The Impact of Climate Change on U.S. Subnational Economies

Moody's Analytics new regional climate change forecasts shed light on the economic impact of this important long-term risk on all states, territories and metro areas in the U.S.

» Exposure to acute and chronic physical risk and the risk associated with a transition from fossil fuels are the foundation of regional climate change forecasts and have a critical role along the coasts.

» Early policy action generally causes less economic pain, but it and the late adoption of climate mitigation strategies put energy-producing regions in the most economic peril.

» Absent policy changes, large coastal states like California, Florida and New York are especially vulnerable, while more inland northern economies will emerge only slightly worse off, with a handful of small metro areas possibly benefiting slightly.

» House prices face crosscurrents, as demographics and insurance costs drive prices lower in more vulnerable areas, but supply destruction will put some upward pressure on prices.

The Impact of Climate Change on U.S. Subnational Economies

BY ADAM KAMINS

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The long-term economic risks associated with climate change have rapidly moved to the forefront for banks and policymakers. In response, Moody's Analytics has incorporated climate risk into its U.S. and global baseline forecasts as well as in alternative scenarios.

From a national perspective, a view for the U.S. is important but regional variation has traditionally gone unaccounted for—until now. Understanding regional nuance is critical in a nation with significant economic and geographic diversity and nearly 100,000 miles of shoreline.[1] This is especially true given the slow pace at which U.S. policymakers are responding to the threat posed by a changing climate, especially in comparison to their European counterparts.

With those considerations in mind, Moody's Analytics has begun to account for climate change at a regional level. Adjustments were first incorporated into the state and metro-area baseline forecasts in October 2022. In early 2023, the first set of U.S. regional climate scenarios based on parameters from the Network for Greening the Financial System was published. This article summarizes key takeaways, with an eye toward which parts of the U.S. will suffer most under a variety of scenarios.[2]

Accounting for risk

When considering the economic impact of climate change, the risk to physical assets is the most intuitive starting point. Using data from the Moody's ESG team,[3] vulnerability at the state and metro-area level is calculated based on relative climate exposure to physical and transition risk.

To account for the former, two categories are considered. The first, acute physical risk, pertains to shocks such as hurricanes, floods and wildfires, with hurricanes weighted more heavily given their historically high price
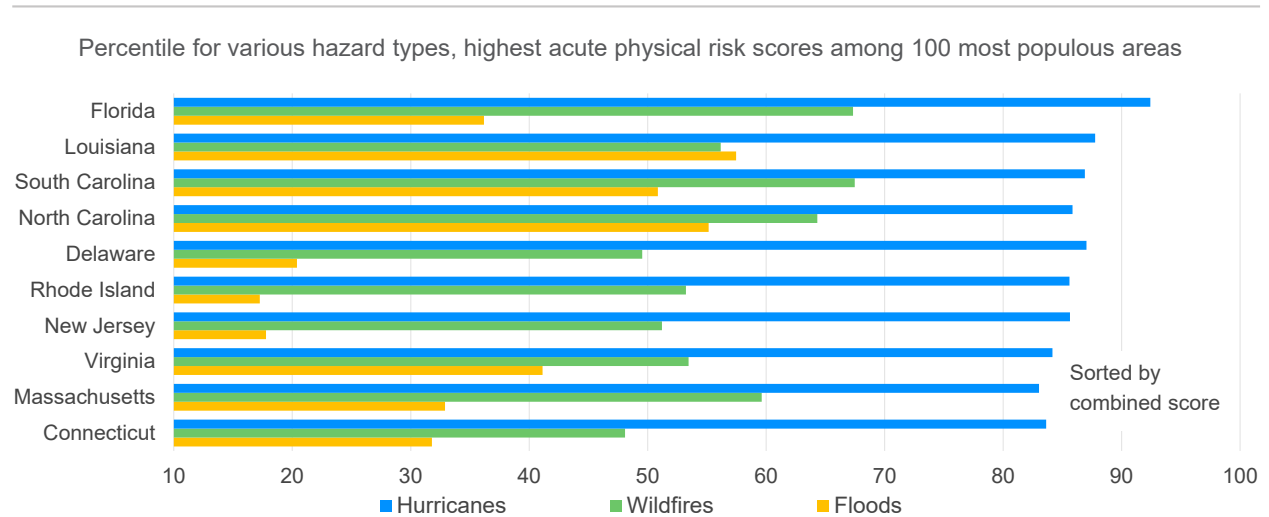
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1 See https://coast.noaa.gov/data/docs/states/shorelines.pdf
2 This paper is focused on the results of this work. A more complete accounting that includes a detailed summary of the methodology can be found here.
3 Formerly known as Four Twenty Seven.

tags. For states and metro areas, there are clear patterns. Florida's exposure to hurricanes makes it uniquely susceptible to acute physical risk. The Carolinas and Louisiana also occupy spots near the top of the acute physical risk rankings, reflecting the especially dangerous position that the southeastern U.S. occupies (see Chart 1).

