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# Interrupted rhythms and uncertain futures: Mortgage finance and the (spatio-) temporalities of climate breakdown

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## ABSTRACT

As intensifying climate-related disasters strike cities across the United States, they are provoking rising concern for the stability of the U.S. housing market and broader financial system. How homeowners, mortgage lenders, federal institutions/regulators, and investors will variously encounter and manage climate risk is an urgent question for urban scholars, as is who might bear the costs of restabilizing mortgage finance under new breakdowns. This paper's multi-scalar intervention draws on financial "following" methods to explore how climate risks are being experienced and governed at multiple illustrative moments of U.S. mortgage finance: (1) working households at the front line of urban climate impacts, (2) mortgage professionals brokering loans to them, (3) government-sponsored enterprises (GSEs) negotiating incoming federal climate risk disclosure requirements, and (4) capital markets off-taking GSE risks through financial derivatives like credit risk transfers. Emerging concerns include ruptures between household risks and financial system-preserving responses and new dangers of "climate redlining."

## KEYWORDS

Finance; hazards; housing; climate risk; mortgage finance; financial disclosure; United States

## Introduction

As intensifying storms, wildfires, and other climate-related disasters strike cities across the United States, they are provoking a rising concern: that climate change impacts may already be hitting high-value urban property markets with enough frequency and severity to destabilize the U.S. housing market, and the broader financial system to which it remains closely tied. To cite only a few examples, new research estimates that U.S. residential properties exposed to worsened flood risk are now overvalued by as much as \$121–237 billion (Gourevitch et al., 2023), while mainstream financial outlets like the *Financial Times* warn that "climate change could cause a new mortgage default crisis" (Tett, 2019). Moreover, in the face of costly long- and medium-term climate risks, experts are now warning that the 30-year mortgage may soon become a thing of the past (Flavelle, 2021).

For 75 years, working households in the United States have been encouraged to pursue homeownership as a means for achieving middle-class status and securing personal livelihoods into an uncertain future. This collective bet has depended on an asset, the U.S. sub/urban home, long argued to be an inherently valuable and secure form of wealth. It has also relied on an initially novel financial innovation, the 30-year mortgage, and trillions of federal dollars to "de-risk" private mortgage lending, including via the U.S.'s major mortgage government-sponsored enterprises (GSEs), Fannie Mae and Freddie Mac. As is now well known, this project has been racially exclusionary and frequently disappointed in practice—strains acutely exposed a decade ago in the Global Financial Crisis. How

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mortgage system actors will variously encounter and manage the more profound uncertainties of a climate-changed future is an urgent question for urban scholars.

In this paper, we advance such questioning by taking a multi-scalar view, qualitatively exploring how climate risks are increasingly being experienced, tracked, and governed at multiple illustrative moments of U.S. mortgage finance. We draw loosely here on financial “following” methods (Christophers, 2011; Gilbert, 2011) particularly used by scholars to unpack the Global Financial Crisis. Such methods draw on traditions of commodity and value chain analysis to track flows of money and/or credit in time and across spaces of the financial system, including moments where those flows risk breakdowns and cascading crises (and see Harvey, 1982).

Following U.S. mortgage lending up its complex value chains highlights how mortgage contracts and related capital flows articulate household experiences in climate-exposed cities with private lenders’ practices, institutional “de-risking” strategies, speculative financial market investments, and, ultimately, the life chances of many distant others connected in and through the global financial system. The subprime crisis set an alarming precedent for how these value chains can translate financial breakdowns on the ground into far-reaching ruptures (Langley, 2008). We also highlight gaps and tensions as climate risks begin to be governed. The subprime crisis is again a cautionary example, prompting important distributional questions (some beyond our ability to answer here). Critics have argued that the financial system was stabilized a decade ago in a way that worsened risks for many households. For what and for whom will new climate risks be managed and transferred? How might strategies deployed in institutional centers of financial power—and ultimately oriented toward the stability of these centers—be experienced by cities and working households at the front line of climate impacts? With what new risks and insecurities?

