



REPORT

HOW REGIONAL FEDERAL RESERVE BANKS CAN CONTEND WITH ECONOMIC RISK FROM CLIMATE CHANGE



AUTHORS:

Sarah Dougherty
Roger Baneman
Peter Trousdale
Natalie Valent

Author Sarah Dougherty worked for the Federal Reserve for 7 years, and was grateful to draw on that experience in writing this report.

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Executive Summary

The adverse effects of climate change are accelerating, as evidenced by the growing frequency and severity of extreme weather events such as hurricanes, droughts, and wildfires. These adverse effects, in addition to endangering human health and safety, are having increasingly harmful impacts on important parts of our economy. For example, coastal economies are harmed by more frequent and powerful hurricanes; agriculture is suffering from worse droughts; and businesses, residences, and people in or near wildfire areas are threatened both by the wildfires themselves and the air pollution they cause. In addition, the fossil fuel industry, already subject to boom-and-bust cycles, will increasingly be affected by the transition to a low carbon economy necessitated by climate change.

The Federal Reserve System (Federal Reserve, or Fed) is the central bank of the United States. It has broad mandates, including to safeguard the stability of the financial system and contain systemic risks, promote the safety and soundness of individual financial institutions, maintain stable prices, maximize employment, and promote community development. The Federal Reserve includes 12 District Federal Reserve Banks, each of which carries out the Federal Reserve’s mandates within its respective geographic area. This is done largely by supervising and examining banks within their districts, making loans and providing other financial services to these banks, convening key stakeholders, and performing research and conducting public outreach, as well as engaging on monetary policy decisions.

Climate change poses a significant risk to our financial system and to individual banks.¹ Therefore, as part of its duty to monitor and contain systemic financial risk, the Fed and the District Banks have a duty to address climate change-related financial risk.

More specifically, fully incorporating climate risk into the Fed’s and the District Banks’ oversight of the financial system and individual banks would help prevent individual bank failures and protect the broader financial system and economy, key Fed mandates. By considering the risks—both to the economy generally and to individual financial institutions—posed by more extreme weather events and a transition to a low-carbon economy, the Fed can potentially avert or cushion shocks to impacted industries, geographical areas, and crosscutting supply chains and to affected lenders, investors, and consumers.



An air tanker dropping retardant on the Fawn Fire in Shasta Lake, California, on September 24, 2021.

© California Department of Forestry and Fire Protection (CAL FIRE)

This report focuses on the role that the 12 District Banks can play in elevating climate change considerations in the Fed’s oversight of the nation’s economy and financial system. We make the following specific recommendations:

1. Perform research, data collection, and public outreach at the District Bank level on climate economic risk. The District Banks should collect data and conduct research on the economic effects of climate change (including worsening hurricanes, droughts, and wildfires and the transition away from fossil fuels), focusing on conditions within their districts, including, as further noted

in recommendation 4, broken down by community, income, and race to ensure that the economy works for all people. They should use their power of public outreach through speeches, convenings, and reports to spread awareness of the economic risk posed by climate change and the crucial importance of adaptation measures and other strategic planning. Internally, the District Banks should educate their staffs about climate change economic risk and build their expertise through their hiring process. Finally, the District Banks should work with the Federal Reserve Board of Governors—which oversees them—to issue strong supervisory guidance on climate change risk, coupled with bank examiner education and other implementation steps. These actions are important because the Fed cannot address the economic consequences of climate change alone. Banks and businesses must be mobilized in this effort, and the District Banks must use their bully pulpit to catalyze these efforts.

2. Spotlight the economic effects of climate change in Beige Books. The Beige Books, published by the Fed eight times a year, are anecdotal reports that highlight different aspects of economic activity in the various districts and, taken together, create a national picture of the economy. The Beige Books provide qualitative information at the district level, a valuable counterpoint to the plethora of quantitative data the Board of Governors receives, helping to inform the Board’s decision-making process.² In addition, although the Beige Book may not be widely known to the general public, it is an information source for news outlets and, in this way, achieves broader dissemination.³ Historically, the Beige Books’ reporting of climate change impacts on the different districts has been spotty at best. As climate change becomes a bigger driver of economic conditions, the District Banks should augment their Beige Book information collection by asking their sources specifically about the climate change–related economic effects of events such as hurricanes, drought, and wildfires and about adaptation measures responders are implementing. For example, the District Banks should ask what adaptation measures are being undertaken by the agricultural sector in response to worsening droughts, by coastal property owners in response to intensifying hurricanes, and by businesses and residents in areas increasingly threatened by wildfires. This information will help the Fed gauge the ongoing financial risk posed by

climate change and inform the steps it should be taking in response. For the fossil fuel industry, the District Banks should ask businesses in this sector about their medium- to long-term strategies to address the likely transition away from fossil fuels in response to climate change; again, this will help the Fed assess the risk to the financial system and develop a prudent response. To obtain a more complete picture of the evolving energy landscape, they should include renewable energy in their data collection about the energy industry.

3. More thoroughly consider climate change risk in price stability research. The potential impact of climate change on price stability, a core Fed mandate, merits special mention. As increasingly severe weather impacts coastal economies, agriculture, and other commodity production, there will be rippling effects on supply chains up and down the economy. As production in affected industries is curtailed or transportation for essential components is deeply or frequently disrupted, supply of many goods could be reduced and prices would very likely rise. If disruptions are deep or broad enough, price increases could have inflationary effects across the economy. In addition, if the nation (and the world) attempts to transition to a low-carbon economy, without sufficient planning or investment in alternative sources, energy prices could increase, also with broad inflationary effect. The District Banks should deepen their research into price expectations in the context of climate change and enhance their climate change–related data collection (including for the Beige Book) and their pricing and inflation modeling. These steps are necessary to inform Fed policy responses for likely price disruptions due to climate change.

4. Address the disproportionate impact of climate change on low-income communities and communities of color. The Federal Reserve System cannot fulfill its mandates to promote maximum employment and keep prices stable, and ensure that the economy works for all people without addressing the disproportionate impact of climate change on lower-income communities and communities of color, which threatens to widen income, wealth, and employment gaps. A climate focus on vulnerable communities would enhance the efforts beginning to be seen across the Fed’s research, convening, and Community Reinvestment Act regulatory arms. The District Banks should collect the data and conduct the qualitative research—broken down by community, income, and race—necessary to provide guidance to policymakers and enable the Fed to carry out this aspect of its mandates.

Introduction

CLIMATE CHANGE WILL IMPAIR THE U.S. ECONOMY

Climate change will increasingly disrupt the U.S. economy. According to the *Fourth National Climate Assessment*, without comprehensive and long-term mitigation and regional adaptation efforts, climate change is expected to “cause growing losses to American infrastructure and property and impede the rate of economic growth over this century.”⁴ For instance, since 1980, the United States has had 323 weather and climate disasters with damage exceeding \$1 billion.⁵ Extreme weather events such as droughts, hurricanes, wildfires, and floods are becoming increasingly destructive; all five years with the most billion-dollar weather disasters since 1980 occurred in the last eleven years (the top five were 2020 with 22, 2021 with 20, 2017 with 18, 2011 with 16, 2018 with 15, and 2016 with 15).⁶ The National Oceanic and Atmospheric Administration (NOAA) notes that “the total [inflation-adjusted] costs for the last five years (\$764.9 billion) is more than one-third of the disaster cost total of the last 42-years (1980-2021).”⁷ Further, although current production remains steady, fossil fuel industries are likely to come under particular stress as the necessary transition to a low-carbon economy accelerates.⁸

According to a 2018 special report by the Intergovernmental Panel on Climate Change (IPCC), the United Nations body charged with assessing climate change science, the world can mitigate the worst impacts of climate change by holding global warming to 1.5 degrees Celsius. But this will require reaching net zero emissions by 2050 and adhering to—and increasing—the Nationally Determined Contributions set by the Paris Agreement, a daunting task.⁹ Even if the world manages to hold global warming to 1.5 °C (and this is far from assured), we will continue to face climate disruption in the form of more extreme weather for the foreseeable future. And this disruption will create financial risk.

Climate-related financial risk can be divided into two categories: physical risk and transition risk. Physical risk refers to the risk to assets caused by changes in climate and related extreme weather events. Examples of physical risks include weather-induced damage to real property or crops, coastal damage from extreme storms, and wildfire damage. Potential victims of these risks include not only the owners of the affected properties but also their lenders, insurers, employees, and local communities, as well as purchasers of output from these properties. Transition risk refers to the risk to the economy (and economic actors) arising from structural changes as the economy shifts to low-carbon activities. Examples of transition risk include declining value of fossil fuel reserves, declining vitality

of fossil fuel production and service businesses, and the adverse economic impact on sector employees and local communities as well as on fossil fuel commodity prices. Transition risk could pose widespread challenges to the economy as entire industries face restructuring under new regulation and communities lose their main sources of employment and their tax base is reduced.

Unless both physical risk and transition risk are adequately accounted for—both in the portfolios of individual banks and in the potential impact on the overall U.S. financial system—the U.S. economy may experience severe financial shocks from climate change, resulting in extreme economic suffering for many Americans.¹⁰ Vulnerable groups, especially low- to moderate-income (LMI) communities and communities of color, are particularly at risk.¹¹ But the economy is interconnected, and none of us are immune.

The Federal Reserve System (Federal Reserve, or Fed), which is the central bank of the United States, has an important role in addressing this financial risk. The Fed’s goal is “to promote the effective operation of the U.S. economy and, more generally, the public interest” and to carry out five main functions: conducting national monetary policy, promoting financial system stability and minimizing systemic risk, promoting the safety and soundness of individual banks, fostering bank payment and settlement system safety and efficiency, and promoting consumer protection and community development.¹² The Federal Reserve System includes 12 Reserve Banks, also known as District Banks, that carry out the Federal Reserve System’s operations and five functions within their respective geographic areas. Their activities include supervising and examining banks and lending to depository institutions, as well as providing data and research to the Fed’s Board of Governors to help inform monetary policy and other decisions.

Because of its outsize role in protecting the nation’s financial and banking system, the Fed, including the Reserve Banks, has a large role to play in shielding the financial system and individual banks against the economic consequences of the physical impacts of climate change and the necessary transition to a low-carbon economy.

