediate effects of climate disasters is also crucial, even though most studies focus on distant effects. This study analyzes climate change and the financial system in depth in this context. Three specific areas are examined in the study, including

bank behavior, asset prices, and insurance. Financial stability is affected by climate change, and the latter provides a means of delaying its occurrence or reducing its effects.

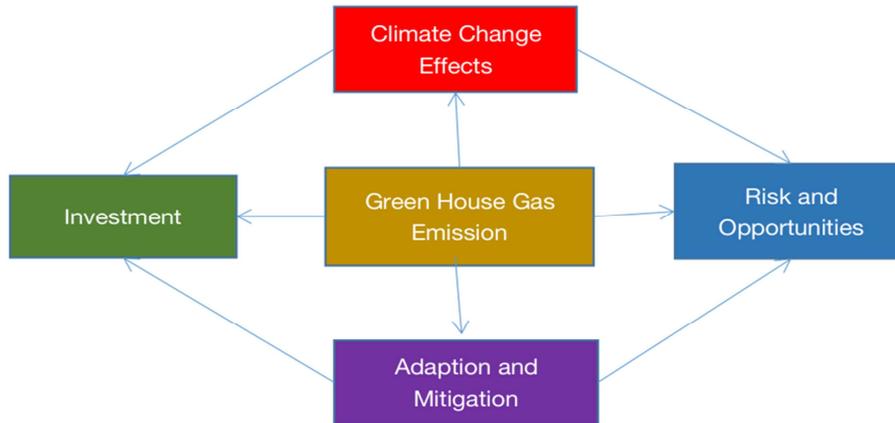
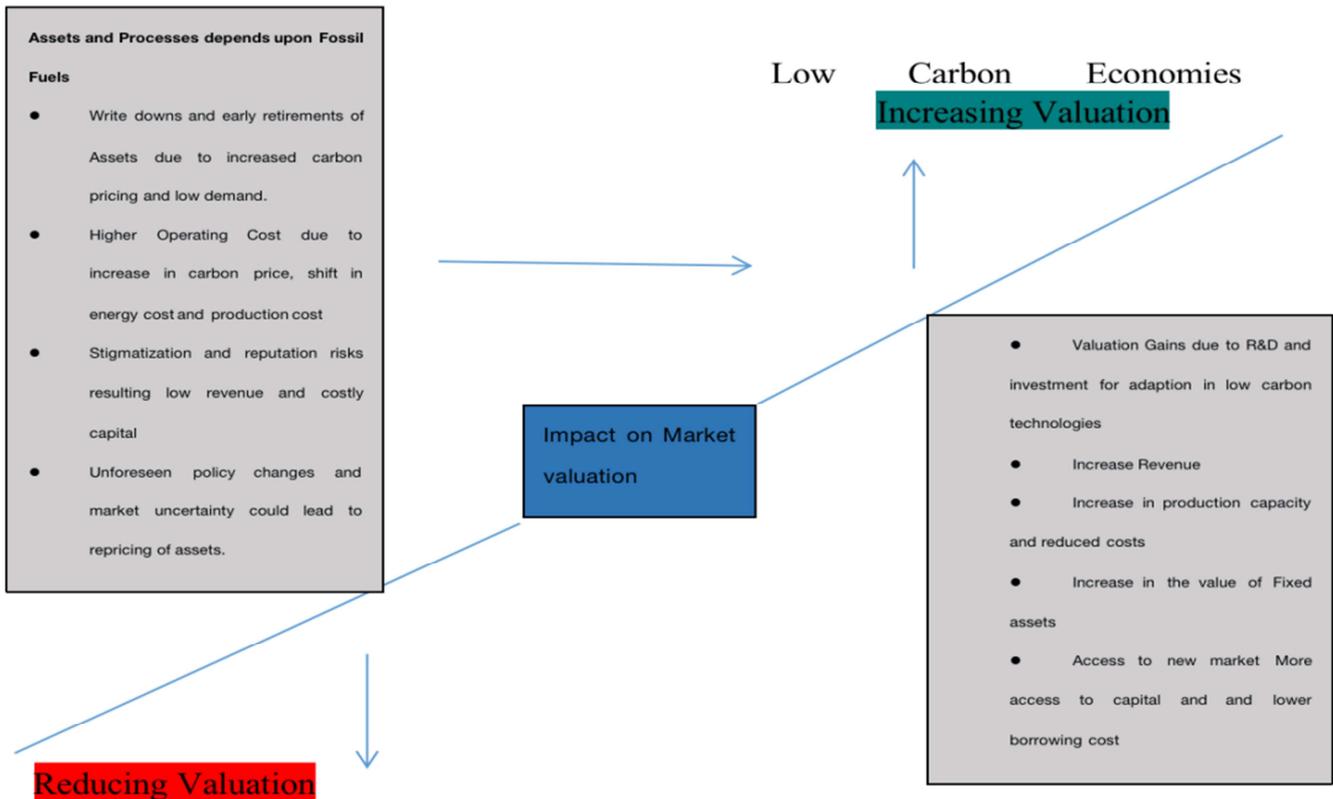


Figure 1. Climate Policy Failure.



Source: OECD Staff Assessment.

Figure 2. Transitional Climate Risks and Opportunities and other Market Consideration.

## 2. Research Methodology Used in Previous Works

Literature on climate change describes and examines its effects in great detail. Up to 3% of global economic growth could be disrupted by climate change in the 21st century, affecting 200 million people. According to Trucost, GDP could drop by up to 20% due to reluctance to reduce Green House Gas (GHG) emissions. The adverse effects of climate

change have led economists to spend a great deal of time trying to determine how climate change influences economic activities. Regarding this, Nordhaus [118] carried out an experiment to investigate the link between climate and economic activities through integrated assessment models. A different approach can be taken by using the IPCC's assessment studies. Statistical studies based on historical data have been the focus of recent research, especially when it comes to extreme weather events.

The relevance of these analyses is that they increase the risk

of natural catastrophes occurring before human populations are able to adjust to an accelerating climate change due to the occurrence of more intense climate-related patterns.