We follow U.S. mortgage finance through four illustrative moments of emerging climate risk impact and intervention. They include, first, experiences of working households in cities acutely exposed to climate impacts, which we explore using an example from Miami, Florida, and, second, mortgage professionals brokering long-duration loans to such households—with, we argue, major gaps in accounting for climate change. Third, we consider what happens when these mortgages are on-sold to GSEs. Fannie Mae and Freddie Mac have historically taken on much of the underlying institutional risk of the U.S. mortgage regime in purchasing residential mortgage loans from direct lenders and holding or on-selling them to secondary investors. As the U.S. federal government joins international efforts to regulate climate-related financial risks, GSEs have been newly called upon to assess and disclose their climate risk exposure. Fourth, we consider how these new risk management efforts encounter preexisting ones. GSEs were hit hard in the subprime crisis and regulators required them to manage their risk in new ways, including through the use of “credit risk transfers.” Via these financial derivative products, Fannie Mae and Freddie Mac effectively recast climate and disaster exposure as mortgage default, or credit, risks, that can in turn be packaged and sold to private investors via capital markets. As these practices encountered major weather disasters like Hurricane Harvey in the 2010s, they became a leading but highly uncertain mechanism for managing climate-related risks facing mortgage GSEs.

In considering these moments, we put into conversation ongoing research by the paper’s authors. Each moment is grounded in extensive fieldwork, interviews, and/or document analysis. Bounding this paper’s intervention, it is important to note that this illustrative, and to some extent speculative, method does not attempt to offer a full representation of U.S. housing finance under climate change, or still greater variability beyond the U.S. context (though mortgage debt has become a similar biopolitical strategy and locus for precarity in other national contexts, e.g., García-Lamarca & Kaika, 2016). Climate change impacts will affect U.S. housing markets in different ways and with varying severity, under evolving urban planning and adaptation strategies (e.g., Melix et al., 2023; Scott et al., 2020; Taylor & Aalbers, 2022). Experiences will further differ along lines of wealth, housing ownership forms, and preexisting exclusions. For example, we set aside for now important climate-related questions facing public housing inhabitants and renters, as well as the significance of parallel transformations like the rise of corporate and financial owners in many housing markets with

significant climate risk exposures (e.g., Aalbers et al., 2023; Beswick et al., 2016; Christophers, 2023). Nevertheless, as suggested above, the combination of acute and already-arriving catastrophic events like major Gulf Coast hurricanes and West Coast wildfires, the precarity of value-at-risk in housing markets like Miami,<sup>1</sup> and the ongoing transnational circulations of U.S. mortgage finance suggest that U.S. local housing-financial crises might cascade into national and global ones. By analyzing this fast-changing situation, we offer new insights into longstanding concerns for urban studies scholars which are increasingly inflected by consideration of climate change, particularly issues of displacement and housing reform (e.g., Oscilowicz et al., 2023; Schuetz, 2022; Shokry et al., 2023).

In the next section, we ground this discussion in developing literatures on climate risk and U.S. housing, financial system risks and regulatory strategies, and other practical and scholarly efforts to connect up these levels. In the following section, we move through each of our four identified moments, then conclude with initial lessons and priorities for further research.

## Literature review

This paper draws, first, on developing scholarship that explores how climate risks are being experienced and managed in (and beyond) U.S. cities. This literature includes growing work on planning tools, strategies, and principles for urban climate change adaptation, and evaluations of these interventions on the ground (e.g., Anguelovski et al., 2016; Melix et al., 2023; Scott et al., 2020; Shi et al., 2016; Shi & Moser, 2021)—important research that we acknowledge though do not engage in detail here. Kear et al. (2022) argue that many adaptation efforts prioritize the protection of single-family homes over other property forms like manufactured housing, among other ways in which preexisting forms of racialized exclusion are being reproduced in resilience planning (e.g., Grove et al., 2020). Other critical scholarship calls out rising dangers of “climate gentrification” (Anguelovski et al., 2019; Keenan et al., 2018; Taylor & Aalbers, 2022), or new speculative strategies for exploiting shifting terrains of risk, property devaluation, and revaluation across housing markets (and see Keenan & Bradt, 2020; Knuth, 2020; McAlpine & Porter, 2018).