THE FED IS NOT PROACTIVE ON CLIMATE CHANGE BUT IS STARTING TO TAKE ENCOURAGING STEPS

There is growing recognition that the Fed cannot fulfill its mandates to promote the stability of the financial system, maintain the safety and soundness of individual financial institutions, and minimize and contain systemic risks,

as well as promote maximum employment, without due attention to the risks posed by climate change. Governor Lael Brainard (currently Vice Chair of the Fed Board of Governors) stated in 2021 that “it is increasingly clear that climate change could have important implications for the Federal Reserve in carrying out its responsibilities assigned by the Congress.” She cited a recent survey of central banks in which a large majority agreed with the view that it is appropriate “to act within their existing mandate to mitigate climate-related financial risks” that “could potentially impact the safety and soundness of individual financial institutions and could pose potential financial stability concerns for the financial system.”¹³

However, the Fed’s Board of Governors has not, to date, made climate change a strategic priority that is expressly part of its monetary policy work or its other mandates. There was significant movement in 2021, as Chair Jerome Powell stated at the Green Swan Conference in June that “there is no doubt that climate change poses profound challenges for the global economy and certainly the financial system that requires bold steps and decades of sustained efforts.” Powell notably mentioned that the Federal Reserve System was “quite actively exploring exactly what climate implications are for our supervisory, regulatory, or financial stability responsibility” but did not make any specific commitments to address the issue.¹⁴ Powell also reinforced the idea that the broader climate change response is primarily the responsibility of elected officials.

During Powell’s recent renomination hearing, the Fed’s role in addressing certain climate change-related risks was a major point of interest for legislators. In response to their questions, Powell claimed that “climate stress scenarios, as we like to call them, will be a key tool going forward.” He went on to say that these stress tests are necessary to assure that “large financial institutions understand all of the risks that they’re taking, including the risks that may be inherent in their business model regarding climate change over time.”¹⁵ While the hearing generally indicated that the Federal Reserve would be taking steps to increase its action to mitigate climate risks, Powell repeatedly qualified his statements by saying the Fed’s overall role in addressing climate change is limited and that its work on the issue would focus on areas related to its congressionally given mandates.

However, it is fair to say that, at a minimum, the Fed’s execution of its mandates and functions—including executing monetary policy that promotes maximum employment and price stability—must be informed by a recognition of climate risk. While the Fed may ordinarily focus on the medium-term inflation outlook, the chief economist for a central banking and economic policy think tank notes that “central banks consider routinely the policy implications of long-term events such as demographic and technological shifts and their effects on labor force

participation and the broader macroeconomy.”¹⁶ Climate risk is no more long-term than these risks already routinely considered; further, it has the potential to affect all sectors of the economy and all regions of the nation. And transition risk, from the transition to a low-carbon economy, may cause a shift in prices, especially energy prices, that could impact medium-term inflation expectations and short-term price volatility due to global instability.¹⁷ Moreover, the Fed’s mandates include promoting the stability of individual banks and containing systemic risks to the U.S. financial system. As noted throughout this paper, climate change unquestionably poses such risks.

While the Federal Reserve System at large has not created a comprehensive policy to address climate change, the San Francisco Federal Reserve Bank has been a leader in recognizing that the Fed should take account of climate change and its potential risk to the economy. Its president and CEO, Mary C. Daly, stated at a 2019 conference that “in order to meet our mission, we need to study and understand how a changing climate may disrupt the safety and soundness of our economy and financial and payment systems. In turn, we’re assessing how to incorporate these findings into our core functions and mandates, focusing on research, supervision, community, and operations.”¹⁸ She went on to say that “the Federal Reserve’s job is to promote a healthy, stable economy. This requires us to consider current and future risks—whether we have a direct influence on them or not. Climate change is one of those risks.”¹⁹ Other Reserve Banks have not yet, to the same extent, publicly declared incorporating climate change risk as a priority for how they carry out their responsibilities.

OTHER NATIONS’ CENTRAL BANKS HAVE BEEN MOVING MORE QUICKLY

The Federal Reserve System has taken a more public stance on climate change in the past two years, most notably by joining the global Network for Greening the Financial System (NGFS).²⁰ The organization is a global group of central banks and supervisors formed with the purpose of “strengthening the global response required to meet the goals of the Paris Agreement [to limit global warming] and to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development.”²¹ In addition to the symbolic importance of the Fed’s joining this organization, its membership will facilitate a collaboration between Fed personnel and their counterparts at other member central banks on climate financial risk concerns. However, the Fed still lags behind many other central banks on this important issue.

Notably, both the European Central Bank and the Bank of England have announced plans to transform their

financial institutions to address climate change, although, admittedly, their functions and mandates are more closely tied to broader policymaking than are those of the Federal Reserve System, which is largely limited to monetary policy.²² For instance, the Bank of England has begun conducting climate scenario analysis and stress testing as part of its tool kit to “assess the impact of climate-related risks on the UK financial system.”²³ And in July 2021, the European Central Bank announced an action plan to

move forward on climate, adding climate considerations to monetary policy in the areas of disclosure, risk assessment, collateral framework, and corporate sector asset purchases.²⁴

Neither of these institutions has completed its work on climate issues, nor, for that matter, has any central bank, but they have taken more concrete steps than the Federal Reserve System has to date.

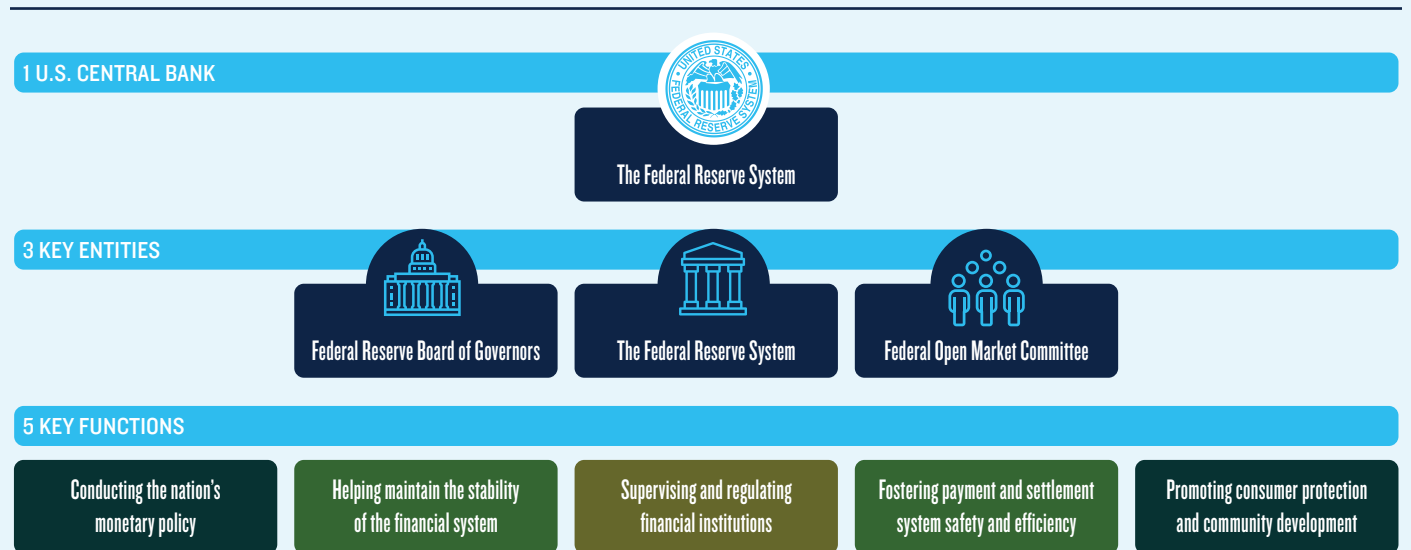
THE ROLE AND STRUCTURE OF THE FEDERAL RESERVE SYSTEM²⁵

The Federal Reserve System was created by the Federal Reserve Act in 1913 after a series of financial crises. Its goal is “to promote the effective operation of the U.S. economy and, more generally, the public interest” and carry out its five main functions, which are to:

1. Conduct the nation’s monetary policy to promote maximum employment, stable prices, and moderate long-term interest rates in the U.S. economy;
2. Promote the stability of the financial system and seek to minimize and contain systemic risks through active monitoring and engagement in the United States and abroad (i.e., macroprudential function);
3. Promote the safety and soundness of individual financial institutions and monitor their impact on the financial system as a whole (i.e., microprudential function);
4. Foster payment and settlement system safety and efficiency through services to the banking industry and the U.S. government that facilitate U.S.-dollar transactions and payments; and
5. Promote consumer protection and community development through consumer-focused supervision and examination, research and analysis of emerging consumer issues and trends, community economic development activities, and the administration of consumer laws and regulations.

The framers of the Federal Reserve System sought to create a decentralized banking system with three key entities: 1) the Federal Reserve Board of Governors, 2) the 12 Federal Reserve Banks, and 3) the Federal Open Market Committee (FOMC). The Board of Governors is an independent agency of the federal government whose members are appointed by the president of the United States. Although the Board of Governors has frequent communication with the president and is overseen by Congress, its decisions are made independently. The 12 Federal Reserve Banks are the “operating arms of the Federal Reserve System” and are overseen by the Board of Governors. The FOMC consists of the members of the Board of Governors and the Reserve Bank presidents. The chair of the Board, currently Jerome Powell, is also the FOMC chair. Depository institutions such as banks, thrifts, and credit unions, as well as Federal Reserve System advisory committees, also contribute to the Federal Reserve System’s operations and functions. Figure I summarizes the structure and functions of the Federal Reserve System:

FIGURE I: STRUCTURE AND ROLE OF THE FEDERAL RESERVE SYSTEM



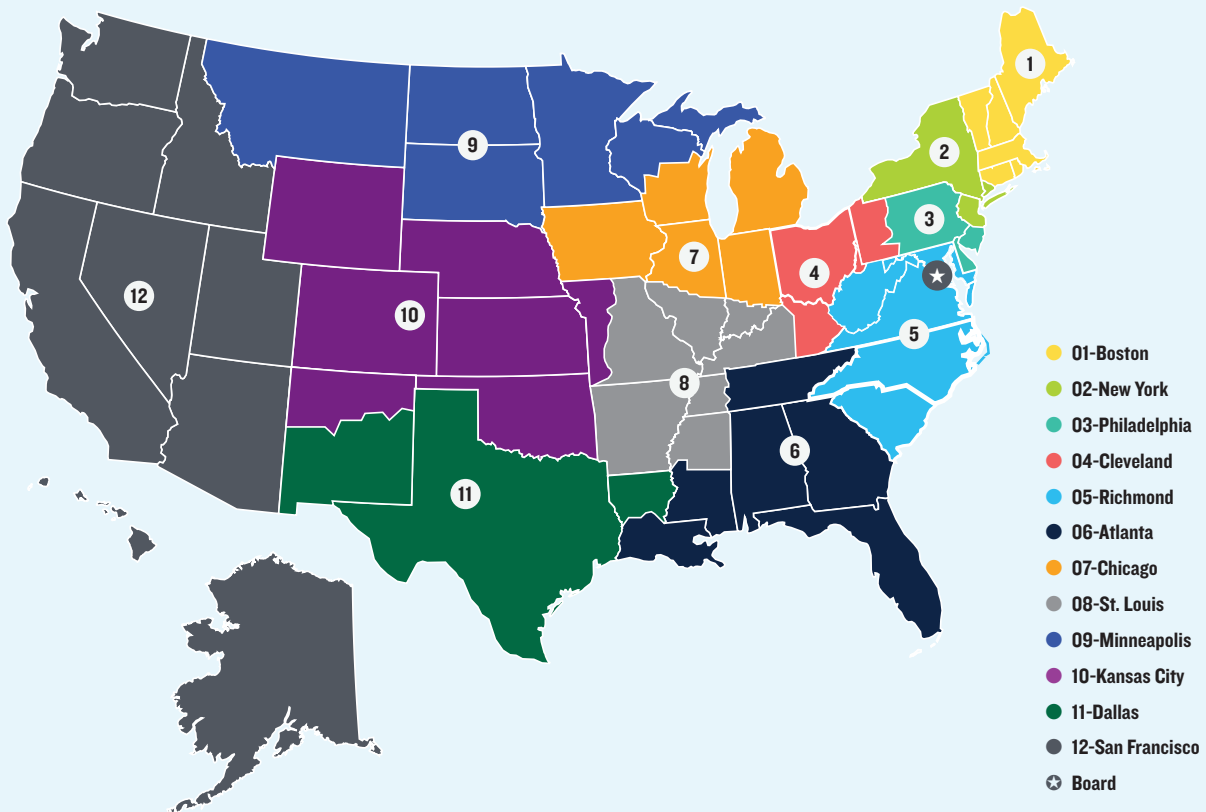
Source: Board of Governors, Federal Reserve System.²⁶

Structure and Role of the 12 Reserve Banks in Policymaking

Due to the importance of a banking system with autonomy as described in the Federal Reserve Act, Reserve Banks operate independently. Each is separately incorporated and has a president appointed by its own nine-member board of directors. Six of these board members are appointed by commercial banks that are members of the Federal Reserve System, while the three remaining directors (all from within the Reserve Bank's jurisdiction) are appointed by the Board of Governors. The boards of directors oversee management and activities of the Reserve Banks and provide insights into local economic conditions. Most Reserve Banks have at least one branch, with each branch having its own board. The Board of Governors also appoints a chair and deputy chair from members of each Reserve Bank's board.

Reserve Banks carry out the Federal Reserve System's operations and five functions within their respective geographic areas, shown in Figure 2. Reserve Banks do this by supervising and examining member banks, lending to depository institutions, providing key financial services, and examining certain financial institutions to "enforce compliance with federal consumer protection and fair lending laws." Importantly, Reserve Banks provide data and research to the Board of Governors that help inform critical monetary policy decisions and perform other functions such as promoting community development. The Reserve Banks also conduct research on local, regional, national, and international issues that play a critical role in bringing broad economic perspectives to policy.

FIGURE 2: MAP OF THE TWELVE FEDERAL RESERVE BANKS AND THEIR DISTRICTS



Source: Board of Governors, Federal Reserve System.²⁷

HOW THE FED AND, MORE SPECIFICALLY, THE DISTRICT RESERVE BANKS CAN USE THEIR TOOLS TO ADDRESS ECONOMIC RISK FROM CLIMATE CHANGE

How can the Fed—and in particular the Reserve Banks—use their tools to address the economic risk presented by climate change? To begin to answer this question, we first reviewed 40 years of the Fed’s Beige Book reports, from 1980 through 2019, to see how they have talked about climate-related economic events in the past. We then set forth the steps the Reserve Banks should take across their full suite of tools to effectively incorporate climate change risk into execution of their mandates.

The Beige Books—formally known as the Summary of Commentary on Current Economic Conditions by Federal Reserve District—are qualitative and anecdotal reports that summarize information on the current economic conditions within each of the 12 Federal Reserve districts. They are published by the Federal Reserve eight times per year.²⁸ These reports—described by a former Fed official as akin to asking your uncle—typically include information about employment and prices in a district’s major industries, which may include construction, agriculture, real estate, manufacturing, and retail, and their contents are a reflection of what each Reserve Bank finds important or notable.²⁹ An overall summary of all 12 district sections is also prepared by a “designated Federal Reserve Bank on a rotating basis.”³⁰

To collect accurate information for each report, Reserve Bank researchers both gather reports from their bank and branch directors and conduct surveys and interviews of industry contacts within their district.³¹ These contacts include business leaders, economists, and other industry experts. Information collected through contacts is usually confidential, and reports discuss economic trends or quote sources without attribution. Beige Book reports help inform monetary policy in conjunction with quantitative economic research, forecasting, modeling, and data collection.

The Beige Books date back to 1970. Arthur Burns, the Fed chairman at that time, proposed that these written reports—initially called Red Books to match their red covers—be distributed at the Fed’s interest rate setting meeting in lieu of oral reports delivered by each of the 12 District Bank presidents. For a number of years, the Red Books were not available to the general public. That changed in 1983. Walter Fauntroy, the District of Columbia’s representative in Congress and chairman of the House Subcommittee on Domestic Monetary Policy, requested that the Fed publish another internal document known as the Green Book, which contained a staff economic forecast. The Fed was concerned that this would telegraph

its monetary policy decision ahead of the Fed meeting. So as a compromise, they agreed that the Red Book (renamed the Tan Book, and later the Beige Book) would be published instead two weeks ahead of the meeting. Because of the two-week interval, the Fed figured that the information would be stale as a predictor of the Fed committee’s monetary policy decision (intervening information could change the meeting outcome). That practice has continued to this day.³²

For this report, we looked at Beige Books from January 1980 through November 2019, focusing primarily on four districts with high exposure to four emerging consequences of climate change—more frequent and intensifying hurricanes, drought and increased precipitation, wildfires (and focusing on the periods of these extreme weather events), and the transition away from fossil fuels. We selected the Atlanta (Sixth) District, which is expected to see disproportionate impacts from hurricanes because of its proximity to the southern Atlantic and Gulf coasts; the Kansas City (Tenth) District, which is expected to suffer disproportionate impacts from drought because of the outsize effect of drought on agriculture; the San Francisco (Twelfth) District, which is expected to see increasing exposure to wildfires; and the Dallas (Eleventh) District, whose local oil and gas industry is expected to feel disproportionate impacts from the transition away from fossil fuels. However, as we discuss below, these consequences are not limited to these particular districts, and each section includes discussion of how climate risks will affect a number of district economies.

We examined the Beige Books with a view toward assessing the extent to which they discuss the economic impacts of these extreme weather events, likely trends if climate change accelerates as projected, and potential adaptation measures, as well as the evidence (or lack of evidence) of a transition away from fossil fuels.³³

In sum, we find the Beige Books include discussion, most of all, of the harmful economic effects of hurricanes, less so of droughts (or flooding), and least of all of wildfires. In some cases, the Beige Book includes more discussion of positive local economic benefits following natural disasters in the form of rebuilding and replacing lost goods and capital than it does of economic and social losses. There appears to be little to no discussion about the possibility that these events likely will intensify due to climate change, nor of adaptation efforts. Discussion of the fossil fuel industry tends to be focused on short-term trends, with little consideration of the possibility or likelihood of a transition to a low-carbon economy.

We believe these omissions deprive the Fed of input that could inform its consideration of policy initiatives to address the economic risks from climate change and limit



Federal Reserve Bank of Kansas City.

its ability to provide useful information to the public. Given the Beige Book’s unique role as a source of current and forward-looking economic assessments furnished by local businesspeople, bankers, and other leaders (unlike most other data collection, which is inherently backward-looking), the Beige Book authors should be canvassing economic actors across the country about how they are considering and planning to adapt to the rippling effects of climate change. As the Beige Books are part of the information made available to the Board of Governors, these proactive efforts would inform the Fed’s decision-making process at both the district and federal levels. In addition, because the news media use Beige Books as a reporting source, this information could potentially help communities understand and prepare for the harsher economic impacts of climate change. This paper makes additional recommendations about steps the Reserve Banks can take relating to both system-wide and individual institutions’ financial risk from climate change.

Consistent with the Fed’s recent efforts to incorporate equity into its economic considerations, we also discuss equity as an important component of the Fed’s evolving focus on climate change-related risks. The Fed’s mandates to promote maximum employment, stable prices, and community development cannot be successfully addressed if large swaths of our society are left behind. Further, to carry out its Community Reinvestment Act (CRA) regulatory oversight responsibilities, the Fed must understand how banks will need to adapt lending and service strategies for LMI communities as climate change impacts their financial well-being.

Climate change poses a clear risk to U.S. economic and financial systems. The goal of this report is to help inform policy and to recommend specific steps to enable the Fed and the Reserve Banks to address this risk and, ultimately, to avoid severe economic damage and financial crises and the human harm they would cause.

Hurricanes

BACKGROUND ON HURRICANES

Hurricanes, defined by NOAA as a type of tropical cyclone with sustained winds exceeding 74 miles per hour, make landfall in the United States every year.³⁴ Sixteen of the 20 most damaging hurricanes (by inflation-adjusted cost) to strike the United States in the last four decades have occurred in the last 20 years (Table 1).³⁵ In 2022 dollars, Hurricane Katrina cost \$182.5 billion and Hurricane Harvey cost \$141.3 billion.³⁶ Although hurricanes have damaged coastal infrastructure and habitats for many years, scientists note in the Fourth National Climate Assessment that “in a warmer world there will be a greater potential for stronger tropical cyclones in all ocean basins.”³⁷ The 2020 Atlantic hurricane season alone produced a record-

breaking 30 named storms (the 1991–2020 average was 14).³⁸ These included seven major hurricanes with winds of more than 111 miles per hour.³⁹

If hurricanes are more frequent, there is less time between them to repair damage and rebuild. The storms, along with other unpredictable climate shocks, can be expected to increasingly impact supply chains and affect industries, employment, and prices.⁴⁰ As sea levels continue to rise, if there is inadequate adaptation and resilience-building, these hurricanes likely will cause even more damage throughout the United States, but especially in districts like Atlanta and Dallas, which include the Gulf and Florida Atlantic coasts.