Chart 1: Florida Faces the Greatest Acute Physical Risk Threat

Percentile for various hazard types, highest acute physical risk scores among 100 most populous areas

Sorted by combined score

■ Hurricanes　■ Wildfires　■ Floods

Source: Moody's Analytics

Wildfire risk is most pronounced in the western U.S., with California, Washington and Utah occupying three of the top four spots. In comparison, inland flood risk matters most in northern New England and West Virginia. But the economic impacts of wildfires and flooding pale compared to those of tropical cyclones. For that reason, the island territories of Puerto Rico, Guam, and the Virgin Islands are all individually more prone to acute physical risk than any one state.
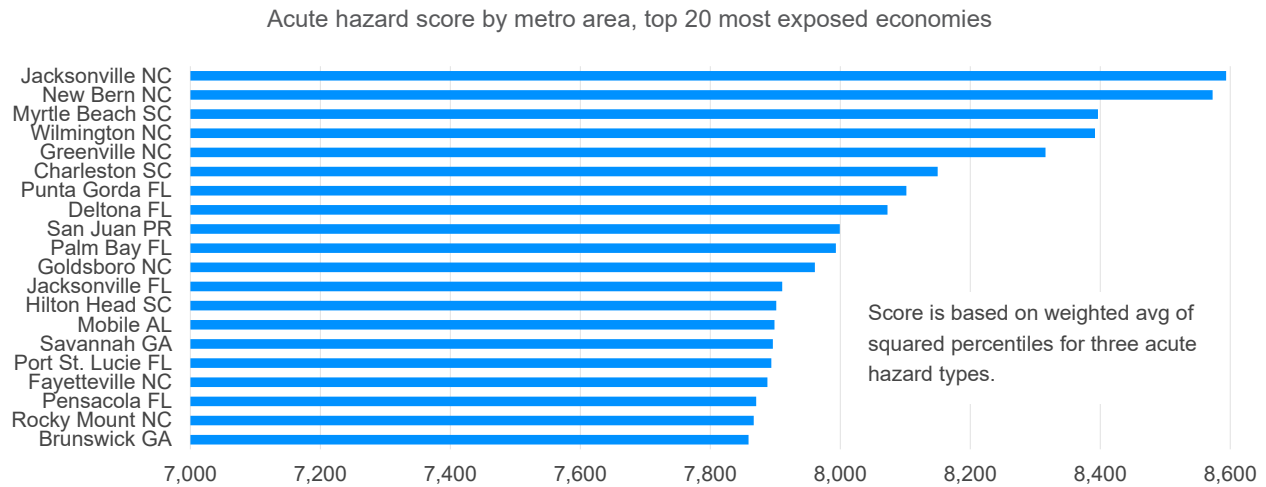
Among metro areas, large coastal economies bear by far the most risk. Nowhere is this more pronounced than along the Carolina coast, with the stretch from Jacksonville NC to Charleston SC facing the greatest threat. After the Carolinas, Florida dominates the list of most exposed metro areas, with San Juan PR also especially vulnerable (see Chart 2).

Chronic physical risk is not tied to a specific event, but rather unprecedented changes over a drawn-out period. The key categories are drought, heat, and sea-level rise, with each weighted equally due to the lack of historical precedent.

In the case of sea-level rise, the geographic patterns largely resemble those associated with hurricanes, most profoundly affecting coastal states and island territories. But unlike hurricanes, flood risks associated with rising oceans are more impactful in Hawaii and the Northeast. New York City, in particular, faces the possibility of significant losses from sea-level rise given that Manhattan is surrounded by water and frequent flooding could prove crippling to an economy where much activity—and the ability to travel—is tied to low-lying land or subway tunnels.

Water stress is most pronounced in the western U.S. This is particularly true of the Four Corners states, with Arizona, New Mexico and Utah all facing significant risk from more frequent droughts. Each has been strug-

Chart 2: Southeastern Metro Areas Are Unusually Risky

Acute hazard score by metro area, top 20 most exposed economies

Score is based on weighted avg of squared percentiles for three acute hazard types.

Source: Moody's Analytics

gling with reduced water levels for years and could be in for additional pain as a changing climate further depletes water sources. Among large metro areas, Phoenix and Tucson AZ are especially vulnerable, with elevated water stress making them some of the most susceptible to chronic risk despite being immune to sea-level rise, given their location and topography.