Of particular relevance are analyses of how climate risks to urban property values may overflow physical adaptation responses on the ground—threatening more thoroughgoing devaluation that requires more systemic interventions. Concerns for property insurance have been central here, alongside other “insurantal mechanisms of assessment and risk spreading [that] are increasingly central to the constitution of climate change as a *public* problem that can be addressed by *collective* decision-making institutions, such as city governments and other public agencies” (Collier & Cox, 2021, p. 276). Scholars have argued that increasingly frequent and expensive climate disasters may depreciate property values at scale if property (re)insurance regimes collapse, or if private insurance becomes unaffordable for too many households. Such devaluations threaten cascading effects, from municipal government borrowing dependent on property tax bases to securitized mortgage regimes built upon the expectation that underlying properties will stay valuable. Contributions like Johnson (2013) and Taylor (2020) explore these strains (and see Elliott, 2021), as well as financial innovations like insurance-linked securitization that have been marketed as a “fix” (after Harvey, 1982) to secure urban real estate and the value of the capital invested in it.

Tett (2019) exemplifies how mainstream actors are beginning to connect these risks to U.S. mortgage finance, arguing that failure to prepare for climate risks may lead to cascading incidents of “disorderly” housing repricing and asset shocks to lenders, insurers, and homeowners in major property markets like Florida. This is far from an empty concern—notably, subprime lending and foreclosure crises were similarly disproportionately concentrated in certain places like sub/urban California and Florida, yet underlying capital circulations turned these local and regional disasters into national and global ones (e.g., Aalbers, 2009; Bardhan & Walker, 2011). Subprime-era crises of “underwater” homes—mortgages valued more highly than underlying properties following a market collapse—may reoccur both institutionally and all too literally in some climate-changed housing markets.

Similarly investigating how urban and financial system risks are materially and strategically linked under climate change, Cox (2022) explores moves by credit rating agencies to price perceived climate risks into municipal bonds. Via rating downgrades, cities perceived to be at high risk will increasingly find it more expensive and difficult to take out debt. Crucially, Cox finds that such risk includes not only direct physical exposures, but also the risk of property tax base decline, by way of housing devaluation and linked disruptions that may erode the fiscal capacity of local states (and see Shi & Varuzzo, 2020). Financial actors frame this repricing of asset values as necessary for informed investor decision-making and broader financial system health—allowing for controlled divestment from too-risky markets or the extraction of higher interest rates and fees as a price of remaining. These arguments problematically echo ones used to justify racialized financial exclusion and redlining in the history of U.S. mortgage finance (Freund, 2007), as well as new forms of racialized predatory lending emerging around climate risk today (Ponder, 2021). Ponder finds that U.S. majority-Black cities are charged more in municipal bond markets, including for crucial infrastructures needed for climate change adaptation—an ongoing stigmatization of “territorialized Blackness” as financial riskiness that goes above and beyond other structural economic disparities and varying exposures.

In this paper, we aim to further connect grounded experiences of climate risk to systemic financial concerns and strategies, and follow how and where financial regulators and investors themselves are making those links. Here we engage a select but growing critical literature exploring how powerful financial regulators and institutions, public and private, are organizing to assess and manage their own vulnerabilities and broader climate risks to the financial system. Efforts include drives for new international regimes of climate-related risk disclosure (Christophers, 2017, 2019)—notably, the Task Force on Climate-Related Financial Disclosure, created by the multilateral Financial Stability Board (FSB) in 2015. They also include climate “stress-testing” efforts by major central banks (Langley & Morris, 2020), increasingly joined together in the Network for Central Banks and Supervisors for Greening the Financial System, which aim to standardize banks’ climate risk management practices. As existing research discusses, these regulatory efforts have moved to codify diverse kinds of financial risk arising from climate change, and in theory to price these risks into institutional practices. Christophers (2017) captures a core argument driving these efforts, using the example of sea level rise:

The risk of rising seas engulfing a Pacific island whose inhabitants and public institutions are essentially isolated from the global financial system is potentially a human tragedy but is not likely to be a threat to financial stability. If, though, for example, those inhabitants have property insurance and their government raises finance by issuing debt in the international capital markets, then, if the numbers involved are big enough, the threat to financial stability represented by rising sea levels could be a very real one indeed. It could bankrupt insurers, investors (e.g., in the government’s debt), and perhaps even the government itself. (p. 1111)