TABLE 1: 20 COSTLIEST HURRICANES, 1900–2021

Tropical Cyclone	Year	Category	Adjusted Costs
Katrina	2005	3	182.5
Harvey	2017	4	141.3
Maria	2017	4	101.7
Sandy	2012	1	80.0
Ida	2021	4	75.0
Irma	2017	4	56.5
Andrew	1992	5	54.3
Ike	2008	2	39.6
Ivan	2004	3	30.8
Wilma	2005	3	27.7
Michael	2018	5	27.5
Rita	2005	3	27.0
Florence	2018	1	26.4
Charley	2004	4	24.0
Hugo	1989	4	20.4
Laura	2020	4	20.3
Irene	2011	1	17.0
Frances	2004	2	14.7
Agnes	1972	1	14.0
Allison	2001	TS	13.5

Dollar values are based on the 2022 Consumer Price Index adjusted cost. *Source: NOAA, Costliest U.S. Tropical Cyclones.*⁴¹



An aerial view of homes in a flooded neighborhood the day after Hurricane Katrina hit New Orleans, Louisiana, on August 30, 2005.

HURRICANES IN THE BEIGE BOOK

Beige Book reports show an increase in disruptions to economic activity due to hurricanes over time. We focus here on Beige Book reports from districts facing the highest threat of hurricanes and tropical storms, such as Atlanta and Dallas, but also include entries from other impacted districts.⁴² The mention of hurricanes in Beige Books is typically tied to devastating economic as well as human impacts. These destructive weather events heavily influence local employment and national prices. Paradoxically, hurricanes can lead to an uptick in the building trades and retail markets because of the need to restore the physical losses. At times, Beige Book reporting seems to unduly emphasize these positive economic effects of rebuilding and replacing what was lost in the storm. But this is not a recommended formula for long-term economic growth. Rather, Beige Books should take a more forward-looking approach by surveying how businesses and homeowners plan to adapt to the increased likelihood of severe hurricanes.

There is no mistaking the devastating impact of the biggest storms in the Beige Book reports. In the wake of Hurricane Katrina, the costliest storm on record, the October 2005 Beige Book was dominated by discussion of its impact. Dislocation of employees and the destruction of business facilities severely disrupted economic activity throughout Louisiana and Mississippi. Regarding employment, in the October 2005 Beige Book section discussing the Atlanta's District, "contacts reported that employee dislocation

presented significant problems for businesses that were reestablishing operations in the affected areas." Energy production also took a severe hit, the same Beige Book section noting that "through the first week of October nearly 90 percent of normal pre-storm oil production and more than 70 percent of natural gas production remained off-line."⁴³

The physical and economic destruction of Hurricane Katrina is an object lesson in how structural racism embedded in American society continues to afflict the lives of the most disadvantaged.⁴⁴ As New Orleans developed, white control over land ownership forced Black communities into areas of "low elevations with high exposure to back-swamp flooding and poor access to transportation."⁴⁵ This longstanding practice of segregating Black communities into isolated and flood-prone areas is a major cause of the racial disparities seen in storm damage.

In the early twentieth century, an industrial canal was constructed in New Orleans to provide a shortcut between the Mississippi River and the Gulf of Mexico. The canal isolated the predominantly Black Lower Ninth Ward from the rest of the city and increased the threat of flooding in that portion of the city.⁴⁶ On the morning of August 28, Hurricane Katrina drove a mound of seawater to break the levee in the industrial canal, which caused a destructive 14-foot-high wall of water to spill into the Lower Ninth Ward.⁴⁷

The mass of seawater permeated the entire community and left a wake of destruction in its path. The houses that weren't swept off their foundations were devoured by mold. Entire neighborhoods were bulldozed away, resulting in "the largest demolition of a community in modern U.S. history as whole... it is estimated that of 220 square blocks from Claiborne Avenue to the Bayou, only 140 homes were left—and most of those uninhabitable."⁴⁸

Katrina was a devastating natural disaster to the Southeast despite that, to some extent, that region expects and prepares for a disruptive hurricane season each year.⁴⁹ In 2012, less than a decade after Katrina, Hurricane Sandy shocked the Northeast, a region unprepared for a storm of its magnitude, and wreaked nearly \$80 billion (2022 dollars) in damage. In the wake of Sandy, the New York Fed noted in the November Beige Book that "virtually all contacts in the New York City area report some loss in business due to storm-related disruptions [and] many homes along the New York City, Long Island and New Jersey shorelines were severely damaged or destroyed." The storm demolished at least 650,000 homes and affected 300,000 business properties.⁵⁰ In New York City alone, the storm inflicted \$19 billion in damage and lost economic activity, damaged 69,000 residential units, and displaced thousands of residents.⁵¹

Less than five years after Sandy, Hurricane Harvey ripped through the Gulf of Mexico and stalled over Texas, dumping 27 trillion gallons of water on Texas and Louisiana over a six-day period in 2017. It was estimated that nearly 30,000 people were displaced by the storm and needed temporary shelter.⁵² According to a survey done three years later by the University of Houston, 20 percent of respondents that had been displaced by Hurricane Harvey were still in temporary housing.⁵³ The damage and displacement caused by Harvey had a clear economic impact, with Dallas's section of the October 2017 Beige Book noting that "reports of labor shortages persisted, spanning most industries. Some manufacturers said the difficulty finding workers was impeding their growth. More than a quarter of firms expect that the impact of Hurricane Harvey will make finding and hiring workers more difficult over the next six months."

Not a year later, Hurricane Michael struck the Florida Panhandle as a category 5 hurricane, making it one of the strongest storms ever to make landfall on the northern Gulf Coast.⁵⁴ In December 2018, the Atlanta section of the Beige Book reported that "Hurricane Michael reduced employment among firms in northwest Florida, and several businesses have not returned to pre-hurricane employment levels." Hurricane Michael, which occurred in October 2018, was still affecting agriculture and other industries into 2019. According to the Atlanta section of the Beige Book for January 2019, "The USDA designated some counties in Alabama, Florida, Georgia, and Mississippi as natural disaster areas due to damages and losses attributed to Hurricane Michael, Tropical Storm Gordon, and flooding."

While hurricanes like Katrina, Sandy, Harvey, and Michael have major physical effects on the regions where they make landfall, their economic effects—like harm to interconnected supply chains, employment, and prices—can be felt throughout the country. Katrina, for example, caused the shutdown of oil and gas pipelines along the East Coast. For the most part, Beige Book reporting after these events reflects the widespread effects of extreme storms, from the destruction of housing and widespread worker displacement to the stoppage of manufacturing activities and the disruption of supply chains. For instance, following Hurricane Harvey, the October 2017 Beige Book section for Richmond—which experienced no direct impacts of the storm—noted that "prices rose moderately, partially due to supply chain disruptions from the hurricane." During this same period, Richmond also experienced disruptions to tourism, Boston noted disruptions in manufacturing, Cleveland mentioned capacity constraints in the nonfinancial services sector, and San Francisco noted a slowing of activity in residential real estate and construction due to shortages of materials.

Labor, housing, and supply chain issues are predictable consequences of hurricanes. Regional Federal Reserve boards should expect these economic effects and prepare for them to get worse. According to current climate science predictions, hurricanes along the south Atlantic and Gulf coasts are expected to increase in frequency and intensity in the coming years. NOAA suggests that "the global proportion of tropical cyclones that reach very intense (Category 4 and 5) levels is projected to increase (medium to high confidence) due to anthropogenic warming over the 21st century."⁵⁵ Furthermore, the Fourth National Climate Assessment, a congressionally mandated report by the U.S. Global Change Research Program, states that "increases in greenhouse gases and decreases in air pollution have contributed to increases in Atlantic hurricane activity since 1970. In the future, Atlantic and eastern North Pacific rainfall and intensity are projected to increase."

Awareness and Adaptation: Beige Books can be most effective as a means of increasing awareness of the economic impacts of climate change—both at the Board of Governors level and, through the news media, among the public—and circulating information about adaptation techniques. In the context of hurricanes, Reserve Bank leadership, particularly in the Atlanta and Dallas Districts, should use the Beige Books as a tool to increase awareness of the economic impacts of climate change through interviews and data collection and to identify adaptation techniques used by businesses and residents to deal with intensifying hurricanes and storms. As noted above, the Beige Books illustrate that intense hurricanes harm parts of the country far beyond where the hurricanes hit. For this reason, the proactive work that districts such as Atlanta and Dallas should be conducting to prepare for hurricanes is important not only to their regional well-being but also to the national economy.

Rainfall Extremes and Agriculture

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A Wyoming Big Sagebrush can live for an average of 42 years once it forms a deeply rooted system. Because of the increase in droughts, these seedlings are finding it harder to prosper and survive, despite being one of the most drought tolerant Big Sagebrush subspecies.



© Dave Kosling/USDA

Drought stricken crops at The McIntosh family farm in Missouri Valley, Iowa.

BACKGROUND ON RAINFALL EXTREMES AND AGRICULTURE

Climate change is already being felt in the nation’s agricultural regions. Agriculture is, of course, dependent on favorable weather free from droughts and severe flooding. Rising temperatures, altered storm circulation patterns, and reduced snowpack volumes threaten to increase the frequency and severity of droughts, especially in the southwestern United States.⁵⁶ Droughts have hurt the U.S. economy significantly, causing \$249.7 billion in damage since 1980 and averaging \$9 billion in damage each year since 2010.⁵⁷ The Fourth National Climate Assessment states that “significant U.S. seasonal precipitation deficits are not confidently projected outside of the Southwest. However, future higher average temperatures will likely lead to greater frequencies and magnitudes of agricultural droughts throughout the continental United States.”⁵⁸

Nationally, in addition to rising temperatures threatening water availability, climate change is driving a shift in weather patterns that will have an impact on ecosystem health and agricultural productivity. For instance, chronic heat stress can cause increases in crop disease and pest outbreaks, and frequent flooding can lead to soil erosion and degraded water quality.⁵⁹ These changes to growing conditions throughout the United States threaten the stability of the agricultural sector and the livelihood of its workers. For instance, it has been projected that, due to increasing heat exposure, among U.S. crop workers, “the average number of days spent working in unsafe conditions

will double by mid century, and, without mitigation, triple by the end of it.”⁶⁰ Furthermore, the effects of climate change are highly localized. While some regions may experience increasing drought conditions, others may experience more extreme rain and other precipitation, which elevates the risk of surface runoff, soil erosion, and loss of soil carbon.