Very low drought risk relative to the nation helps ensure that some portions of the mid-South and Gulf Coast are better protected from climate change. Kentucky, Louisiana and Tennessee all boast ample water supplies, including an extensive network of aquifers that significantly reduce the likelihood of extreme drought. This largely explains results that, at first blush, appear surprisingly favorable for each state.

While heat risk is problematic for much of the South, its impact will be greatest in the middle of the U.S. Iowa is the single-most vulnerable state to rising temperatures, reflecting the outsize impact of warmer weather on agriculture. Risks are also elevated in states that struggle with poverty, perhaps owing to a lack of adaptive capacity, such as air conditioning. This places more residents at risk.

Put it all together, and exposure stemming from chronic physical risk is far more geographically diffuse than acute physical risk. San Francisco is not especially susceptible to any one hazard, but above-average risk from each category makes it the single-most exposed large metro area or division. The New York City metro area and Florida are also near the top (see Chart 3). The Sunshine State features a handful of larger metro areas, including Orlando and Cape Coral, that face some of the most significant exposure to acute and chronic physical risk, which will weigh on their prospects.

Depending on the scenario being considered, transition risk can prove just as important as physical risk, if not more so. This category reflects the cost of decarbonizing the economy and is determined largely by the industrial structure of states and metro areas. The most glaring example of how transition risk matters is when aggressive mitigation strategies are assumed and energy-producing regions suffer severe lost output and job declines. This can be captured within the model itself, based on the way that broader industry forecasts drive regional trajectories

Chart 3: Chronic Physical Risk Is More Widespread

Percentile for various hazard types, highest chronic physical risk scores among 100 most populous areas

Sorted by combined score

■ Heat   ■ Sea-level rise   ■ Water stress
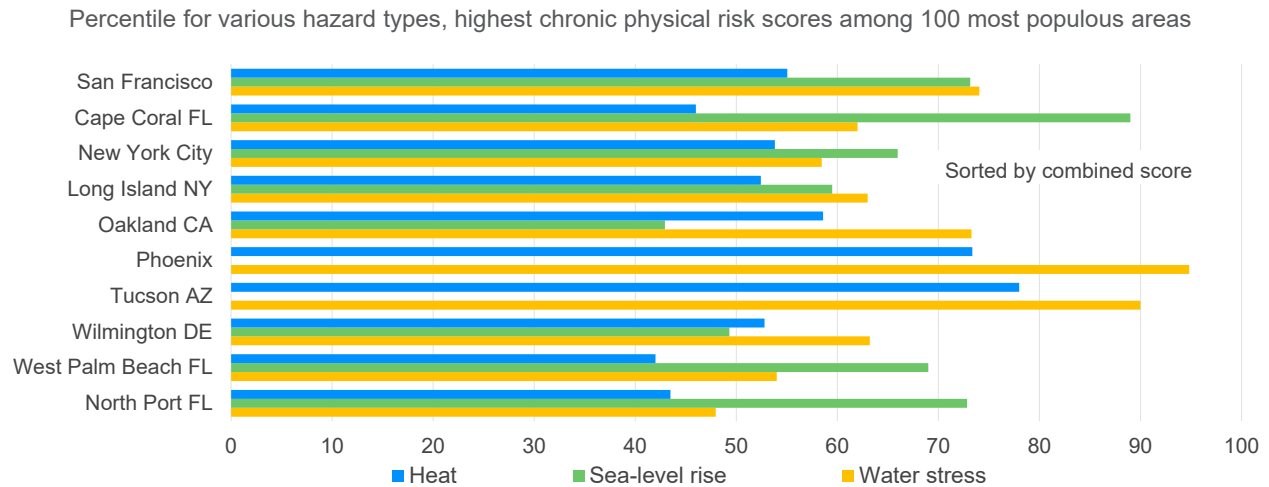
Source: Moody's Analytics

NGFS scenarios

While climate assumptions were incorporated into the regional baseline forecasts in the fall of 2022, the potential impacts on regional economies are far clearer in custom scenarios. To this end, parameters from the Network for the Greening of the Financial System have been expanded to the regional model as of early 2023. Four of the NGFS scenarios are currently being converted into global and regional forecasts:

» A Reference scenario that reflects a counterfactual in which climate change does not exist.

» An Early Policy action scenario based on near-immediate mandates going into place to combat climate change's impacts.

» A Late Policy action scenario in which there is little movement for about a decade until new regulations go into effect in 2031, triggering a recession.

» A Current Policy scenario that assumes no new climate mitigation policies, which minimizes disruption but increases physical risk.