Scholars note that climate risk regulation has been significantly influenced by the legacy of the Global Financial Crisis. The FSB was formed after the crisis, intended as a new pillar of global economic governance alongside existing multilateral financial institutions like the IMF and World Bank. Christophers (2017) discusses how the creation and activities of the FSB reflect growing post-crisis concern for systemic (rather than simply institution-specific) financial risk. Critics argue that these regulatory efforts worked to “restore and keep open uncertain financial circulations” in ways that have done little to address the inherent risks and crisis tendencies of today’s more broadly deregulated financial system (Langley, 2013, p. 113 and see; Cooper, 2010; Mirowski, 2013). Christophers (2017) maintains that emerging climate disclosure regimes similarly fail to discard neoliberal notions of market discipline and rationality used to justify the progressive deregulation of financial markets since the 1970s. Namely, they continue to equate *disclosing* climate risks with actually *lowering* them, and keep private financial actors and markets in the drivers’ seat of governance efforts. In many ways, attempts to govern through techniques of risk pricing and observations reflect the speculative nature of the object they attempt to govern (Morris, 2018)—we have no guarantee that these market-led efforts can actually prevent future climate-related crises, though they may nevertheless have very real near-term consequences for exposed cities and households.

The financial “following” method (Christophers, 2011; Gilbert, 2011) we draw on here exposed important distributional and justice concerns in the subprime crisis, including within governance of the crisis. Critical urban scholars (e.g., Aalbers, 2009; Crump et al., 2008; Wyly et al., 2009) used this method and related techniques to explore the multi-scalar mortgage value chains and breakdowns that generated the subprime collapse. They moved from the many households that were sold subprime mortgages (often via predatory practices) and the brokers and lenders on-selling them, to investment banks generating mortgage-backed securities, to public and private institutional investors purchasing and holding these financial instruments, and markets for financial derivatives promising (erroneously) to guarantee the stability of these complex debt architectures. Similarly, scholarship (e.g., Immergluck, 2013; Langley, 2013; Mirowski, 2013) tracked where government efforts to bolster the financial system and “too big to fail” institutions stopped, as many households and communities were abandoned to suffer the longer-term effects of the foreclosure crisis. This negative legacy clarifies important stakes in linking mortgage finance to the broader search for more just, “transformative” climate adaptation strategies in U.S. cities (Shi & Moser, 2021).

## Four moments of climate-financial risk in U.S. housing

### *Moment 1: Frontline households*

Françoise feels trapped between a present she can't afford and a future she fears. Wiping away at the sweat steadily collecting along her glass of water, she identifies her captor: the South Florida housing market under climate change. “People don't understand why I'm so upset about this,” the 53-year-old says regarding the Liberty City, Miami home she just inherited from her mother. “They go, ‘Françoise, isn't it nice you can return to the home you grew up in? To know you're set and taken care of even though your mom passed?’” She pauses to take a deep breath. “I really wish I could feel that way,” Françoise says, now in a lowered voice. “But it just feels like a burden. I look at the property values here, and they're rising. And they're going to keep rising since it's on high ground. That should be a good thing. But I know I'm going to get reassessed and the mortgage is going to go up, on top of property taxes, and I just can't afford it.” Importantly, Françoise doesn't think she can resolve this dilemma by selling the house and moving somewhere close that is more affordable. “If I sell, I won't be able to buy in Miami again. It's too expensive now. I'll only be able to go to places like Homestead.” Referencing the ongoing flooding there, Françoise expounds, “And I've been out there, I know what's going on. If I buy a house down there and it becomes worthless, I've still got a mortgage to pay but I have no future.” (Personal communication, June 16, 2019)

Françoise's story comes from an encounter during fieldwork in South Florida—the same region that the *Financial Times* centered in its sanitized warning of “disorderly repricing.” While some of Françoise's concerns are unique to the political, economic, and physical geographic conditions of this paradigmatically at-risk place, they speak to the novel pressures that climate change poses to individual residential mortgage holders across the country. Like many living in South Florida, Françoise's first home was not Miami. She moved there with her family from Port-au-Prince, Haiti as a little girl. Upon arrival, Françoise's family worked to realize one of the biggest promises that the United States has to offer: that homeownership, made possible through the long-duration residential mortgage, can advance upward economic mobility and produce intergenerational wealth.