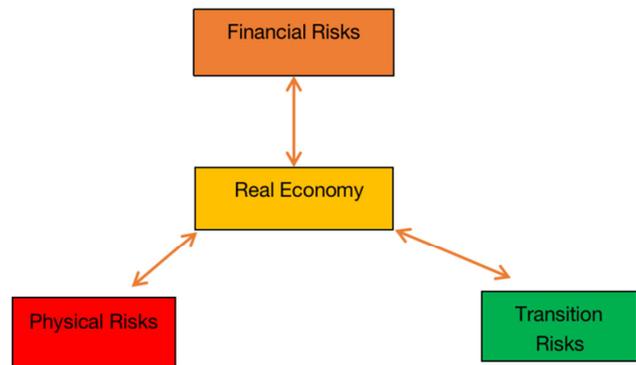
#### *Finance and Climate Change: A Relationship Explanation*

In recent years, central banks have shown increasing interest in climate change as a significant threat to the global economy [31, 10]. It is also crucial to learn more about the ways in which the financial system is contributing to global warming. *Physical risks and transition risks* are considered to be the most significant forms of climate risk. The manifestation of these risks exposes the financial system to direct and indirect approaches: the first involves the direct participation of the financial sector, while the second involves the participation of the real economy. The real economy and financial system may reverse if the financial system is disrupted. Risks arising from an altering climate are called physical risks and they are divided into two categories: acute risks caused by adverse weather conditions like floods and droughts, and chronic risks caused by long-term changes in weather patterns, such as sea level rise. Physical risks means tangible assets and are susceptible to damage, such as factories or houses. In turn, this may harm banks' balance sheets since firms and households may lose credibility. As a result, markets may also experience a decline in the value of securities, which can have a negative effect on credit access for firms and households. Due to this, banks are unable to provide credit at the right time in future if firms and households will not repay and cash flow decreases. Similarly, if insurance coverage covers the resulting damages from physical risks, insurers might foreclose on properties to meet their obligations. Over-payments can undermine insurers' ability to stay solvent.

In the same vein, *transition risks* come with the shift toward a carbon-less economy. Policy changes, technological innovations, and changes in behavior can all contribute to these risks. A tax on carbon emission may reduce the profitability of fossil fuels from oil and coal, causing firms to have "unprofitable assets," like fossil fuel reserves, production and refinery facilities, as well as distribution networks that won't generate economic gains. In other words, such assets are likely to negatively affect the financial statements of companies holding them. Furthermore, as fossil fuels become scarcer, energy prices as a whole may increase, which could harm the profitability of many businesses. A growing number of electric cars, for instance, could supplant traditional automobile producers and companies with significant links to these sectors may suffer losses as a result of technological progress, but innovation does bring benefits in the long run. In the financial markets, attitudes toward climate change have already changed substantially.

Despite the fact that physical risks and transition risks are considered to be separate and unrelated, they are inevitably connected as depicted in figure 3. Citizens become aware about change in climate and pressurize the policymakers to take proactive steps, which will affect transition risks as well. Transmission mechanisms, also exist on the inverse relationship when the financial sector affects environment and

then the real economy. Anderson et al. (2019) discuss how financial system undermines households and businesses' mitigation and adaptation efforts and value of assets are mis-valued. In the valuation of companies, stock markets often do not clearly differentiate between companies that emit high and low carbon emissions, which can make curbing carbon emissions more difficult. Importantly, government policies, providing public disaster insurance, can trigger moral hazard and cause resource allocation to be skewed.



Source: Batten, Sowerbutts, and Tanaka (2016)

**Figure 3.** Transmission Mechanism between Financial Sector and Environment.

Funding is also a possible obstacle. Tightening the financial system would be beneficial for the climate by decreasing manufacturing and the emissions but they are actually destructive since they discourage companies from reducing emissions. Levine [109] showed that firms generally invest more in research and development when air pollution taxes increase, but small firms experiencing financial hardships to get the benefit, then small firms invest in research and development only if they have external funding. Howell, S. T. [79] finds that government funds increase the chances by which a company gets additional venture capital and contribute substantially to brand awareness to generate significant returns from hydrogen power, energy-efficient building and lighting strategies, and energy-efficient transportation. Moreover, a study by the International Monetary Fund [86] finds that recent episodes of financial and macroeconomic instability often negatively impact the environmental performance of companies, discourage green investments, and impede their growth substantially. Interestingly, investors can affect the environmental performance of companies through their attributes and actions. Dyck [51] use data from the Survey of World Values to create a normative index and finds that If investors originate from places where there is a widespread awareness of Environment, Social and Governance (ESG) concerns, authors conclude that corporate participation enhances ESG performance. Additionally, Choi [35] concluded that financial institutions have been cutting the shares of polluting industries in recent years, especially those based in regions where environmental awareness is high. Companies in Asian countries tend to report low Price to Earning ratio and Price to Book value as a result of divestitures, which is risky for companies that take on

equity financing. However, they have increased investment costs and Research and Development expenditures, which indicates that emission-intensive companies are investing in technologies to lower emissions.

Juvenot [91] confirms the theory that companies have more pressure to reduce their environmental impact when investing through banking sectors. Prior to the enactment of the carbon footprint disclosure requirement, many UK firms already addressed the problem and their contribution in pollution is a concern for a decrease in financial institutions' investments. Two other factors may have contributed to a failure, they suggest: apprehension of negative media attention and excessive competition in the industry. According to Shive [132], strengthened corporate governance may subsequently enhance their environmental performance.

There is also conflicting evidence from a new study that examines the effects of debt and equity financing on environmental performance. De Haas et al. (2019) demonstrate that the level of CO<sub>2</sub> emissions per capita is lower for economies that are predominantly equity-financed than for those that have a predominantly debt-financed economy. Two distinct channels are revealed by their analysis. Stock markets reorient investment to environmentally friendly sectors by encouraging the adoption of green technology and the development of green patents. As Levine [109] demonstrate, borrowing from non-bank loans encourages to reduce the emissions. Shive [132] suggest that firms which are not backed through stock market, release less carbon emission.

### 3. Objective and Future Implication of the Paper

Here a concise review of literature on climate change and its economic implications is provided. We will examine the climate change relationship with financial system, and will discuss strategies that the financial sector could possibly implement for addressing climate change. A causal relationship within this context is crucial. This is because without such data, it is hard to develop a universal framework through which to evaluate a variety of possible financial strategies. While current discussions are focused on the anticipated future implications of climate change.

### 4. Discussion

Most financial institutions ignore climate change or deal with it only sporadically. In the event of climate change threats manifesting or when citizens become fully aware of the dangers, the capital markets are at risk of disruption. A disruption of the capital markets have a prominent impact on the real economy when sudden increases in the value of underlying assets weaken the budget of households and firms. A drop in asset prices may also severely affect the creditworthiness of a company if its assets are pledged as security. The inefficiency of resource management can also be attributed to an underestimate of climate change risks.

Financial markets may discourage companies from trying to lower their carbon emissions, since they do not fairly reward firms with lower emissions. Similarly, if housing prices don't take risks such as flooding or sea level rise into account, this could lead to uncontrolled growth in high-risk areas. Public safety, infrastructure, and housing are all at risk as a result. A competitive energy market can motivate proactive efforts to mitigate global warming [4].