While the long-term trajectory and lack of consistent rank ordering across scenarios and variables lead to more nuanced takeaways, an assessment of high-level variables still yields numerous insights. Not only is the exposure to various risk factors reflected in the list of hardest-hit areas, but the lack thereof drives minimal impact or even slight benefits in a handful of areas. This is particularly true of the Current Policy scenario, which involves minimal damage to states like Montana and the Dakotas that feature a cold climate and distance from the coast. Those traits promote a pickup in migration, contributing to job growth resembling that in the Reference scenario. Of course, the flip side of this is the near-total elimination of mining output in the Early and Late Policy scenarios, decimating energy states in the long run.

Early Policy outcomes

The Early Policy scenario minimizes physical risk and is driven predominantly by the impact of a transition away from fossil fuel use. Because of the nature of the scenario, state and metro-area forecasts do not stray as far from their model-driven results as they do in other climate scenarios.

It should come as little surprise, then, that a very bleak forecast for the long-term future of oil and gas production carries significant weight in the Early Policy scenario. Alaska, North Dakota and Wyoming are hit especially hard. So, too, are New Mexico and Oklahoma, which rely heavily on the energy industry (see Chart 4).

Chart 4: Transition Risk Is Concentrated in Energy States

Real GDP, % decline in Early Policy vs. Reference scenario, 2053Q4

≥3.5
2.5 to <3.5
1.5 to <2.5
<1.5
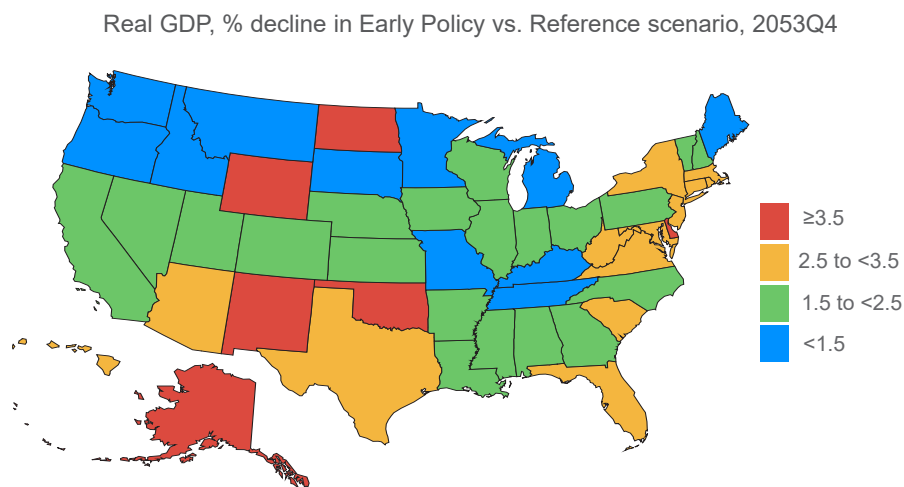
Sources: NGFS, BEA, Moody's Analytics

These patterns make Houston and Oklahoma City two of the most vulnerable large metro areas. This reflects the importance of energy to each, even though support and headquarters positions play a more significant role than actual mining jobs in both places.

Meanwhile, Delaware's uniquely high exposure to acute and chronic physical risk, albeit without any category proving especially severe, makes it vulnerable. Similarly, island territories are not hurt directly by their industrial makeup, but the physical risk profile for each is severe enough to ensure that the impacts of climate change to date place them among the most affected geographies.

Generally, states that perform best are those with minimal exposure to both transition and physical risk. This puts the Pacific Northwest, northern Rockies, and water-rich mid-South in the most favorable positions. Of course, with varying national trajectories across variables and different places responding differently to shocks, there are marginal differences across series. But generally, the Early Policy scenario story revolves around a combination of transition and physical risk, with the long-term productivity shock noticeably less severe than in other scenarios.

Late Policy action

The Late Policy scenario results bear some resemblance to those of the Early Policy framework in the long run. While the scenario yields a more tumultuous path that drives more pain early next decade for more cyclical states, the long-term results are fairly similar.

Once again, Alaska and Wyoming are the biggest losers, although they are joined by more states with elevated physical risk. In addition to Delaware, large states like Florida, New Jersey and New York are among the most vulnerable. This reflects the delayed implementation of climate mitigation policies driving more severe outcomes for vulnerable coastal areas. The set of relatively well-insulated states is also little changed.

One can decompose each state's output forecasts for the final quarter into four parts to better understand how they are derived: difference from the U.S., adaptation/transition risk, acute physical risk, and chronic physical risk. The first is simply an application of the scenario-to-baseline ratio for the U.S. to all states, amounting to slightly more than a 4% drop in the Late Policy scenario. Next, transition and adaptation risks are grouped together, reflecting the model-determined forecasts for each state. This can lead to a sharp downward adjustment to energy states, or a more favorable shift for places with relatively low exposure to vulnerable industries, pushing their relative losses to more than 4% (see Chart 5).