Growing research on how climate change may impact housing markets has thrown that promise—however unevenly it has been made realizable in practice in any case—into considerable doubt moving into a more uncertain future. Experts estimate that in the coming decades, approximately half a million homes in the United States will be on land that floods once a year. These ever-expanding floodplains and parallel climate change impacts may, in turn, result in drastic changes in insurance premiums and coverage, as well as to property values. The state of Florida alone could see between \$10 billion to \$30 billion in property devaluations linked to climate change by 2030 (Woetzel et al., 2020). As lenders increasingly incorporate these prospects into their practices, working- to middle class individuals like Françoise are paying the price. For one, the now standard 30-year timespan of her mortgage—a long duration, low-rate loan first authorized in 1948 by Congress as a central feature of

the nation's postwar economic growth strategy—may revert to its pre-war duration of 15–20 years (e.g., Freund, 2007). This temporal constriction will be felt hardest by those with the fewest financial resources: with less time to pay off their debt, low- to medium-income individuals will likely be priced out of homeownership.

However, as Françoise's experience illustrates, those who can purchase and/or remain in a home over a mortgage's lifespan still face daunting futures. What if, for instance, a disaster strikes over the course of the mortgage cycle—be it 15 or 30 years long—triggering significant property damages and devaluations, leaving homeowners with significant repair costs they cannot afford, and on a home that is now worthless but for which they still owe a significant amount of debt? Likewise, as noted above, homeowners in risky locations increasingly face either rising insurance premiums or a lack of available insurance altogether, significant as insurance historically has been required to acquire a mortgage in the first place. Doomsday scenarios like these are not confined to some abstract future, nor are their economic effects confined to individual homeowners. Following Hurricane Harvey's 2017 landfall in Houston, Texas, researchers found that countless homeowners defaulted on their mortgage payments in the wake of the storm (Kousky et al., 2020).

Ultimately, the solution Françoise arrived at speaks to one of the most surprising consequences of climate change for norms of U.S. residential mortgages and those that hold them: the financial instrument long intended to secure household livelihoods over the long term may, under climate change, be the force behind their displacement. “Honestly, I think I'm going to move to South Georgia,” Françoise concluded at the end of the conversation relayed here. “It's dry.” While she reported regrets about formally ending her family's history in Miami with this planned move and uncertainty about how to reestablish similar connections somewhere new, it is the future—whose temporal limits the strained mortgage under climate change increasingly demarcates—that guides her present-day decisions. Increasingly many homeowners in highly climate-exposed cities face a similar moral dilemma, of staying and risking future housing damages and losses or choosing to walk away without knowing if anyone will want to buy their home.

These imposed decisions raise serious questions about the notion that homeowners can build and maintain intergenerational wealth using credit in the form of a mortgage—climate-financial risks in cities like Miami increasingly threaten both homes and wealth-building strategies based upon them. Moreover, to borrow from Françoise's story once more, additional uncertainties arise about whether or when the “drier” place/s to which she and homeowners like her relocate may face their own climate-linked price pressures. In other words, climate-linked relocation doesn't diminish wealth-building anxieties so much as it defers and stretches them into an uncertain future.

## ***Moment II: Mortgage professionals***

The kinds of decisions that Françoise and individuals like her can—and cannot—make about their futures are shaped by those who broker these long-duration loans. A broad constellation of technical experts is now involved in the U.S. mortgage lending process. Major questions exist about how these diffused, geographically fractured professional networks are accounting for new forms of climate risk emerging unevenly across U.S. housing markets. Where they are failing to do so, equally urgent questions are the costs and risks that these networks may both directly experience and transfer to others across the U.S. mortgage finance system: “down” to households on the ground and “up” to institutional actors like GSEs and the broader financial system.