This variation in weather plays a crucial role in the agricultural economy—for example, in determining crop prices in the short term.⁶¹ Severe and prolonged periods of drought or excessive precipitation due to climate change can make it difficult to maintain crop yields, leaving farmers with less product to sell. Lower yields can lead to higher prices, which can hurt consumers both in the United States and abroad and work against the Fed’s price stability mandate and goals. If these consumers are less likely to buy U.S. agricultural products due to increases in prices, this decrease in demand could further hurt farmers. A decline in agricultural productivity would also have major consequences for the rural communities where agriculture is the bedrock of economic activity. Generally, farm income tends to decrease and loan delinquencies tend to increase as the number and duration of severe droughts increase.⁶²

Agriculture in the Dallas, Kansas City, Atlanta, and San Francisco Districts is especially susceptible to changes in regional temperatures and precipitation levels due to climate change.⁶³ In the Great Plains, which encompasses

most of the Kansas City and Dallas District economies, rising temperatures and extreme drought conditions in the more southern states such as Kansas, Oklahoma, and Texas are expected to lead to greater evaporation and surface-level water loss, threatening the water supply needed to irrigate crops.⁶⁴ At the same time, in the northern portion of the Great Plains, in states such as Nebraska and the Dakotas, climate change is projected to lead to unusually heavy precipitation in the winter and spring. This can increase flooding and runoff, which reduces water quality and causes soil erosion.⁶⁵ The impact of the changes in weather patterns will have major implications for the sizable agricultural economies of these regions. In 2016, Kansas City's Tenth District had nearly 30 percent of the country's agricultural banks and 60 percent of its agricultural counties.⁶⁶ In Dallas's Eleventh District economy, 86 percent of Texas land is used in some form of agricultural production, and one out of every seven working Texans is employed in the agricultural industry.⁶⁷

Atlanta's Sixth District economy will likely face a similar array of issues as a result of the changing climate; the Southeast has experienced an increase in the frequency and intensity of heavy downpours since the 1980s, and this trend is expected to continue.⁶⁸ For example, the Fourth National Climate Assessment notes that "the number of days with 3 or more inches of precipitation has been historically high over the past 25 years, with the 1990s, 2000s, and 2010s ranking as the decades with the 1st, 3rd, and 2nd highest number of events [since 1900], respectively." It further notes that "climate model simulations of future conditions project increases in temperature and extreme precipitation for both lower and higher scenarios."⁶⁹ While parts of the Sixth District, such as Georgia, Tennessee, and Alabama, are expected to experience some very wet periods, flooding, and soil erosion due to increased rainfall, the southernmost portions of the district, including Florida and parts of Louisiana, may experience increased drought conditions. Across the Southeast, soil erosion and increased temperatures will affect the Sixth District's agricultural economy and potentially the national price and availability of food. In Atlanta's Sixth District economy, Georgia and Florida lead the nation in production of citrus crops, peanuts, and broiler chickens.⁷⁰

San Francisco's Twelfth District economy faces a similar increase in temperatures and drought conditions that are likely to threaten the surface water and groundwater supplies needed to irrigate this agriculturally rich region. The Twelfth District includes the Central Valley in California, one of the most productive agricultural areas in the country. In the state as a whole, about 79 percent of water use is for irrigation. California is already facing drought issues, and average annual temperatures in the Southwest are projected to rise an additional 3.5 to 9.5 °F by the end of this century.⁷¹ Worsening drought could hinder California's ability to continue producing

agricultural goods at current levels. The other Southwest states in the Twelfth District, Arizona, Nevada, and Utah, are likely to face similar issues.

The northeast portion of the Twelfth District (Oregon, Washington, and Idaho) could also face water supply challenges, as increased winter and spring temperatures could limit snowpack volume—the principal source of water for this mountainous region. At the same time, rainfall may not be able to make up for the difference in lost snowmelt because summer precipitation is expected to decline in this region by as much as 30 percent by mid-century, further limiting water availability.⁷² This could hinder the production of the region's iconic crops, such as apples in Washington and potatoes in Idaho.

The Twelfth District makes a significant contribution to the nation's agricultural goods, and the district's agricultural sector makes up a large portion of the nation's economy. Over a quarter of the land in California, Oregon, Washington, and Idaho is used for farming, and California is the state with the highest value of agricultural cash receipts: \$49.1 billion in 2019.⁷³ For this reason, addressing climate change's impacts on agriculture in the Twelfth District is especially important for stabilizing regional employment and national prices.

RAINFALL EXTREMES AND AGRICULTURE IN THE BEIGE BOOK

As noted above, climate change is projected to lead to increased frequency of drought and extreme precipitation, which would impact regional agricultural production and employment and impose increasing costs on farmers and consumers. The Federal Reserve Bank of Kansas City released a report in 2020 detailing the economic impact of recent droughts on farmers and the rising threat that droughts could pose due to climate change. The authors found, on the basis of recent drought data, that "farmer losses from extreme drought can reach 20 percent of production value for corn and wheat and 35 percent for soybeans."⁷⁴ The report went on to state that "amplified climate and drought variability is likely to depress yields and increase stress for the agriculture sector in the coming decades."⁷⁵ The acknowledgment of increasing risk of drought to the agricultural sector is an important step in developing Fed strategies to maintain stable prices and employment. However, there is more the Fed can do to address the rising threat of drought, including Beige Book data collection and reporting.

The Beige Book reports make clear the impact of drought and dry weather on prices. During the height of the 2011–2012 Midwest drought, the most intense period of drought in Kansas since 2000, the Kansas City section of the August 2012 Beige Book stated that "agricultural conditions deteriorated as crops withered under extreme drought. The majority of the corn and soybean crops were rated in fair or poor condition, cutting production estimates and sending



Aerial views of Colorado farmland suffering from drought, 71 miles east of Denver, Colorado.

crop prices to record highs.⁷⁶ While this particular period of drought was extreme, this excerpt is an informative example of how the Beige Book provides snapshots of the effects of drought on agricultural production and crop prices.

The San Francisco sections of the Beige Books discuss economic effects of drought to some extent. But considering the frequency and severity of droughts in the Southwest, and in California in particular, mentions of prolonged droughts in the district's Beige Book reports are surprisingly infrequent and understated, an area to consider modifying for future reports to help the San Francisco Reserve Bank work toward its strategic climate priority. In the midst of California's most widespread drought since 2000, the San Francisco section of the July 2014 Beige Book noted that "drought conditions contributed to reduced production of some agricultural and resource-related goods." It also noted that "food price inflation has risen, driven by higher price inflation for beef, pork, and dairy items, as drought conditions in California constrain supplies."⁷⁷ While these statements may be an accurate reflection of economic conditions at the time, they may not fully convey the gravity of a historically intense drought that afflicted nearly 60 percent of California's land area.⁷⁸

Awareness and Adaptation: The Beige Books should build awareness of the economic effects of worsening droughts in some areas and increasing precipitation in others by surveying farmers about the harmful effects they are experiencing and noting the trends they are seeing. This will inform the Board of Governors' consideration

of appropriate policy interventions and allow farmers to take adaptive measures to alleviate, as best they can, the harmful economic effects of changing growing conditions on production. As the impacts of climate change cannot be predicted precisely and will vary by region, the Beige Books could serve as a useful source of information for its audiences to demonstrate, at least anecdotally, how climate change is affecting growing conditions in different regions. In addition, the District Banks should undertake research or host convenings on what adaptive agricultural techniques could be or already are successful.

By way of illustration, the U.S. Department of Agriculture has published some suggested techniques for farmers to consider when adjusting their farming practices under the threat of climate change. For instance, to adapt to higher temperatures, growers could select heat-resistant or drought-resistant crops, or those that thrive in longer growing seasons with higher temperatures. To adapt to more extreme precipitation events, growers could diversify existing annual cropping systems with new combinations of crop species more resistant to higher peak flows, runoff velocities, and erosion. Additionally, incentivizing farmers to adopt low-risk and water-efficient practices like cover cropping, no-till farming, and drip irrigation would help make the agricultural sector more resilient to climate change at a low cost.⁷⁹ Updating farming practices, maintaining biodiversity, and enhancing landscape connectivity will help to reduce the susceptibility of agriculture's individual components to weather events like flooding and drought.⁸⁰ The Beige Books can help by canvassing local farmers about emerging practices.

Wildfires

BACKGROUND ON WILDFIRES

Wildfires afflict the entire United States, but especially the western part of the country. California, Oregon, Montana, Washington, and Arizona were the top five states in acres burned by wildfires in 2021.⁸¹ According to the U.S. Forest Service, more than 73,000 wildfires burn more than seven million acres of federal, state, tribal, and private land and destroy more than 2,600 structures each year.⁸² Researchers note that fires have been increasing in frequency and severity over time due to prolonged droughts and record heat waves.⁸³ Since 1984, nearly all

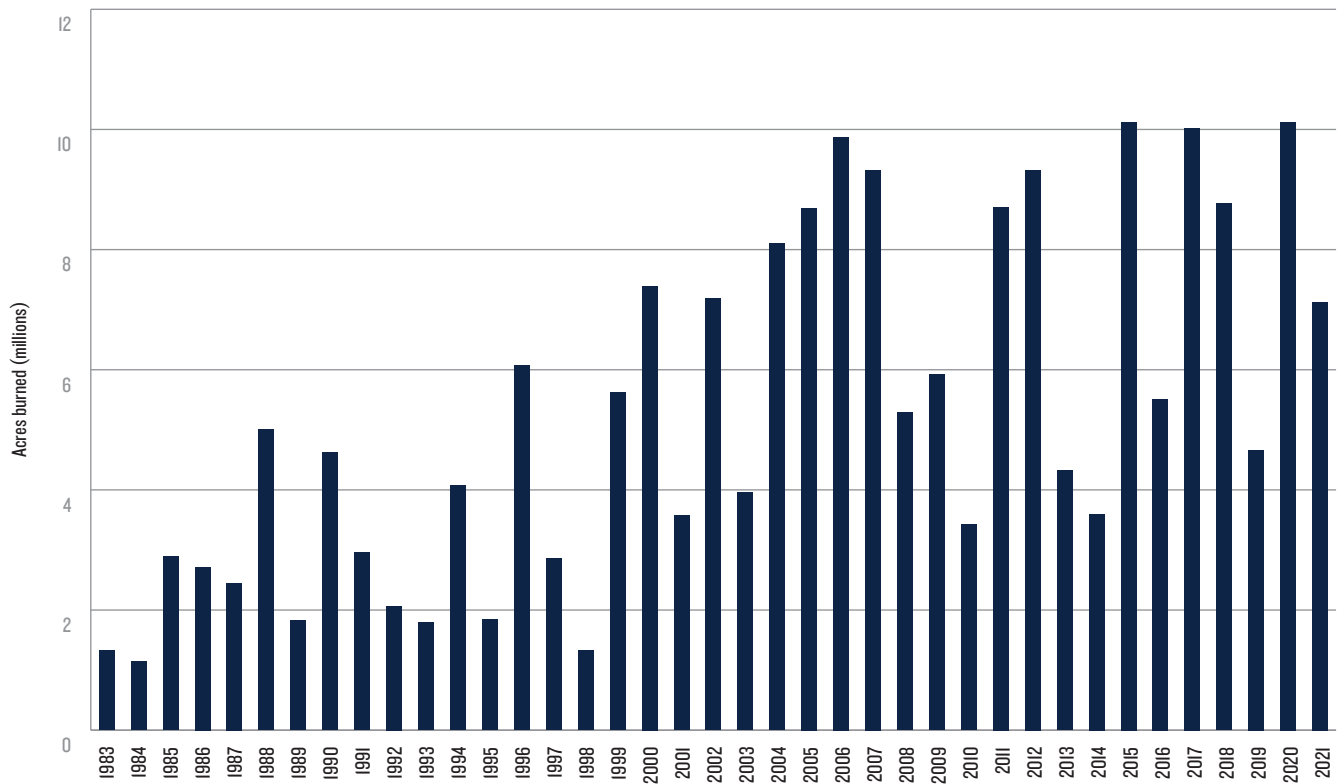
regions of the western United States have seen an uptick.⁸⁴ Between 1980 and 2021, there have been 19 wildfire events in the United States causing at least \$1 billion in damage (Consumer Price Index-adjusted), 16 of which have occurred since 2000 and 13 since 2005.⁸⁵ All but two of the ten most costly wildfires, measured by estimated insurance loss, have occurred during the last five years, as noted in Table 2 below. Additionally, all 10 of the costliest wildfires in the United States have occurred in California. Figure 3 shows the acreage burned in wildfires by year.⁸⁶