Chart 5: Late Policy Scenario Reflects Transition and Physical Risk

Real private-sector GDP, % difference between Late Policy and Reference scenarios, 2053Q4
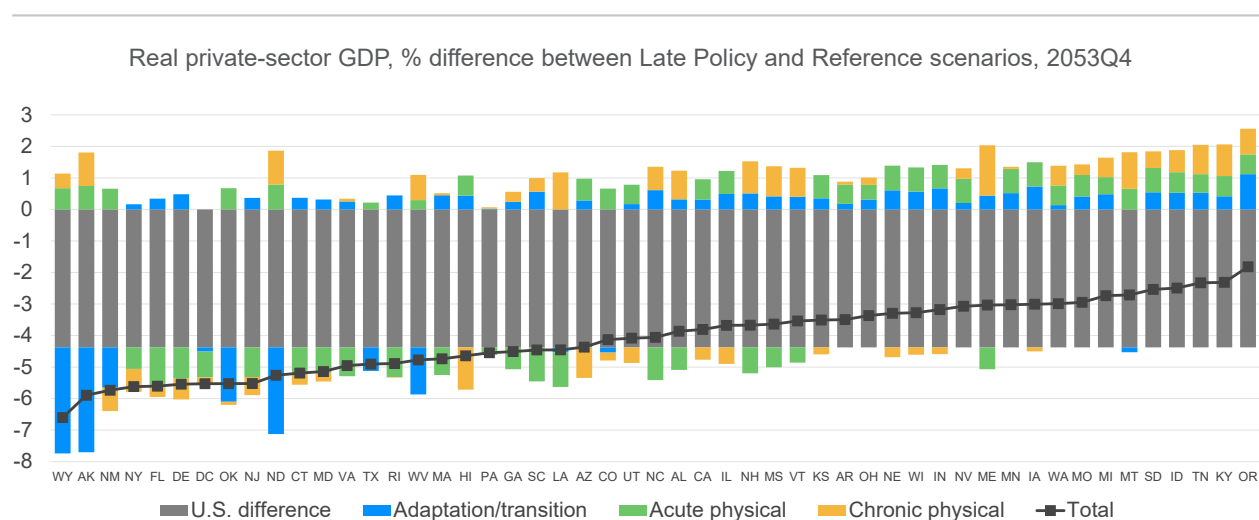
Sources: NGFS, BEA, Moody's Analytics

Acute and chronic physical risk scores exacerbate losses or help to offset them. The latter is true in many energy-based economies in the northern U.S., including those of Alaska, North Dakota and Wyoming, where the hit associated with transition risk is partly negated by below-average physical risk. While those states experience the strongest crosscurrents, they are hardly alone. Most places that face the especially pronounced physical risk are moderately better off than their peers when it comes to transition risk, and vice versa.

The state that fares best in the scenario is Oregon. It benefits from continued growth in electronics production, providing a boost to the pivotal computer chip industry, which is primarily fueled by Intel. While the state, like all others, is made worse by climate change relative to a world without it, the delayed adoption of mitigation strategies has only a modest impact through the mid-2050s.

Current Policy impacts

The Current Policy scenario includes a minimal allowance for transition risk and is instead dominated by physical risk. While there are slight model-driven changes that can be traced to industry output, these

generally owe to adaptation costs. The lion's share of the impact of the scenario, however, stems from the effect of a warming planet on areas with more severe risk profiles.

This spells trouble for the usual vulnerable coastal states like Florida and New York, along with steep losses for island territories. For any state or metro area with an especially pessimistic outlook, a straight line can generally be drawn from physical risk scores to the forecasts. On the flip side, those places that perform better boast some advantages—a combination of cooler temperatures, plentiful water supplies, and/or minimal exposure to low-lying coastal areas and storms. Other factors also come into play, but this helps explain why northern states and the mid-South come out of the scenario in better shape than their peers (see Chart 6).