Beyond mortgage lenders themselves, which may be banks or credit institutions, many professionals are involved in the U.S. mortgage lending process. These experts include loan officers, who connect homebuyers to potential loans; mortgage underwriters, who assess homebuyers' risk and “credit-worthiness”; and risk modelers, who may be brought in to assess hazards, loan-to-value ratios, and other environmental and financial factors that may make a transaction more or less risky. Information from underwriters and risk modelers is used to shape pools of mortgage loans into an aggregate portfolio that can be bundled and on-sold in the form of a residential mortgage-backed security (MBS)—particularly, as an aid to rating MBSs according to their underlying risk profiles. Finally, mortgage

brokers act as a conduit between prospective homebuyers and mortgage lenders, and play a key role in advising households on mortgages. Their awareness of climate-related risks plays a key role in shaping what households know before they are “locked in” via long-term mortgage contracts.

Mortgage lenders are directly exposed to climate risks in both acute and chronic terms. Acute shocks, like large-scale disasters, may result in pools of a lender’s retained portfolio of loans being written down due to delayed payments or high rates of default, should homeowners walk away from damaged or destroyed homes altogether (Ratcliffe et al., 2019). Mortgage loans are secured by physical properties as collateral, meaning that lenders’ ultimate remedy in case of default is to foreclose upon these properties. This strategy has major limits in cases where properties are significantly damaged or their long-term value otherwise falls into doubt—especially in markets exposed to more chronic, gradual climate risks like rising seas. If lenders repossess homes in post-disaster settings, they may be required to invest significant funds to repair them in order to recover some of their losses. Looking ahead, one might imagine that “distressed” homes located in neighborhoods or broader urban-regional markets with unfavorable climate risk perceptions might be resold at an even steeper discount. Alternatively, one might also imagine that savvy mortgage lenders might leverage existing mechanisms to pass risks on to other market stakeholders. Emerging research points to three related ways in which mortgage actors may be inclined to transfer risk to other actors across the housing finance system—some may already be doing so.

First, U.S. mortgage lenders with concentrated exposure to climate risks appear more inclined to rely on securitization to transfer associated financial risk and uncertainty (Keenan & Bradt, 2020)—thus passing risks on to other housing finance institutions. Testing this hypothesis by comparing the securitization rates of concentrated versus diversified mortgage lenders in sea level rise-exposed geographies in the U.S. Southeast, Keenan & Bradt argue that “local, concentrated lenders are already taking action to transfer risk and to limit exposure” and that “[t]hese local lenders are likely taking these actions based on their ability to collect superior, soft information” (p. 2059) relative to less granular, less sophisticated “off the shelf” physical climate risk assessment products now widely used by more diversified mortgage lenders and other real estate finance institutions.<sup>2</sup> This suggests a multifaceted information asymmetry—between, on the one hand, local lenders and other actors like builders and realtors who can marshal high levels of tacit knowledge about local climate risk, and, on the other hand, both more diversified lenders and other mortgage market stakeholders (e.g., mortgage security investors, many individual borrowers) without such information. This disparity has significant potential ramifications across the mortgage value chain, a point to which we return in the following sections.<sup>3</sup>

Second, the mainstream mortgage lending system expressly defers responsibility for pricing and managing acute, near-term physical climate risks to homeowners’ insurers, their reinsurers, and their capital providers, by way of insurance-linked securitization and other risk transfer techniques (Taylor, 2020). U.S. housing enterprise regulations require all government-backed mortgages to maintain insurance over the life of the loan term (Kunreuther, 1996). Mortgage brokers may help connect homeowners with relevant insurance products, but insurance protections are not guaranteed for the lifetime of mortgages (though homeowners may assume that they are). Insurers and reinsurers may choose to adjust premiums annually, or to exit risky markets altogether, leaving growing swathes of risk to the public through “insurers of last resort” (Taylor, 2020). In recent disaster events such as Hurricane Katrina, less than 30% of homeowners had flood insurance (Michel-Kerjan, 2010). In the case of Hurricane Harvey, less than 20% of homes were insured (Ross, 2019). Such experiences show that many homeowners have faced rebuilding without any financing from insurance claims. Meanwhile, many lacked financial guarantees from mortgage lenders for loan forbearance or moratoriums on foreclosures (e.g., Gallagher & Hartley, 2017; Overby, 2007). Crucially, insurance only serves as *ex post* finance—there are generally few and limited insurance premium-linked mechanisms in place to mitigate risks upfront (e.g., through discounted premiums if owners undertake “hurricane hardening” or “wildfire hardening” retrofits to their homes), despite significant policy experimentation in places like Florida and California. Relatedly, an important post-disaster remedy sought today