© California Department of Forestry and Fire Protection (CAL FIRE)



Flames from the Caldor Fire burn through a forest in El Dorado County, California, 2021.

FIGURE 3: ACRES BURNED IN WILDLAND FIRES, 1980–2020



Source: Insurance Information Institute, *Annual Number of Acres Burned*.⁸⁷

TABLE 2: COSTLIEST WILDLAND FIRES IN THE UNITED STATES THROUGH 2021

Rank	Year	Name	Location	Estimated Insured Loss (million \$)	
				Dollars When Occurred	2021 Dollars
1	2018	Camp Fire	Butte County, CA	\$10,000	\$10,750
2	2017	Tubbs Fire	Napa, Sonoma, Lake Counties, CA	\$8,700	\$9,560
3	2018	Woolsey Fire	Los Angeles, Ventura Counties, CA	\$4,200	\$4,520
4	1991	Oakland Fire (Tunnel)	Alameda County, CA	\$1,700	\$3,350
5	2017	Atlas Fire	Napa County, CA	\$3,000	\$3,300
6	2020	Glass Fire	Napa, Sonoma Counties, CA	\$2,950	\$3,070
7	2020	CZU Lightning Complex Fire	San Mateo, Santa Cruz Counties, CA	\$2,500	\$2,600
8	2017	Thomas Fire	Ventura, Santa Barbara Counties, CA	\$2,250	\$2,470
9	2007	LNU Lightning Complex Fire	Lake, Napa, Sonoma, Solano, Yolo Counties, CA	\$2,250	\$2,340
10	2020	Witch Fire	San Diego County, CA	\$1,600	\$2,080

Source: Insurance Information Institute, *Top 10 Costliest Wildland Fires*.⁸⁸

The general increase in acreage burned and cost over time is likely attributable to climate change.⁸⁹ Rising temperatures and more frequent drought contribute to the increasing frequency and intensity of wildfires. And daily temperatures in the western United States are reaching record levels, with areas in Oregon and Washington even climbing to 118 °F in June 2021, respectively setting and tying an all-time high for the two states.⁹⁰ More wildfires means more firefighting expenses. For example, in 1985, federal firefighting costs for suppressing wildfires were about \$239 million (\$408 million in 2020 dollars), while in 2020 these costs reached about \$2.27 billion.⁹¹

The Twelfth District economy is particularly exposed to worsening wildfire risk. A San Francisco Reserve Bank report estimates that the share of regional GDP with elevated wildfire exposure in the district could rise to more than 60 percent by 2040, compared with 52 percent exposure in 2018.⁹² Translating this into projected dollar risk, the report's researchers estimate that wildfire exposure in 2040 will be either \$4.0 trillion or 4.4 trillion, depending on assumptions, compared to \$2.1 trillion in 2018.⁹³ Other regions of the United States are projected to see only modest changes from 2018 (GDP exposure flat or slightly declining).

The increasing extent and frequency of wildfires has major economic implications. First, there is damage and risk to property caused by wildfires—nearly \$28 billion in capital losses in California alone in 2018, including damage to both homes and businesses.⁹⁴ Second, wildfires can indirectly disrupt a wide range of economic activities and displace hundreds of thousands of Americans during fire season. For example, of the nearly \$150 billion in damage estimated to have been caused by California's 2018 wildfires, approximately 60 percent was indirect economic loss caused by externalities such as interruptions to transportation systems, air quality issues, and reduced tourism and recreation.⁹⁵ Finally, during periods of increased wildfire risk, electric utilities have taken to shutting off power to hundreds of thousands of households and businesses to reduce the likelihood of igniting a wildfire. While effective at preventing fires, these disruptions cause closures of businesses and interruptions to public services.⁹⁶ For example, one precautionary power shutoff in October 2019 was estimated to cost California's economy as much as \$2.5 billion.⁹⁷

WILDFIRES IN THE BEIGE BOOK

Wildfires are rarely mentioned in Beige Book reports despite ample evidence that they directly and indirectly affect a wide range of economic activity. For example, in

2018 the San Francisco section of the Beige Books did not include any mentions of wildfires, despite the fact that 2018 was the deadliest and most destructive wildfire season on record in California.⁹⁸ The 2018 fire season included the Camp Fire, the worst wildfire in California history and one of the world's costliest natural disasters in 2018.⁹⁹ The first Beige Book mention of wildfires following the devastating Camp Fire and the overall 2018 wildfire season came in the March 2019 Beige Book, which stated that "the California utility sector observed modest upward pricing pressures for electricity rates due mainly to higher financing costs following recent wildfires."¹⁰⁰ While presumably accurate, this does not seem to be enough discussion to fully capture the magnitude of the impact wildfires had on the Twelfth District economy.

The 2020 wildfire season was similarly extreme, especially in California and the Pacific Northwest. That year, the California Department of Forestry and Fire Prevention noted that "nearly 10,000 fires burned over 4.2 million acres in California alone, more than 4 percent of California's roughly 100 million acres of land, making 2020 the worst wildfire season in California's modern history."¹⁰¹ California's August Complex fire in 2020 has been described as the first "gigafire," as the area burned exceeded 1 million acres.¹⁰² In the Beige Books following this historic fire event, discussion of wildfire impacts was somewhat more robust than in previous editions yet still provided only a narrow view of wildfire's economic impacts. In the midst of the August Complex fire, which burned from August through November, the October 2020 Beige Book stated, "Contacts expressed some concern over the undersupply of affordable housing, especially after some regions suffered from wildfire-led destruction."¹⁰³ In the same Beige Book, the authors wrote that in California and the Pacific Northwest, "hiring for lower-paid positions especially lagged ... partly due to smaller labor supply as people fled from wildfires."¹⁰⁴ These observations are likely to grow more common as wildfires become more frequent and intense. The Beige Book's survey methodology is well suited to capture on-the-ground inflection points as climate change affects economic conditions across District economies.

Awareness and Adaptation: Consistent with the San Francisco Reserve Bank's laudable public stance and research on the economic risk of climate change and wildfires, the Bank should consider collecting and publishing far more survey information on wildfire economic impact and adaptation strategies in the Beige Books. This public outreach to understand the economic effects of wildfires on local residents and businesses and their adaptation techniques would be a useful complement to the research that the bank is already undertaking.

Transition Risk and Fossil Fuels

BACKGROUND ON TRANSITION RISK AND FOSSIL FUELS

The U.S. economy, and that of the Dallas Federal Reserve Bank District in particular, relies heavily on producing and consuming fossil fuels. In 2020 the United States obtained almost 70 percent of its energy from oil and gas, 10 percent from coal, and another 8 percent from nuclear electric power.¹⁰⁵ Although renewables accounted for only 12 percent of U.S. energy in 2020, this represents a significant increase over prior years.¹⁰⁶ Domestic production of oil and gas had generally increased in recent pre-COVID years despite its massive contribution to pollution and climate-altering carbon emissions.¹⁰⁷ Jobs in oil and gas have continued to grow nationwide (although not in all regions), from about 876,000 jobs in 2016 to about 950,000 in 2019 (production and electric power generation jobs), for an average annual growth rate of about 2.75 percent.¹⁰⁸ By way of comparison, renewable energy jobs (electric power generation jobs in solar, wind, geothermal, bioenergy/CHP, low-impact hydro, and production jobs in certain biofuels)

saw an increase in the same period, from about 540,000 to 563,000.¹⁰⁹ (In addition, there were almost 2.4 million energy efficiency jobs nationally in 2019.¹¹⁰) However, in 2020, the number of jobs across all parts of the energy sector decreased markedly, likely a result of the COVID-19 pandemic. Oil and gas jobs saw the highest percentage drop, losing “186,000 jobs in 2020 for a decline of 21 percent. Nine in ten (166,000) of these losses were in the mining and extraction sector, a decline of 31 percent.”¹¹¹

Overall, the energy sector has not seen a significant transition away from fossil fuel jobs in the past five years. However, the outsize loss of fossil fuel jobs during the COVID-related economic shock of 2020, along with domestic and international developments, may foretell a different story in the next five years. The Biden administration has re-entered the Paris Climate Agreement and set a U.S. target for reaching net-zero climate emissions by 2050. Ford is ramping up its investment in



A worker with Zilla Rack installing photovoltaic modules on a rack of solar panels just north of the National Renewable Energy Laboratory (NREL) parking garage in Golden, Colorado, on September 28, 2016.