Chart 6: Current Policy Scenario Highlights Divergent Physical Risk Profiles

Real private-sector GDP, % difference between Current Policy and Reference scenarios, 2053Q4
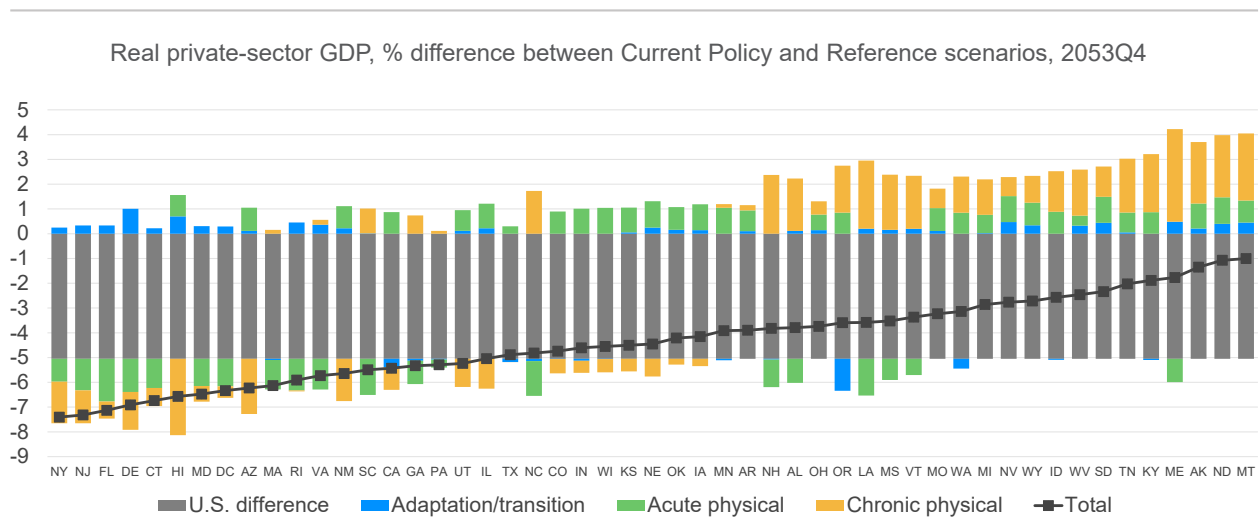
Sources: NGFS, BEA, Moody's Analytics

The most at-risk metro areas are predominantly coastal. The New York City area and Florida are especially vulnerable, but so too are other parts of the Eastern Seaboard and California. Fast-growing Boise ID and Nashville are among the least exposed areas due to their limited physical risk. Interestingly, another magnet for in-migration is holding its own despite being in the middle of a desert. Las Vegas is significantly less exposed to drought and wildfire risk than Phoenix, putting it in a far stronger position than a somewhat nearby metro area that shares many similarities.

While the overall effect is modest, the forecasts show what migration patterns could begin to look like in the second half of this century. Highly vulnerable states will start to experience out-migration to areas that are less exposed to climate risk. Yet the lack of historical precedent for climate refugees dispersing within the U.S. and still-generous insurance programs should prevent an exodus from vulnerable places over the existing 30-year horizon (see Chart 7).

The relatively short time horizon also means that the small handful of places for which the Current Policy scenario confers a small net benefit only experiences modest outperformance. Still, portions of Alaska, Maine, Montana and North Dakota would ride improved demographics to slightly better job growth than experienced under the no-climate change Reference scenario if new policies are not adopted.

Chart 7: Subtle Changes in Migration Patterns May Lie Ahead

Difference in net domestic migration per 1 mil residents, Current Policy vs. Reference scenario, 2044-2053, #

Legend:
- >400
- 0 to <400
- -300 to <0
- <-300
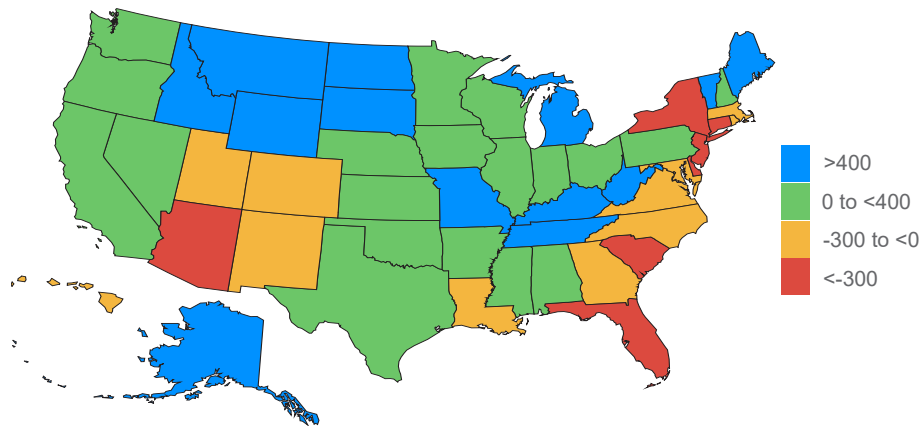
Sources: NGFS, Census Bureau, Moody's Analytics

Housing

Academic literature quantifying the linkage between rising temperatures and house price appreciation is insufficient. However, the effect of any of the three climate scenarios on most of the economy is apparent: lower productivity growth will limit housing affordability, and natural disasters will do significant harm.