by bankers and brokers is for indebted homeowners to obtain *additional* loans to manage the financial costs of rebuilding and repair, often in response to underinsurance (Klein, 2022). Such gaps have potential stakes for mortgage professionals as well: in transferring risk downward, these actors may ultimately be creating conditions for their own instability if local/regional housing markets are undermined at scale.

Third, and related to the role of the state as an insurer of last resort, mortgage lenders have essentially relied on the sustained provision of Federal Emergency Management Agency (FEMA) support and other forms of government assistance after disasters, including histories of debt forbearance (temporary payment relief and foreclosure moratoria) offered through mortgage GSEs. GSE forbearance programs have seen frequent use under recent climate-related disasters, though also have been criticized for temporal mismatches with the months- to years-long timescales usually needed for post-disaster recovery and rebuilding.<sup>4</sup> For example, Kaul and Goodman (2017) argue: “forbearance works best during financial disruptions, such as job loss or a temporary increase in expenses. Deferring a few mortgage payments gives households time to stabilize their financial situation (e.g., by finding a new job) before resuming monthly payments. Natural disasters, on the other hand, can be a long-term affair.” Meanwhile, FEMA channels often-substantial federal funding directly to homeowners to cover uninsured losses, repairs, and rebuilding (Blickle et al., 2021) but does not impose corresponding financial obligations to mitigate underlying risks via short- or long-term approaches (it provides other hazard mitigation assistance such as funding for home retrofits, but on an optional grant basis; e.g., Elliott, 2021). We return to this point in the concluding discussion.

A crucial challenge remains in tying these disparate dynamics together in constructive ways without prompting substantial disruptions, either to housing provision or to overarching financial markets. Recent research funded by the Mortgage Bankers Association (Beckett, 2021) argues that we know too little about the likely impact of climate-related disruptions on rates of mortgage default—including due to collapses in property insurance regimes—and the number of potentially adverse loans and MBSs now in the system. Similarly, there is insufficient information to assess levels of volatility in housing prices and other factors which might trigger climate-related migration at scale to less risky housing markets (see BIS, 2021). However, a particularly crucial route, as we will see in the next section, has been direct lenders’ on-selling of mortgage loans to federal GSEs as well as to other secondary buyers. These more distant institutions may face significant challenges in understanding the climate-related risks hidden within seemingly safe portfolios of mortgages and MBSs.

### ***Moment III: Mortgage GSEs under federal climate risk disclosure***

In 2020, a letter to the U.S. Federal Reserve from major financial institutions argued that “the climate crisis poses a systemic threat to financial markets and the real economy, with significant disruptive consequences on asset valuations and our nation’s economic stability” (Ceres, 2020). The letter was part of a raft of private sector efforts to spur the Federal Reserve and U.S. federal government to join solidifying international regimes of climate risk disclosure. These hopes were realized in the Biden administration’s 2021 Executive Order on Climate-Related Financial Risk, which compelled a government-wide accounting of climate exposures. This order includes GSEs like Fannie Mae and Freddie Mac, entities which have crucially supported—and assumed much of the systemic risk of—the U.S. residential mortgage system. In the subprime crisis, these institutions suffered their own financial breakdowns when homeowners rapidly defaulted on mortgage loans en masse. How will such government disclosure push or pull experiences like Françoise’s as they evaluate GSEs’ rising exposure to climate risk? Will they help, or provoke a “system-protecting” retreat from risky housing markets?