*Real Estate Market* Bernstein [7] have found that houses near ocean will be sold for less than inland properties, but the difference becomes most apparent in the rental market, where "affluent" renters are sought. Despite the fact that coastal erosion risks are rarely directly linked to property values, they do have an impact when locals are concerned about rising sea levels, which suggests "naive" buyers are likely to believe local opinion. Their findings further indicate that consumers of residential properties do not take climate risks sufficiently into consideration. Research paper of Baldauf [8], analyze detailed transaction information to plot flood risks of residential homes, and estimate perceptions regarding climate change in every state in the United States (US). It turns out that coastal counties, where a high percentage of residents believe in global warming, offer houses at a lower price in comparison to those in globally warming-denying areas.

On the other hand, Hino [70] suggest that flooding-affected properties are excessively overpriced in United States. Most purchasers are categorized as 'limited liability companies' and classified as commercial entities, which have acquired experience in purchasing real estate and more funds to get flood-based information comparatively to households. A significant markdown has been reported in states where homeowners have to disclose flood risk information to prospective buyers and improved risk management could increase the efficiency of the market. Giglio [63] indicate that lack of transparency is contributing to the exorbitant price of housing. They devise a "Climate Attention Index" analysis of available properties to assess the frequency of storms or flooding and if climate change occurs double, the price of a home in a flood plain will decline slightly compared to other similar homes.

Housing altitude is found to be associated with positive housing aspects, such as scenic views. Consequently, higher altitudes do not alter the value of properties. The reason for this may be the lower sea level rise and better amenities [113] Bakkensen [17] discuss how heterogeneity in risk perception is an influential factor driving inflated property prices and propose that pessimistic investors may move to riskier areas rather than positive investors if the risk increases.

Muller [112] highlight the knowledge advantage is distorted by irrelevant variables and aligned with policy changes which make flood insurance at high-risk areas compulsory. They found that houses in flood-prone areas experienced a roughly seven to sixteen percent drop in value following a large external shock following the city's awareness campaign. As a natural experiment, Ortega [120] used all housing sales in New York City from 2012 to 2017 to analyze the impact Hurricane Sandy had on real estate in the

city and concluded that the continued decline in prices was largely influenced by changing views on flooding.

The valuation of real estate as security plays a significant role. An overvaluation of securities can result in an inefficient use of assets, while a decrease in securities prices puts the financial system at risk. Garbarino [61] demonstrate that after the floods in England during 2013–14, property values declined but banks did not change mortgage rates or interest rates even though the appraisal of the property needed for mortgage refinance failed to benchmark itself with the decline in surrounding areas. It means that banks gave incentives to investors to put money at high-risk zones.

#### **4.1. Stock Market**

There's a significant difference between studies on real estate and studies on stocks as the former emphasize physical risks, while the latter place more focus on transition risks. Large emissions of carbon dioxide are a common characteristic of industries with substantial transition risks. These industries would experience challenges if policies to curb emissions were implemented. If a company is vulnerable to climate change, investors will demand higher earnings from its stock. A large number of analyses have shown that climate change-affected industries actually provide higher returns.

Companies with the highest levels of harmful emissions have more valuable stocks when external factors are considered [81]. This risk premium is derived from a number of reasons, like the uncertainty of environmental regulations. Evidence of a carbon bonus, meaning earnings will be higher for firms emitting more carbon dioxide and conclude that there is a high emission bonus in Asia, Europe, and North America [23]. Climate risk bonus into the options and the findings appear resilient to declining petrochemical and energy companies [82]. Climate change improves investors' returns by reducing vulnerability, a measure of the stock market's risk assessment [72].

Portfolio data is used rather than company data to verify the definitive relationship between stock prices and temperature trends, but the association is stronger for a shorter time. Investors are more interested in the economic impact of high temperature [9]. It can also substantiate the empirical evidence and demonstrate that rising greenhouse gas emissions have a significant social cost.

Market participants react favorably to the announcement of the issuance of green bonds, which is positive for upcoming issuers and green bonds that are endorsed by a third party [53]. In addition, their sustainability ranking increases, carbon emissions go down, and they see more equity investment from green and institutional investors. By issuing green bonds, firms demonstrate their environmental commitment. Investors receive details about a company's involvement in green projects when it sells green bonds for the first time. Corporate investment surged whenever companies issued green bonds, particularly from local banks. Green bonds substantially increase the liquidity of the stock market [134]. As the feasibility of implementing environmental policies depends greatly on political events, transition risks can fluctuate in a

cyclical manner based on political developments.

If the Paris Agreement is able to raise the future transition for a carbon-free economy and then the prices of asset appeared to be incorporated to a more comprehensive level. ESG scores for future emission reductions and discovered quite positive returns for firms that prioritize climate change [126].

Using stock prices of domestic and international food producers, which depend on water and thus are susceptible to droughts, Possibility of drought is negatively correlated with the profitability and stock performance of those producers [74]. This consistency of performance suggests that shares of food firms are unfairly priced. Calculated responses of most climate-sensitive firms can be understood by examining the impact of share price movements on extreme temperature fluctuations in the United States [100]. An increase in energy demand during cold weather, producers in the coal and oil sectors expect higher profits. This indicates that stock prices are generally not affected by temperature variations.

Incorrect assessments of climate change risks may lead to abrupt shifts in perception of risk, which may lead to a shift from risky assets, a decline in their share price, and instability in the financial sector. Web searches about global warming rise significantly when temperatures in these cities are abnormally high, suggesting that investor beliefs about climate change have been influenced positively [35]. During unusually warm weather, carbon-intensive stocks performed less well than shares of low-carbon companies.

Private investors are more likely than institutional investors to sell companies in harsh weather that have a high carbon footprint. Individual investors have insufficient awareness and consequently to the effects of significant events. Both energy companies and leisure companies are affected through the economic activities. Rather than shifts in profitability or revenue, these findings indicate fluctuations in returns are due to changes in investors' expectations. They become less incline to invest in emissions-intensive firms, and they do not invest in "dangerous" stocks such as alcohol, tobacco, and gaming companies. It is also validated this conclusion by studying the effects of concise and extreme facts instead of comprehensive information on investors [68].