Rising temperatures mean more frequent and severe natural disasters that could destroy homes and spark out-migration from some areas. Similarly, enough disasters will eventually force insurers to abandon markets they deem too risky; this has already happened in some parts of the country, including much of Florida, forcing the public sector to step in. That practice, however, will be difficult to sustain and could eventually compel more people to move out of areas that become classified as uninsurable. Similarly, while there is a strong tendency today to rebuild after natural disasters, a lack of insurance and government funding could make that far less palatable in the future. Ultimately, the cost and availability of insurance, combined with damage to the housing stock from storms, represent the two most direct channels through which house prices are affected by climate change.

Yet the permanent destruction of homes reflects a potentially sizable supply shock. While individual neighborhoods would see the value of their housing stock plummet with severe destruction, a reduced inventory of homes could put some upward pressure on prices for a broader metro area or state economy.

While these different considerations will be examined further in future climate forecast updates, the demand argument moves the needle for now. Reduced incomes will harm the fundamental value of homes, and while inflation may keep house price indexes moving deceptively higher, that story is hardly reassuring.

Ultimately, the housing markets that are hurt most by climate change are dealing with a handful of potential weaknesses (see Chart 8). These largely revolve around income, which cannot be generated at the same rate when productivity is diminished. In addition, the breakdown between wage and salary income and nonwage earnings is important. The Bay Area, for example, relies far more heavily on wages and salaries, given the importance of lucrative white-collar jobs in tech and finance. Given that nonwage income weath-

Chart 8: Risk to Housing Is Most Severe in Pricey Coastal Markets

FHFA All-Transactions Index, % decline in Current Policy vs. Reference scenario, 2053Q4

Legend:
- ≥11
- 9.5 to <11
- 8.5 to <9.5
- <8.5
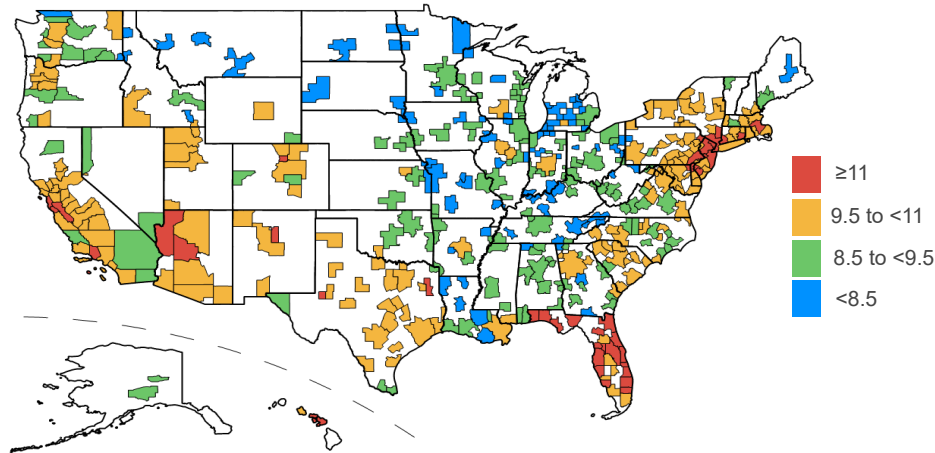
Sources: FHFA, Moody's Analytics

ers climate change far better than salaries do, house prices fall far more sharply than average in the Bay Area. This pattern is mirrored in several other big cities, where the prevalence of high-wage jobs increases vulnerability (see Chart 9). A white paper describing how climate change affects house price appreciation will be forthcoming in 2023.