© Dennis Schroeder/NREL, 40320

electric vehicles, heralded by its new F-150 All-Electric Lightning Truck, and General Motors is expanding its electric vehicle product line, planning to make its global products and operations carbon neutral by 2040.¹¹² The Glasgow Alliance for Net Zero, launched in April 2021, aims to provide “a forum for leading financial institutions to accelerate the transition to a net-zero global economy.”¹¹³

These and other developments appear to portend an accelerating trend away from fossil fuels and related downstream industries and toward increased investment in renewable energy-related infrastructure. This shift could be reinforced as oil and gas producers face increasing difficulty accessing credit to finance the development of new reserves. There are indications that funding the development of new oil and gas projects is losing its appeal in comparison with new renewable energy projects. According to a Bloomberg Green article, “Ten years ago, the ‘cost of capital’ for developing oil and gas as compared to renewable projects was pretty much the same, falling consistently between 8% and 10% . . . The threshold of projected return that can financially justify a new oil project is now at 20% for long-cycle developments, while for renewables it’s dropped to somewhere between 3% and 5%.”¹¹⁴ Blackstone CEO Stephen Schwarzman noted in a recent interview that, in regard to fossil fuel companies, “if you try to raise money to drill holes, it’s almost impossible to get that money on an extremely widescale basis.”¹¹⁵ If this trend continues (which is, of course,

desirable from a climate change viewpoint), fossil fuel production and employment will suffer. (Although the oil and gas price increases due to the war in Ukraine have provided a boost to the fossil fuel industry, we do not view this as likely to alter long term trends.)

Texas, a bastion of the oil and gas industry, has an interesting clean energy jobs story. In Texas, renewable energy provided 39,000 jobs in 2019, while grid and storage provided 13,000 jobs and energy efficiency services 169,000. Additionally, clean fuels and clean vehicles collectively provided 19,000 jobs. In total, clean energy jobs (renewables, grid and storage, energy efficiency, clean fuels, and clean vehicles) in Texas have grown from approximately 28,000 in 2011 to 241,000 in 2019, making Texas, perhaps surprisingly, the second-highest state for total clean energy jobs in the country.¹¹⁶ Further, in 2020 Texas accounted for one-fifth of all U.S. utility-scale electrical generation from renewable sources and three-tenths of all U.S. total wind-powered electrical generation.¹¹⁷

In contrast, oil and gas extraction jobs in Texas contracted from their high of 106,000 in 2014 to only 73,000 in February 2020, even before the pandemic-related drop in jobs (Figure 4).¹¹⁸ While not comprising all oil and gas-related jobs in Texas, the extraction job figures show a decreasing trend quite unlike the growth trend for clean energy jobs.

FIGURE 4: TEXAS OIL AND GAS EXTRACTION JOBS, 1990–2020



Source: Federal Reserve Bank of Dallas, *Oil and Gas Extraction Employment in Texas*.¹¹⁹

As renewable energy continues to expand, critical from a climate change viewpoint, fossil fuel industries may decline, and their communities may suffer unemployment and reduced local tax revenue available to fund public services. Moreover, transition effects would not necessarily be limited to the fossil fuel industry. These structural changes to the economy could have a major impact on employment in related industries as well. For example, as consumer preference and industrial production shifts toward electric vehicles, demand for traditional auto parts such as mufflers and fuel injection systems would greatly diminish, putting manufacturers out of business and leaving many workers jobless.¹²⁰

In response, the Fed, through research, convenings, and public statements, can help catalyze policies that cushion vulnerable communities from adverse economic shocks (such as policies promoting job retraining and stimulating local new business development). As the fossil fuel industry currently plays a major role in our economy, the Fed should also be proactive in taking similar steps to help ensure that, to the extent feasible, both the U.S. economy and large supply chains are prepared for the repercussions of a transition away from fossil fuels.

TRANSITION RISK AND FOSSIL FUELS IN THE BEIGE BOOK

Fossil fuels have dominated the U.S. energy mix over the last century, but the composition of the mix has changed significantly over time. Coal achieved its maximum share of energy consumption (22.4 percent) in 2007 and reached peak production in 2008.¹²¹ Since then, U.S. demand for coal has declined significantly (it represented 10 percent of consumption in 2020), resulting in a decimation of the industry and forcing many coal-driven communities to seek new sources of jobs and local tax revenue.¹²² This decline is also evident from Beige Book reports. In July 1980, the Cleveland Federal Reserve Bank noted that “energy stocks, especially petroleum and coal, are judged to be more than ample,” yet in June 2016 it mentioned that “demand for natural gas is rising as gas displaces coal as the fuel of choice.” In 2018 and 2020, the district did not mention coal once in its Beige Book reporting; in 2019 it mentioned coal twice, but only to say that shipments were down. Although this transition has helped the environment, many coal workers have been left behind and their communities harmed by job losses and lower local tax revenues.

In some districts, the Beige Book has served as an incomplete reflection of the energy industry, neglecting to discuss renewable energy at all. Reports of the Dallas Reserve Bank (encompassing Texas) and the Kansas City Reserve Bank (encompassing Oklahoma) have largely viewed the energy sector as synonymous with oil and gas, without notable mention of the growing importance of renewable energy to the districts’ economy, despite the fact that, as noted above, Texas actually has the second

most clean energy jobs among all states. Report authors, especially in the Dallas and Kansas City Districts, choose almost exclusively to survey oil and gas representatives for the energy section of the Beige Book. In a similar vein, the 2022 Dallas Fed Energy Survey canvassed respondents from “200 oil and gas firms located or headquartered in the Eleventh District—Texas, southern New Mexico and northern Louisiana” but included zero respondents from clean energy firms.¹²³ This methodology captures the outlook of the historically predominant energy producers in the region but fails to include outside perspectives that would inform an understanding of where the energy sector is heading overall. In fact, from 2015 through 2021, the Dallas Beige Book reports do not mention job growth or increased investment in clean energy, consistently conflating the energy sector with oil and gas activity. In contrast, the Atlanta Reserve Bank (encompassing the Gulf Coast states other than Texas) regularly mentions renewable energy developments in its energy sector reports.

Both the Dallas and Kansas City Reserve Banks mention energy production, exploration, and infrastructure in nearly every Beige Book report. But how they discuss the future of the energy industry has changed. For instance, in 1980, the Dallas section of the Beige Book noted that “drilling for oil and gas continues at a record level.” In contrast, the 2019 Dallas Beige Book section stated that outlooks were more pessimistic, saying this three times in relation to debt and equity issuance challenges and twice in the context of a weaker global economic outlook. This pessimism was expressed by oil and gas contacts in 2019 even though this was a period of generally positive economic growth nationwide.

A major contributor to this pessimism is the growing frequency of bankruptcies, defaults, and mergers and acquisitions among oil and gas firms. Dallas noted in January 2015, October 2015, July 2016, January 2020, and April 2020 that additional oil and gas firms had filed for bankruptcy. However, the reports seem to indicate that the troubles among firms during these periods were linked primarily to low oil prices and an inability to achieve expected profit margins. The reports did not provide additional details regarding whether the number of firms ever rebounded, nor did they cover future expectations.

The increasing insolvency and pessimism among oil and gas firms is further fueled by oil and gas firms’ decreasing access to credit. The oil industry financing issue was actually reflected in Beige Book reporting. Kansas City mentioned reductions to credit access for firms in the oil and gas industry in January 2016, July 2016 and October 2019, while Dallas mentioned the inability of firms to access credit in April 2020. The Kansas City Beige Book section noted in January 2016 that “mergers and acquisitions and defaults/bankruptcies were projected to increase in 2016 as a result of low cash flows, hedges

rolling off, and reductions to credit.”¹²⁴ In January 2020, after a few years of growth, the Dallas Beige Book section commented that the oil industry “remained distressed as access to capital was limited, especially for small firms. Bankruptcies were likely to rise, according to contacts. However, U.S. crude oil production is still projected to grow in 2020.”

The Beige Book reports focus on current conditions and, for the most part, do not attempt to address whether the inability to access capital through credit is due to short-term cyclical issues, like commodity pricing, or long-term structural problems, like more hostile regulatory environments or decreasing demand as a result of increased renewable energy production and energy efficiency measures.

Awareness and Adaptation: As part of surveying local business sentiment, Beige Book reporters should be asking how respondents view the effect of climate change on the prospects of the oil and gas business. Do they view the current adversity as portending a fundamental change in their business, or is it just a temporary dip in an industry characterized by boom-and-bust cycles? What, if any, adaptation measures are they contemplating? When collecting views on the prospects for the oil and gas

industry, Beige Book reporters should seek the views not just of oil and gas entrepreneurs, who obviously have a vested interest in the continuation of their industry, but also knowledgeable people outside the industry, who may offer a more objective perspective. The answers to these questions will help inform Fed policy.

One critical element of adaptation is preparing for the job loss and community harm that will result from the shift to renewable energy sources. Communities dependent on coal jobs are already being stressed by the shift from coal to other fossil fuels or renewable energy. These communities deserve a just and equitable transition to a post-coal economy that supports high-quality jobs for displaced workers and helps communities shift to an economy not based on fossil fuel taxes and revenues.”¹²⁵ A similar decline in jobs for those working in oil and gas, coupled with increased community stress, is likely to occur as the U.S. economy moves further toward clean energy. However, community-based transition efforts and job retraining may help prevent oil and gas communities from being left behind, as coal workers, unfortunately, have largely been. The Fed should use its research, public voice, and convenings capabilities to help jump-start this process.

Equity, Community Development, and Climate Change

CLIMATE RISKS AND ENVIRONMENTAL RACISM

Climate change has, and will continue to have, a disproportionate adverse impact on low- to moderate-income (LMI) communities and communities of color, who generally have fewer monetary resources to prepare for the physical and transition risks that climate change poses.¹²⁶ Climate change will also exacerbate existing economic inequalities in housing, poverty concentration, infrastructure, and employment. It is essential to find adaptation solutions for these communities to ensure a more equitable future for all in the face of climate change.

Environmental racism refers specifically to the “disproportionate impact of environmental hazards on people of color,” as the nonprofit Greenaction puts it.¹²⁷ Environmental racism also encompasses the governmental rules, policies, and regulations and the actions of polluting industries, such as oil and gas, that have historically inflicted harm on communities of color. As a result of historical disadvantages and insufficient political power, communities of color often lack the institutional clout to prevent harmful environmental actions, such as the siting of polluting facilities in their communities. As climate change worsens, communities of color will be more severely impacted by environmental racism in areas such as health and the economy.

The Fed has lately acknowledged that its mission to maximize employment cannot be achieved if communities of color and low-income communities are left behind. Tackling environmental racism is important, therefore, not just for those directly exposed to it, but also for the broader economy. In its Statement on Longer-Run Goals and Monetary Policy Strategy, as revised and reaffirmed on January 26, 2021, the Federal Open Market Committee (FOMC) added new language stating that “the maximum level of employment is a broad-based and inclusive goal.”¹²⁸ Chairman Powell subsequently explained that “this change reflects our appreciation for the benefits of a strong labor market, particularly for many in low- and moderate-income communities.”¹²⁹ This was a shift from the Fed’s historical focus on overall or average employment measures without consideration of the distributional components, like higher unemployment in particular minority communities or income groups. During a May 2021 conference on community development, Chairman Powell, after citing statistics showing COVID’s disproportionate economic impact on people of color, stated along similar lines that “the Fed is focused on these long-standing disparities because they weigh on the productive capacity of our economy. We will only reach our full potential when



A children's playground located next to the Valero Houston Refinery in Houston, Texas.