Market participants may not only become inured to the risks of severe weather events, but may also respond overly to these events as a result of a salient tendency, when estimating an event's intensity, closeness, or psychological effect, they might exaggerate its severity. Institutional investors operating in disaster-prone areas overlook catastrophe stocks to a greater extent than outside investors [3]. Investors are hesitant to invest in disaster-prone areas because of a perception problem, not because they have an accurate picture of managers in those areas. The worst performing disaster zone stocks are those that are under-weighted by disaster zone funds. The fund's overreaction and incorrect assessment of the market may have caused price pressure.

Many papers have explored how disclosure affects stock price and climate change risk. Using a quantitative test and a study conducted with institutional investors, Investors prefer

climate risk disclosure which is equally important as financial disclosure and their analysis shows that issues involving physical risk are the most significant in terms of technological, policy, and legal factors [82]. Regulatory risks have the smallest impact and physical risks are business and geographically specific, making them extremely difficult to measure. On the other hand, regulatory risks are institution-agnostic and regulated, which makes gathering data on such risks simpler for institutions that are not affiliated with the firm. An increase in institutional investment, especially from high-income countries where firms are more willing to disclose greenhouse gas emissions and use independent audits to provide better estimates.

Real-time financial disclosure is beneficial to a certain degree and without disclosure, shares will be discounted, especially for firms which produce small emissions [83]. Emissions information and concluded that valuation declines as emissions rise and their finding suggests that a fee is levied on firms that fail to provide disclosures [108].

Implementation of carbon dioxide disclosure requirements for companies on the London Stock Exchange and demonstrate that companies reporting reduced emissions generally have better returns [91]. Additionally, Shareholders involve actively in the disclosure process in the absence of formal disclosure regulations [54]. A long-term interest is especially relevant if the initiative is taken by institutional investors. Due to institutional investors' immense influence and the fact that long-term investors possess stocks for a long period of time, these proposals are seen as credible by long-term investors. Shareholders likely appreciate the transparency regarding climate change risks.

*Aspects about Other Assets* Taking a close look at research on other asset types, including green bonds, weather derivatives, and consortium loans, we now examine the research on other asset types. It's interesting to note that the results confirm what had been observed previously, these assets are valued substantially with climate change risks in mind. In particular, a variety of studies indicate that corporate bond rates and credit rates take into account firms' environment-related characteristics. Firms with a low environmental rating have a correspondingly wider bond return spread, even when the firm is situated in a region with increasingly strict environmental restrictions [131].

Information about Fossil fuel resources identified by firms, which indicates the possibility of non-renewable resources and the resulting impacts on the economic potential of these resources [43]. Analysts combine this information with syndicated loan data to calculate the interest rates offered to fossil fuel producers and compare them with other firms. Moreover, local bonds also reflect climate change risks. For longer-term municipal bonds, An association between higher underwriting expenses and higher returns for states most vulnerable to rising sea levels, but a different pattern does not hold for shorter-term local bonds [122]. In 2011, Prices of short-term municipal bonds began reflecting rising sea level exposure along with the accuracy of climate predictions [66]. There is a lot of damage in the East and Gulf areas, where

storms pose a big risk, but relatively little on the West Side, which has had fewer cyclone-related flood disasters. A study of weather derivatives has shown that the price of weather futures is predicting global warming correctly [129]. As temperatures drop or rise over time, the value of futures contracts is affected.

Due to a full understanding of the forecast, market participants do not irrationally alter their positions in response to weather events. Green bonds have received considerable research attention, and numerous studies have examined the return or "Greenium" on such bonds. US green bonds differ from ordinary bonds in that most of the revenue is allocated to eco-friendly endeavors. Investors' preferences for risk-free assets explain bond yield variations, not variations in perceptions of expected cash flows or risk.

'Greenium' has ambiguous empirical findings. Green bonds provide a cost advantage based on secondary market returns [103]. On the other hand, Yields after taxes in their calculations and find that for securities branded as green but independently verified by a third party, the real value of this return increases by two or three [6].

#### **4.2. Banking Behavior**

Climate-related risk typically emphasize the future impact on climate change, but the immediate catastrophes impacts are also vital. The following part reviews the study material on bank behavior due to disasters. Our focus is on why banks are so readily available to provide credit to meet liquidity needs after a catastrophic event. The disaster provides an opportunity to examine factors affecting credit demand and supply, as it is considered an external disruption to the economy. Increasingly, climatic studies are of growing importance in identifying the financial risks brought forth by natural disasters. Natural disasters negatively affect the financial health and lending performance of banks. Research has been conducted on whether the geographical spread of banks, a topic that has been highlighted in a prominent study in the financial literature, explains the spread of problems to remote areas. Our next step is to analyze the advantages and disadvantages of government assistance in the banking sector.

*Credit Constraints and Damage to Banks* As a result of natural disasters, banks can experience several threats to their financial stability, these catastrophes can put a strain on their balance sheets, reduce the value of secured assets, and put their service systems and physical locations at risk. Severe weather-related disasters have a significant impact on the Z-score for commercial banks, an indicator of their ability to survive or, more specifically, their risk of inversion [94].

Alternatively, Noth and Schuwer (2018) demonstrate that Collateral losses weaken the resilience of banks and increase the non-performing assets due to natural disasters, and increase in default rates as well as lowered returns on assets and falling ratios of capital in banks [119]. Moreover, Hurricane-hit banks on the Gulf Coast had poor Z-scores, which made them far riskier than their counterparts who did not suffer damage [130]. Impact of flood in Germany, with underlying model excluding banks in affected counties to

prevent distortions in the loan supply and credit availability within the distressed areas [95]. Affected banks are identified as banks with a high proportion of corporate debt based in flood-prone regions, while unaffected banks are identified as banks with low corporate debt levels based in low-lying areas.

Catastrophes also affect the financial situation of debtors and after combining detailed mortgage, property value, and temperature data. Dramatic spike in default and bankruptcy following a devastating fire in California [88]. Additionally, they show that the impact decreases as the fire grows larger. Insurance Code states that people who reconstruct their homes receive insurance coverage to cover the damage. In particular, Impact of household financial affairs. In the most flooded areas, the default rate on credit cards increased [59]. The borrowing of firms and households that have been damaged by natural disasters frequently increases. This is because they attempt to replace damaged property, cover shortfalls as they receive government assistance or insurance coverage, or maintain liquidity during these times.

A number of studies show an increase in credit demand. Brown, During adverse weather, corporations, particularly solvent small firms, borrow more and rely more on credit [26]. Companies that were damaged by hurricanes were more willing to disclose that they applied for credit right after the disaster [38]. Many smaller firms sought credit after the disaster. Affected banks expanded credit at a higher rate than unaffected banks [95]. According to experts, the modest uptick in credit is due to an increase in business demand. As a result, exposed and unexposed banks are outside the scope of their research. Their only difference is whether they lend to flood-prone businesses.