Chart 9: Reliance on Wage Income Increases Risk to House Prices

Wage and salary income, share of total income, 2021, %

Metro areas or divisions among the 100 most populous that rely most heavily on wages and salaries
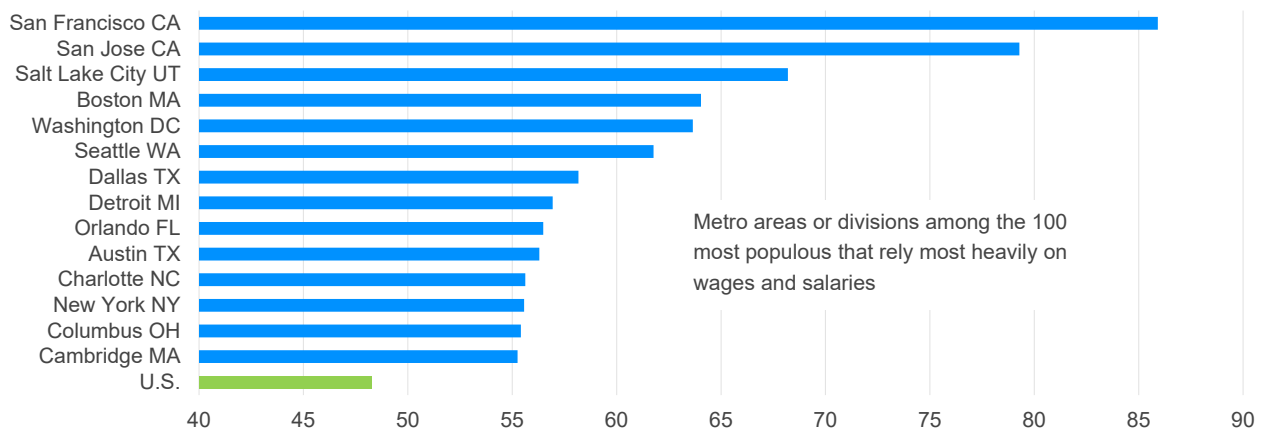
Source: BEA, Moody's Analytics

Takeaways

The importance of accounting for climate change will only grow for the banking system and corporate decision-makers. While national and global views are important, the granular detail associated with state and metro-area forecasts of climate change impacts will prove a valuable new addition to bankers' and regulators' toolkits.

Areas with the most and the least to lose will evolve over time, but the broad parameters of the three scenarios outlined in this paper should not change meaningfully. Neither should the nearly independent rank orders among states and metro areas when comparing scenarios (see Chart 10). As more scenarios emerge, whether from the NGFS, the Federal Reserve, or other stakeholders, having a framework to translate climate risk to subnational economies will prove increasingly pivotal.

Chart 10: Climate Scenarios Are Designed to Create Significant Variation

Payroll employment, % decline vs. Reference scenario, 2053 avg
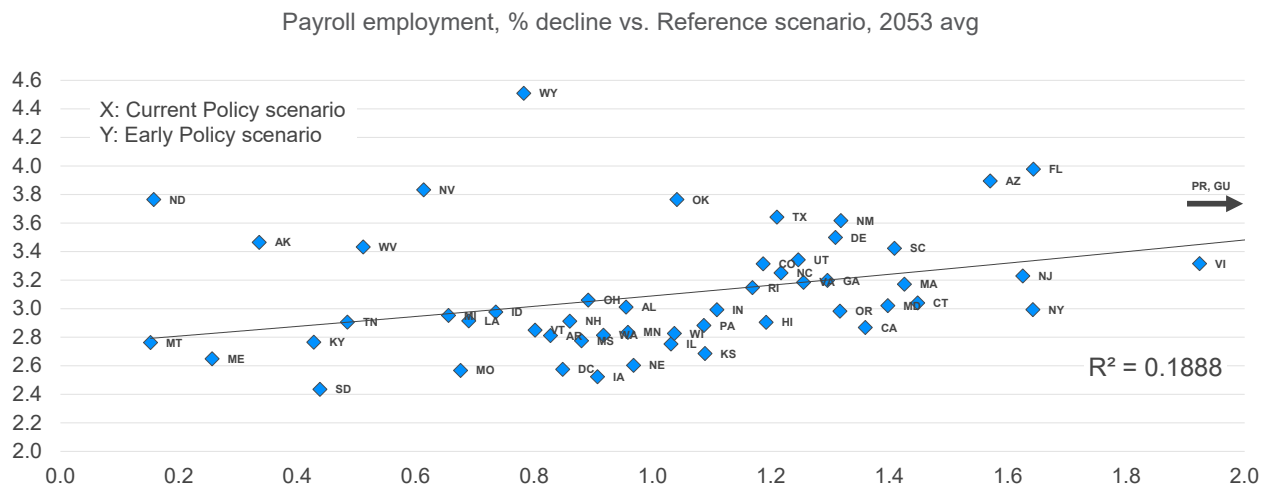
Sources: BLS, Census Bureau, Moody's Analytics

About the Author

Adam Kamins is a senior director at Moody's Analytics. He manages the firm's U.S. subnational forecasting process and covers a wide variety of topics related to regional economics while frequently writing and presenting about both the New York and broader Northeast economies. Adam is also responsible for state and metro area scenarios, analyzing and forecasting commercial real estate prices and activity, and quantifying the impact of external events such as natural disasters. Prior to joining Moody's Analytics, Adam was a research manager at the Initiative for a Competitive Inner City, where he analyzed urban economies. He holds an MBA from the University of Chicago Booth School of Business and a bachelor's degree in quantitative economics from Tufts University.

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