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everyone can contribute to, and share in, the benefits of prosperity.”¹³⁰

Thus, the Fed generally recognizes that it cannot fulfill its mandate to maximize employment without addressing disparate impacts on distressed communities. In fact, the federal Community Reinvestment Act (CRA) both directs the Fed to address the needs of low- to moderate-income communities and serves as a tool for starting to carry out this mission (see text box on page 26). As the Fed begins to address the economic risks of climate change, it must use the CRA and any other tools at its disposal to pay special attention to the protection of communities of color and low income-communities from the impact of climate change.¹³¹

District Banks have likewise recognized equity issues. The San Francisco Reserve Bank has posted a “Racial Equity Primer” on its website, the Philadelphia Reserve Bank has a program focusing on equitable small-business recovery, the Federal Reserve Banks of Atlanta, Boston, and Minneapolis collaborated to create and present a series of virtual events examining the economic impact of racism, and the New York Fed recently hosted a roundtable event on scaling equitable solar finance.¹³²

The San Francisco Federal Reserve Bank has gone farther by beginning to focus on the interplay of community development, equity, and climate change.¹³³ Its research focuses on how to marshal resources and address climate impact for LMI communities and communities of color.¹³⁴ The bank hosted the 2020 Financial Innovations Roundtable (FIR), at which it prioritized “thinking big” about climate finance to manage systemic risk, viewing housing policy as integral to addressing climate change,

EQUITY AND THE BEIGE BOOK

and advocating for regional approaches that involve local governments and disadvantaged communities. Finally, the bank has stressed its commitment to monitoring and addressing the impact of climate change on the economy, particularly in regard to disadvantaged communities. Between June 24 and July 30, 2021, the bank conducted a survey called “Understanding Climate-Related Risks Faced by Low- and Moderate-Income Communities and Communities of Color” that asked community development practitioners throughout the district about climate-related risks and adaptation and mitigation strategies in underserved populations.¹³⁵ The results of the survey were released on December 9, 2021. Respondents included local nonprofits and governments, which noted that climate change-related risks already affect areas they serve, especially in regard to lack of savings, transportation and housing options, and worker health. Furthermore, respondents noted that they lack the resources and capacity to help the communities they serve respond to climate related risks.¹³⁶ These survey results will contribute to the bank’s understanding of how climate-related risks impact the economic health of communities and their ability to fully participate in the economy.¹³⁷

In keeping with these efforts, the District Banks are well positioned to conduct research, convene critical stakeholders—including community members—and generally provide a forum to advance solutions at the regional level to address the outsize impact of climate change on vulnerable communities.

As described above, Beige Book reports are concerned primarily with monetary policy related to the Federal Reserve System’s mandates to maximize employment and stabilize prices. Equity has not historically been viewed as part of these mandates, and the Beige Books do not generally mention equity, despite the importance of recognizing disproportionate impacts in a qualitative report describing current economic conditions and providing anecdotal forecasts for various industries and sectors. For example, although the Reserve Bank of San Francisco now prioritizes equitable, community-based solutions to address climate change, its Beige Book reports generally do not discuss the topic, nor do they discuss equity considerations more broadly.

Without a discussion in Beige Book reports of whether changes in income or employment have different impacts in different communities, Reserve Bank management may not be fully understanding what is going on in the local economy; this lapse is akin to not collecting information on different industries within a district, for example. This inhibits the Fed’s ability to effectively conduct the nation’s monetary policy. The Fed should modify the Beige Book’s current research, reporting, and data collection methods by incorporating information on these kinds of differing impacts. Doing so would provide a fuller picture of district economies and bring the Fed’s Beige Book practices more in line with its asserted goals.

CONSUMER PROTECTION, COMMUNITY DEVELOPMENT, AND THE COMMUNITY REINVESTMENT ACT

The Fed acknowledges that healthy communities and protected consumers are pillars of strong economic growth. To ensure that the Fed upholds these principles, the 12 District Banks conduct research to identify community issues, engage with community stakeholders to understand local needs, and provide risk-focused supervision of financial institutions regarding their compliance with relevant consumer protection laws.¹³⁸ One of the most important laws regarding community development and consumer protection is the Community Reinvestment Act of 1977 (CRA).

Congress enacted the law in response to discriminatory lending practices, known as redlining, that excluded members of minority communities from receiving financial services. The CRA is a comprehensive and flexible tool to ensure that financial institutions meet the credit needs of the low- and moderate-income communities in which they do business.

The Federal Reserve monitors state member banks’ CRA compliance by evaluating their record of identifying and meeting community investment needs, including in LMI neighborhoods, and considers the performance of banks under the CRA in decisions regarding applications for mergers, acquisitions, and new branch openings.¹³⁹ In addition to this supervision and evaluation, the Fed provides information on community development techniques to banks and the public to encourage adequate community reinvestment.¹⁴⁰ This effort is intended to build on the CRA to increase the scale and sustainability of community development finance in growing the workforce and improving access to affordable housing.¹⁴¹

Conclusions and Recommendations

To ensure financial stability, safety, and growth, the Reserve Banks should incorporate climate change economic risk into their operations, research, supervisory duties, payment systems, and community development practices within their geographic jurisdictions, as the San Francisco Reserve Bank has already begun to do. As the operating arms of the Federal Reserve System, Reserve Banks, acting at the local level, can help mitigate the economic consequences of climate change and help promote adaptation strategies. If done comprehensively, the Reserve Banks' actions would reverberate throughout the broader U.S. economy.

Our recommendations are focused on steps individual Reserve Banks can take to integrate climate considerations into their work, particularly for the Beige Books and other research that informs monetary policy and other Fed decisions. We direct our attention to areas that are fully within their control, areas that can provide meaningful information and facilitate collaboration (both external and internal) during the next six to twelve months.

1. Perform research, data collection, and public outreach at the District Bank level on climate economic risk. The District Reserve Banks should collect data and conduct research on the economic effects of climate change (including worsening hurricanes, droughts, and wildfires and the transition away from fossil fuels), focusing on conditions within their districts including, as further noted in recommendation 4, broken down by community, income, and race to ensure that the economy works for all people. They should use their power of public outreach through speeches, convenings, and reports to spread awareness of the economic risk posed by climate change and the crucial importance of adaptation measures and other strategic planning. Internally, the District Banks should educate their staffs about climate change economic risk and build their expertise through their hiring process. Finally, the District Banks should work with the Board of Governors to issue strong supervisory guidance on climate change risk, coupled with bank examiner education and other implementation steps. These actions are important because the Fed cannot address the economic consequences of climate change alone. Banks and businesses must be mobilized in this effort, and the District Banks must use their bully pulpit to catalyze these efforts.

2. Spotlight the economic effects of climate change in Beige Books. The Beige Books, published by the Fed eight times a year, are anecdotal reports highlighting different aspects of economic activity in the various districts and, taken together, create a national picture of the economy.

The Beige Books provide qualitative information at the district level, a valuable counterpoint to the plethora of quantitative data the Board of Governors receives, helping to inform the Board's decision-making process.¹⁴² In addition, although the Beige Book may not be widely known to the general public, it is an information source for news outlets and, in this way, achieves broader dissemination.¹⁴³ Historically, the Beige Books' reporting of climate change impacts on the different districts has been spotty at best. As climate change becomes a bigger driver of economic conditions, the District Banks should augment their Beige Book information collection by asking their sources specifically about climate change-related economic effects of events such as hurricanes, droughts, and wildfires and about adaptation measures responders are implementing. For example, the District Banks should ask what adaptation measures are being undertaken by the agricultural sector in response to worsening droughts, by coastal property owners in response to intensifying hurricanes, and by businesses and residents in areas increasingly threatened by wildfires. This information will help the Fed gauge the ongoing financial risk posed by climate change and inform the steps it should be taking in response. For the fossil fuel industry, the District Banks should ask businesses in this sector about their medium- to long-term strategies to address the likely transition away from fossil fuels in response to climate change; again, this will help the Fed assess the risk to the financial system and develop a prudent response. To obtain a more complete picture of the evolving energy landscape, they should include renewable energy in their data collection about the energy industry.

3. More thoroughly consider climate change risk in price stability research. The potential impact of climate change on price stability, a core Fed mandate, merits special mention. As increasingly severe weather impacts coastal economies, agriculture, and other commodity production, there will be rippling effects on supply chains up and down the economy. As production in affected industries is curtailed or transportation for essential components is deeply or frequently disrupted, supply of many goods could be reduced and prices would very likely rise. If disruptions are deep or broad enough, price increases could have inflationary effects across the economy. In addition, as the nation (and the world) attempts to transition to a low carbon economy, without sufficient planning or investment in alternative sources, energy prices could increase, also with broad inflationary effect. The District Banks should deepen their research into price expectations in the context of climate change

and enhance their climate change–related data collection (including for the Beige Book) and their pricing and inflation modeling. These steps are necessary to inform Fed policy responses for likely price disruptions due to climate change.

4. Address the disproportionate impact of climate change on low-income communities and communities of color.

The Federal Reserve System cannot fulfill its mandates to promote maximum employment and keep prices stable, and ensure that the economy works for all people without addressing the disproportionate impact of climate change on lower-income communities and communities of color, which threatens to widen income, wealth, and employment gaps. A climate focus on vulnerable communities would enhance the efforts beginning to be seen across the Fed’s research, convening, and Community Investment Act regulatory arms. The District Banks should collect the data and conduct the qualitative research—broken down by community, income, and race—necessary to provide guidance to policymakers and enable the Fed to carry out this aspect of its mandates.

We cannot emphasize enough that climate concerns cannot be siloed within Federal Reserve institutions. Climate change risk cuts across all of the Federal Reserve mandates and must be integrated across all Fed functions in a whole-of-system approach.

Fully incorporating climate risk in the Fed’s and the District Banks’ oversight of the financial system and individual banks would help prevent individual bank failures and protect the broader financial system and economy—key Fed mandates. By considering the risks both to the economy generally and to individual financial institutions of more extreme weather events and a transition to a low-carbon economy, the Fed can potentially avert or cushion shocks to impacted industries, geographical areas, and crosscutting supply chains and to affected lenders, investors, and consumers.

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