Firms located in the path of hurricanes increased cash flow and managers were more concerned about hurricane damage, even if the probability remained the same [47]. They observe a decline in apparent liquidation risk as time passes, along with the disappearance of perception bias. Based on their findings, attention bias may explain managers' behavior. Information pertaining to clients of a financial institution in Ecuador focused on credit for small businesses, along with information on the activity and earthquakes of its largest dormant volcano [15]. They found that the demand for loans, which is their measurement of credit, dramatically increases during volcanoes.

When an economy is devastated by a disaster, its capacity to handle the additional demand for credit becomes crucial. Researchers have demonstrated that both banks' lending decisions and firms' borrowing capacity are affected by climate disasters. Disasters-affected firms observed a decline in both sales and production. An active volcano hinders the access of borrowers to take credit [15].

Businesses negatively affected by the recession were nearly double as likely to state that their access to financing had diminished since the previous year [38]. One third were asked to show collateral and witness interest rate hikes. A larger firm was better able to obtain the funds that it had requested than its smaller counterpart. This was supported by the fact that they were able to get secured loans. According to Banks charge

loan applicants higher interest rates and also make inefficient or infuriating adjustments to non-price loan terms following exceptionally harsh winters [26]. Due to these factors, mortgage terms are shorter, collateralization is more common, and fixed interest rates are less common. There is evidence that deposits in financial institutions grow during natural disasters, helping to mitigate credit market disruptions. Specifically, Deposit growth of consumer and inter-bank deposits of affected banks exceeded the growth of non-affected banks, but not commercial lending [95].

*A Contraction in the Supply of Credit in Unaffected Regions*  
We just learned how natural disasters contribute both to increasing credit usage from individuals and businesses, as well as the limited support by banks. Geographical growth of banks has negative impacts due to the dissemination of adverse blow and advantageous features for sharing risks and creating new businesses [45, 110].

During a natural disaster, multiple analyses indicate that banks limit lending in safe geographic areas. Rather than focusing on funding the flood-affected areas, analyze focuses the impact on the unaffected regions [95]. This is the reason for comparing firms located in areas not affected by flooding attached to disaster-prone banks, defined as those which granted loans to large corporations in flood-damaged counties based on an even more extensive scope of loans, with firms located in the same area but without any connection to disaster-prone banks. These researchers conclude that the flood damage was spread to non-disaster affected firms by their banks-the banks linked to disaster-hit banks reduced their borrowings. More disaster-exposed banks there were in a non-flooded area, the greater the drop in GDP there.

Investment in the affected area by firms that had their principal banks nearby was less than that of firms in the area that had their principal banks situated outside the region [77]. It suggests that the insolvent banks' reduced lending capacity increased the borrowing limits of their undamaged clients. Banks transfer shock-waves of natural disasters to nearby areas as a result of unrealistic asset valuations that prevent a contraction in credit in disaster-affected areas [61]. According to them, property values in England fell during the flooding, but bank valuations did not adjust for the change in value.

However, physical risks, drivers of network effect, also have implications related to regulatory and technological development. The price of fossil fuels will fall dramatically with the implementation of a carbon tax. As a result, they are no longer valuable, effectively making them useless as an energy source. Companies that possess such resources are likely to suffer serious financial consequences and banks will be unable to provide credit to such companies. Natural gas and oil exploration activities generally are associated with a rise in mortgage availability, it is plausible that a fall in demand for fossil fuels could result in the opposite, a fall in loan volume [64]. They focus on the ensuing surge in deposits for banks with presence in oil-producing counties following the unpredicted technology development that made large reserves of unconventional energy feasible to exploit. Studies have shown that banks exposed to stress expand their lending in

their regions at a rate of 13 percent faster than those that are unstressed. They discussed possible network effects on deposit levels as a problem in the research.

Natural disasters banks may increase deposit rates in interconnected markets, markets where banks extend credit prior to the disaster hitting those individuals who are not immediately affected, and markets where banks extend credit during a disaster [41]. Implications of financial institutions deciding how to set interest rates on deposits in a particular region [50]. A branch can determine the deposit rate, and they tend to increase rates significantly if they are allowed to do so. Depositors are encouraged to deposit more money if a natural disaster occurs. Also, banks in regions where deposit rates are fixed offer about ten percent higher loans. It has been concluded that the impact is caused by debt remaining on the books and not being refinanced. In light of the fact that banks do not have to raise funds to finance loans that have been written off.

Real estate prices in these areas increase relatively quickly, which results in more insolvency petitions. This indicates that bank equity entanglement is prevalent and that the sharing of power within banks plays an essential role in disaster recovery. Banks are reinvesting in the region and lending forty cents for every dollar lost [90]. On the other hand, they do not provide any data that demonstrate how local catastrophes and shocks caused by the network influence deposit rates [50]. Banks sometimes increase interest rates in addition to shocks at the regional level. According to the study, local banks within counties are considered regional banks, and to fund recovery from a natural disaster, their deposit rates must be increased.

As a number of variables influence the severity of a natural disaster, there is a possibility for significant variation in the effects including, lending practices and regulations, borrower-lender relationships, the age and size of businesses, and other forms of financing. Climate catastrophe threats are inversely related to monetary control with extent of financial and economic development [94]. According to Berg and An Ecuadorian microfinance entity, regular customers are as likely to obtain loans after the earthquake as before, but inexperienced customers have more difficulty obtaining loans [15]. The easing of credit constraints will be made possible by building trust between a lender and a borrower. Importance of this type of banking and banks in non-affected areas increased lending by 16 percent during flooding in Germany in 2013 [95]. The firm structure is the another important factor affecting diversity. Smaller firms with substantial debt had a greater likelihood of being unable to borrow from banks following the Tohoku Earthquake [136].

Startups and micro-businesses were unable to receive all the credit support required after Hurricane [38]. Experiencing non-bank facilities also contributes to diversity. Borrowers' financial strain is reduced when they have access to high-interest loans [111]. Based on the data for California and natural disasters as external factors, easy access to loans reduces the number of bankruptcies per 1,000 homes by 1.0-1.3. Where household policies cover damages, recourse to short-term financing has no mitigation impact. Banks in

disaster-hit areas are especially vulnerable, resulting in significant lending restrictions. Banks in the disaster area will likely be eager to keep credit in place following the disaster because borrowers are of greater relevance to them than to other lenders. There are also fewer monitoring costs for regional lenders in the recovery process.

Vulnerability to the shocks, due to Katrina hurricane, of regional banks and banks that are part of networks [130]. Financial institutions located in the hurricane-hit areas improved their capital-to-risk ratios, but the others did not. By decreasing its lending to non-financial businesses in remote areas, independent and capital-rich banks increased their government bond holdings and lent to firms in the region. Per capita income and job creation tend to be greater in areas with a relatively high proportion of independent banks. In New Orleans, borrowers spent flood relief assistance to clear loans instead of reconstructing their homes in the affected area [59]. The high reconstruction costs in New Orleans might be contributing to the decrease in debt and also found that repayments are higher in regions where people are more likely to obtain home loans from companies outside their local area.

After examining hurricane damage in the U.S., local banks in areas devastated by recent storms have a greater number of low-interest residential mortgages than widely diverse banks [59]. Banks reduced lending to unaffected counties, and this enabled lenders to offer more mortgages. The elevated approval rate was offset by a comparable decline in claims in other counties. Regional lenders made up a larger part of the new loans. Local banks are able to take advantage of their unique capabilities to exploit opportunities. Lenders with adequate capital in these regions frequently handle loans in these areas. The local banks, however, refused to give more loans to afflicted regions where defaulted loans made up a much higher percentage of their loan portfolio. This data indicates that local banks have not affected property values or economic activity in the area.

Several studies conclude that local banks facilitate the recovery in the economy after natural crisis. Bank will be genuinely regional if approximately two-thirds of its assets are located there and regional lending facilitates job preservation and growth, especially among small businesses [40]. Disaster-prone areas recover more quickly after a disaster if they have a substantial share of lenders. local banks were less interested to provide loans to earthquake-prone real estate after the January 1994 Northridge earthquake in California [62]. In particular, numerous studies indicate that bank attributes play an influential role in network effects. Independent banks grant credit primarily to well-capitalized firm and bank capitalization affects network effects. Capital restrictions have a significant effect on disasters, as banks with less capital tend to spread disasters to non-affected areas [90]. Size of the bank also influences the network effect and that unexpected changes in the credit market are reflected in financial systems only by small banks, and not big ones [41]. The network effects vary greatly depending on whether the large banks' head offices or branch offices are affected [77].

Banks limit credit in resilient regions just because they are

not economically significant [90]. Lending contractions are most prevalent in countries where banks do not have branches [41]. In contrast, Shale industry-connected banks extended loans quicker than their counterparts in areas close to their branch offices [64]. As a result, if windfall profits evaporated, banks would soon reduce their credit again because they had extended their credit capacity during this time. Banks decrease the lending to regions that remain vulnerable despite not being affected by disasters [127]. The ease or difficulty of collateralizing a loan has been found to be a determinant of the network effects of a disaster. Securitization permits local banks to continue lending in hurricane-damaged regions [33]. Local banks originate a significant proportion of mortgage credit in risky regions, compared to geographically dispersed banks. These loans are also sold on the secondary market.

### 4.3. Understanding the Role of Insurance

The insurance industry is also essential to fighting climate change alongside the financial sector. A policyholder can use insurance to control the effects of climate risks, same as social security. Insurance claims for disaster-related damages are a major source of recovery funding. Insurance settlements may threaten the financial stability of insurers or trigger the sale of real estate, which would weaken financial stability. The coverage may also lead to moral hazards, which will slow down efforts to mitigate climate change. In this study, we will look at the empirical evidence for how insurance mitigates disasters and supports bank finance, but it has the adverse effect of altering the distribution of resources.

*The importance of insurance* A natural disaster's negative economic impact can be mitigated by insurance. Catastrophic insurance for property in developed countries shows that recovery can get speeds through insurance after disasters, but comprehensive research on the topic is lacking [97]. Several researchers conducted cross-national studies and found that insurance coverage directly impacts the recovery from natural disasters. Large crisis adversely affect economic growth [138]. Despite this, only the portion of the disaster that is uninsured has significant negative economic consequences. The availability of bank credit is also determined by insurance. Generally, disasters tighten credit conditions, increase default rates, and boost credit demand. The effect of insurance can be mitigated to some extent.

Worse the flooding was for homeowners, the more debt reduction was achieved as they utilized their insurance policies to settle their obligations instead of having to start from scratch [59]. In an analysis of California fires over the past few decades. A significant fire resulted in credit defaults and bankruptcy for a small business. A subsequent claim is that insurance benefits contributed to the outcome.

The study also finds that firms with substantial losses and no insurance coverage were more likely to seek loans instead of businesses who had substantial losses covered by insurance. Exposure to short-term loans may increase the likelihood of foreclosure following a catastrophe, since insurance does not cover the catastrophe [111]. Unfortunately, catastrophe insurance may also affect planning and decision-making prior

to the occurrence of a crisis, contrary to analyses that focus on the implications of a crisis for credit. In an empirical investigation and formal analysis, Insurance market flaws can constrain the availability of credit [62]. Insurance companies are able to track the safety-enhancing behavior of property owners while banks are unable to do so. Since insurance plays an influential role, the question is why premium insurance policies are so expensive. Providing comprehensive protection will ensure many different types of individuals and businesses will be protected from natural disasters, which in turn will improve the economy's resilience to natural disasters. Recent research shows that the current level of protection is inadequate. Swiss Re's research shows that most climate-related disasters are not insured by companies, and this is especially true of floods and earthquakes [73].

It is possible, however, that even an insurance policy won't compensate businesses for the type of damage they might suffer. Hurricane Sandy-2012, severely impacted approximately 33 percent of businesses in New York and caused property damage and business interruptions [38]. In many cases, the businesses that suffered losses lacked insurance coverage. There were also many companies without insurance to protect against the losses caused by Sandy. It is possible that some losses may be different from the kinds of damages covered by insurance policies. It would appear that the coverage of a policy is insufficient to cover the expenses incurred by firms alleged to have been adversely affected by consumer and service issues. Coverage, therefore, had a less significant impact on Sandy's recovery funding than debt. Sandy caused more severely damaged firms to default on debt than to collect insurance benefits.

According to various reports, there are also inconsistencies in coverage because it fails to reach the most vulnerable. In their study of New York City homeowners affected by Tropical Storm Sandy, Homeowners with less earnings were less interested to purchase flood insurance comparatively to high earning homeowners [24]. Small and young businesses had a lower likelihood of being insured [38]. It appears that the less-susceptible individuals are those with low incomes, along with small businesses, who are the most likely not to be insured.

Researchers have also found that cross-border risk-sharing with insurance companies is minimal. Natural disaster damages are distributed globally on a mostly modest scale. International risk sharing is hindered by country bias in taking on disaster risks. It is divided into the amount of coverage and the percentage of risks that are covered globally. Insufficient participation in coverage in the domestic market is a major factor in the ineffectiveness of international insurance. Data from the balance of payments can be used to calculate global risk-sharing arrangements. They found that, based on regression analysis, more prosperous countries insured fewer catastrophes between 1985 and 2017. As a result, their foreign assets are a proxy for their acceptance of natural disasters. Globally, advanced nations have constrained fiscal space due to a lack of risk-sharing. The following implies that countries that are required by the state to fund their social security have

a limited amount of flexibility in how they fund it. As long as the sovereign debt level is high enough, shortage-existing insurance can turn a crisis into an economic risk.

Studying the factors that influence insurance uptake indicates that supply and demand driven factors are involved. Insurance demand is closely related to flooding frequency [58]. A panel data analysis of flood insurance claims for a region that was affected by a severe flood during that year shows that the insurance market increases after a disaster, and then gradually drops down to its original level over time. Even though flood-related headlines are likely to be featured in media markets during periods of heavy flooding, the researcher found that unflooded areas in another industry increased the adoption of policies at about one-third of the rate of flood-affected areas. Flooding may have been forgotten by residents or new residents may not fully understand the risks. There is a lack of demand for protection due to the rare frequency of natural disasters. According to the study, increasing people's knowledge about dangers could also increase the demand for insurance. There is also variation in the demand for insurance, according to the study. Families can often afford to pay a premium amount that exceeds the estimated cost of their insurance, but they have a wide range of choices [39]. Climate sensitivity of families in the Dutch river delta and many families ignore the low flood probability despite the increased chance of flooding [25].

Several factors have limited the availability of catastrophe insurance, notably asymmetric information and an insufficient supply of insurance. A major characteristic of disasters is how large populations, assets, and economies are affected together. Therefore, the principle of big data seems pointless when compared with other forms of insurance, such as vehicle coverage and medical coverage. In order to cover catastrophes, insurance companies must create funds, obtain risk insurance, and issue bonds. The literature indicates that insurance is becoming prohibitively expensive. Most companies have very limited catastrophe insurance against catastrophic risks, and that policy premiums are expensive compared with possible damages [56].

Supply and capital constraints are the two biggest contributing factors in this market. As opposed to the relatively small group of companies that have market dominance. Researchers find that risky bonds require an extraordinarily high premium in the financial market. By doing so, the company is able to reach a wide range of individuals and institutions. A premium of 2.69-fold is calculated for catastrophe risk for a long period [108]. As a result of climate change, natural disasters are becoming more frequent, making the estimation of losses and, therefore, the supply of disaster insurance more challenging. Governments typically take steps in the insurance sector to ensure that disaster coverage is accessible and affordable, given the challenges insurance companies face. Government-sponsored insurance is typically inexpensive and largely immune to risk, which creates problems of moral hazard.

*Losses Incurred by Insurance Companies* Insurance companies are also becoming more vulnerable to climate

change. The premiums will be inadequate to compensate for any losses ex-post since they are miscalculating disaster risk proactively. The financial stability of an insurance company may be affected by sudden major disasters. In 1992, many insurance companies went bankrupt during Tropical Storm Andrew in Florida. Liquidating assets to cover insurance claims may threaten financial stability in the insurance sector. Insurance sales have a negative impact on financial markets. Insurers with significant Katrina vulnerability reduced their debt bonds by a quarter, but household insurers only reduced them by one percent, and life insurers merely increased ownership of these bonds [107]. Companies with bonds owned by Katrina-affected companies experienced greater losses on their adjusted bond performances. Immediately after Katrina, disaster-hit companies began borrowing from banks instead of investing in bonds.

Companies may also increase costs to mitigate possible dangers, in which case fewer people will participate. A company may also decide to stop providing insurance after taking on the financial burden of a natural disaster. Insurers in California were forced to cover higher amounts following the Northridge earthquake in 1994 than they had been doing before. A number of companies had been dangerously close to bankruptcy, but none had actually filed. Insurance companies with homeowners coverage to also offer earthquake coverage in California, some companies have ceased to sell residential insurance. As a result of this exodus, the California housing market experienced a crisis.

*Moral hazard* In terms of insurance, moral hazard is another significant factor. Insurers can pose a moral hazard if they encourage individuals to engage in risky undertakings because they are confident that any losses will be covered by the insurer. A moral hazard can occur when policyholders refuse to implement policies designed to mitigate climate-related damages and insurers are adversely affected by their profitability as their expenses far outweigh the premiums received. It is plausible that the socioeconomic burden of risk-taking-induced actions outweighs the benefits conferred by protection. Numerous studies demonstrate that public insurance causes moral hazards. Heatwaves affect crops more severely if they are protected against heat [5]. According to them, crop insurance prevents the agricultural sector from investing in adequate adaptation measures to cope with climate change. Anthropogenic climate change will exacerbate the problem, since it will lead to extremely high temperatures. Government insurance creates unintended motivations and moral hazard by cutting premiums for flood-prone communities with the misconception that poor people live in flood-prone areas and the lack of political intervention prevents policy changes to effectively facilitate adaptation [92].

In addition, how urban, agricultural, and rural land markets provide reliable indicators of climate change impacts and how they facilitate adaptation by facilitating proactive measures or mitigating measures on the part of landowners and policymakers [4]. A well-designed insurance policy can alleviate moral hazard, even though moral hazard poses a

challenge. A number of different types of coverage include deductions as a means of making policyholders compensate for part of the damages. As a result, insurance companies will be encouraged to take preventative measures and this will encourage rebuilding by providing financial assistance for recovery from disasters.

## 5. Findings

Due to the mis-valuation of corporation equity, the incentives for corporations are compromised, leading to higher greenhouse gas emissions. Transparency is believed to be a successful strategy. The implementation of performance testing has also been proposed, but there remains a challenge in creating relevant conditions. A special status for green securities in financial regulation has been criticized for actively participating in resource allocation. The majority of studies indicate that prices of assets, including stocks, private and government bonds, secured debt, and climate derivatives, contribute to climate-related risks to some level. Several other analyses indicate that property values and stock prices do not accurately capture climate risks. Property prices incline to be greater in regions with a low concentration of citizens who think about global warming, regardless of other factors. Investor actions and asset prices fluctuate and can increase when threats are more readily perceived due to natural disasters hitting neighboring regions. Moreover, the misapprehension of climate risks can result in inefficient use of resources. Hence, transparency and risk management are essential in ensuring the appropriate pricing of assets. The findings for the return on the investment of green bonds offered to climate-related projects, are mixed.

Whenever a natural disaster strikes the region where the banks operate, their performance suffers. Several reports have noted that the scarcity of bank resources can limit the availability of funding in disaster-affected regions as the need for financial assistance grows. It has been stated that start-ups and small businesses have a high risk of capital shortages. The money supply also seems to be constrained in other regions. This tendency is accentuated if banks have a weak capital ratio. A review of the studies discussed here indicates that banks suffer a loss of health when their region is hit by a natural disaster. A number of factors determine the impact of disasters including, characteristics of a bank, the area, and the loan type. If banks maintain adequate capitalization, they are more likely to continue lending in affected areas. Government assistance and other aid can mitigate the effects of a catastrophe.

In the insurance sector, there are three significant obstacles, extending the reach of insurance to deliver additional security and to facilitate risk sharing, safeguarding the viability of insurance companies when climatic threats occur, and preventing the issue of moral hazard. Small businesses and low-income families are especially vulnerable to inadequate coverage. There is evidence to suggest that this can be partially attributed to a lack of information on demand. Studies have shown that lack of differentiation in natural disaster coverage limits access to insurance and risk transfer.

The strength of insurance companies may have been eroded by natural disasters. There has been a liquidation of assets, an increase in insurance premiums, and a reduction in underwriting. Moreover, insurance is considered to be a moral hazard.

## 6. Conclusion and Policy Implications

We will summarize the study's three policy implications by addressing a variety of research topics in the literature. Future research and facts-based policy discussion will also be suggested.

People emit too much CO<sub>2</sub> for a variety of reasons. Insufficient awareness and negative externalities are the two most prominent causes. In the case of negative externalities, the production and consumption entails a social cost to those who are not related to it. Carbon emissions are shared by everyone on Earth. Since CO<sub>2</sub> emissions from end-users and producers are not covered by them, they are not responsible for the entire cost. Hence, consumers and producers are motivated to consume and produce. As a result, greenhouse gas emissions are higher than what is socially desirable. There is also the possibility of negative externalities from financial institutions. Irrational large investments in carbon-intensive projects could be made by banks without the accompanying climate change costs being accounted for. Such omission may impact decision-making regarding, for example, investing in stocks. As a result of this lack of information, low-carbon businesses have a lower share of resources than firms that are similar but more carbon-intensive. Businesses do not seem to want to cut greenhouse gas emissions.

Due to negative externalities and insufficient information, markets do not allocate resources efficiently. A failure to allocate resources efficiently may require intervention by the government. A mandatory disclosure program may be an effective way to fill the information gaps, but deregulating carbon emissions is the best way to curb negative externalities. However, many economists believe the carbon pricing strategies proposed thus far are insufficient. Carbon tax is not only essential but will need to be accompanied by other policies, such as financial policies [98].

By analyzing central bank roles, Policies from a central bank perspective. A database of 133 central banks' responsibilities and priorities is maintained by the IMF [49]. Approximately 80 percent of central banks state that their mandate does not cover direct assistance to green the financial system and country. They also state that forcing central banks to promote sustainability has the potential to be divisive due to inconsistencies with their core mission. An overview of stress and risk weight tests is provided here, which appear widely in the literature.

In order to mitigate climate change, stress testing is an effective method to check the vulnerability of the financial sector. Climate stress tests are an effective method of assessing financial institutions' resilience [137, 2, 128] Although they tend to be based on unreliable data and unrealistic long-term assumptions about financial stability

[114-116]. The majority of climate change models also neglect to consider how the financial sector contributes to climate change.

Some are skeptical that risk weights can be reduced to encourage sustainable finance and capital formation. Financial policies are relatively ineffective tools to manage environmental impacts and that easing capital conditions in a way that simply facilitates specially designed credit could threaten the stability and viability of finance systems, as well as reducing the ability of businesses with high carbon emissions to invest in environmentally friendly technologies [12].

Among other measures, granting preferential treatment to green investments and credits [28]. It is critical to address three obstacles at the outset: green investments may be a risk by nature, authorities may be reluctant to classify investments as "Green". A business with enough resources, experienced management, and a viable long-term strategy might be able to handle the change well, whereas green companies may face transition challenges if their business strategy relies on technologies that haven't been tested at an industrial scale. A compliance risk assessment should eventually take into account the different vulnerabilities of asset types using internal scoring models and third-party ratings. If variables are adjusted, climate-related risks will become redundant, causing a distortion.

The study suggests that residential property and stock markets do not adequately reflect risk. The study also shows that financial institutions change their risk assessments after experiencing climate change directly. Climate change threats will lead to sharp declines in asset prices. A false assessment of assets can then undermine households, businesses, and financial institutions' ability to implement mitigation and adaptation strategies. A number of studies have conclusively shown that climate change transparency and effective information are indispensable in mitigating these concerns. Although the results of this study do not necessarily support making transparency enforceable when governments are restricted in their ability to gather data, they still provide useful information on how governments can influence asset markets to take in more climate risk.

Research shows that while asset prices, including stock and bond prices, factor in climate risk to some extent, stock and real estate prices are not always an accurate measure of physical risks. As a result of new awareness of risks such as cataclysms or evidence of climate change, several reports offer proof that investment decisions and asset values have shifted. Climate risks to lead to a decrease in the value of assets. Adaptation and mitigation measures can be hampered when asset prices don't factor in enough uncertainty by extending credit to high-risk regions or preventing investment by firms with low carbon footprints.

The resulting lack of credit availability of banks impacted by natural disasters also negatively impacts economic activity, even in non-affected regions. A mitigation effort is likely to adversely affect capital allocation by reducing profits. Conversely, some argue that the consequences of a catastrophe on banks and the banking system are not

significant for countries with stricter regulations and banks with higher capital ratios. In light of these findings, statutory measures aimed at ensuring financial institutions' resilience to shocks other than climate change can also be beneficial in mitigating climate change. To address the 2007–2008 global financial crisis, governments and international financial institutions adopted revised regulation regimes, such as Basel III norms. The regulations are now being fully implemented. In addition to climate change, survey results show that these efforts are imperative, so countries and international organizations need to keep working toward them.

Lastly, due to the crucial role that insurance plays in mitigating the negative impacts of climate change, literature also addresses concerns. These concerns include ensuring insurance companies' financial stability when climate change threatens them and eliminating moral hazards. Regulatory and prudential rules for the insurance industry need to consider both advantages and difficulties as they develop regulatory and prudential rules.

Despite significant improvements in our understanding, much research remains to be done on the subject. Several gaps remain in our understanding. It is, therefore, crucial to ensure that upcoming political discussions are based on scientific research and reflect the increasing scientific research in the field.

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