As we saw above, a rising initiative in climate governance has seen major institutions and regulators track and formally disclose their exposures to climate-related financial risks. After much foot-dragging, the U.S. Federal Reserve joined other central banks in the Network for Greening the Financial System in December 2020. In May 2021, the Biden administration followed up with a major executive order mandating agencies across the federal government to “assess, in a detailed and comprehensive manner, the climate-related financial risk . . . to the

financial stability of the Federal Government and the stability of the U.S. financial system” (White House, 2021a). Though many uncertainties remain about how this new federal government regulation will take shape, it may significantly affect U.S. residential mortgage lending—directly so for GSEs if the Federal Housing Finance Agency (FHFA), their regulator, issues new rules.

Government-backed corporations like the GSEs played a crucial role in driving mid-20th century federal government efforts to support mass private homeownership. A central project was the normalization of the 30-year fixed-rate mortgage. These then novel long-duration debt contracts were made affordable for the white working class through a raft of federal government programs. Government initiatives linked mass livelihood security to homeownership and durable and increasing home values—while simultaneously excluding many households via practices like racial redlining (Freund, 2007). The activities of Fannie Mae and Freddie Mac, for example, have played a central role in making U.S. residential mortgages available and affordable. These GSEs purchase a significant share of mortgages made by private lenders and securitize them. In other words, they aggregate pools of individual mortgages with a common risk profile, package each pool into a security, and on-sell these MBSs to capital markets (as well as holding a significant share themselves as internal investments). This practice allows mortgage lenders to recycle their capital into new loans, and transfers much of the risk from these direct lenders upwards, to GSEs themselves as well as to other institutional investors across the financial system.

GSEs have issued MBSs since long before the subprime crisis (Quinn, 2019). In the 2000s, private investment banks infamously took up this established GSE practice, using it to channel more and more capital into high-risk, high-return predatory home lending and creating a boom in “private-label” MBSs. Big banks sought new ways to profit from packaging and on-selling cost-burdened homeowners’ streams of debt repayment, but many of these streams (and banks) failed when households were forced to default—sparking further defaults and foreclosures in the resulting crisis. Ultimately, it fell to the GSEs and federal government—and U.S. taxpayers—to make up for the bulk of losses (Schuetz, 2022). The GSEs had become major off-takers and holders of these “bad loans,” and suffered badly from resulting defaults. In part, they had become so to negotiate multi-sided political critiques and conflicting imperatives, exacerbated by escalating neoliberal defunding of, and more chronic underinvestment in other federal public and affordable housing supports (e.g., Quercia & Galster, 1997). After years of lobbying by community reinvestment movements, Democrats in the 1990s directed GSEs to invest more in low-income communities to combat legacy redlining—meaning that GSEs inadvertently helped fuel the predatory “greenlining” rush of the subprime era. These multi-sided conflicts between just practice and solvency are recurring in new ways under climate change, as for other federal supports like the National Flood Insurance Program. Such programs are already facing potentially unbearable expectations under political neoliberalism, and now are inadvertently becoming a front line of governmental climate response (Elliott, 2021). These negotiations will, ultimately, directly structure the possibilities available to working homeowners like Françoise.

In this context, federal mandates to drive better understanding of the mortgage system’s growing climate risk are highly significant. Despite shifts in GSEs’ risk management practices following the subprime crisis, as we will see below, their vulnerability to climate risk remains a major concern. Ten-plus years after the subprime crisis, trillions of dollars in U.S. MBSs continue to circulate in international capital markets, most once again issued by the GSEs. In 2020, GSEs’ MBSs were valued at \$7.3 trillion, 63.4% of the U.S.’s total outstanding mortgage debt (Housing Finance Policy Center, 2021). These mortgage securities may contain significant climate risk. Ouazad and Kahn (2021) have argued that “in the aftermath of natural disasters, lenders are more likely to approve mortgages that can be securitized, thereby transferring climate risk” and that without GSE support, “[m]ortgage credit supply would decline in flood zones and lenders would have a greater incentive to screen mortgages” (p. 1; see also Keenan & Bradt, 2020). Fannie Mae-sponsored research partially disagrees with these

findings but suggests that such transfers of climate risk by lenders “could [occur] in the future, especially if climate risk becomes easier to estimate and/or worsens” (LaCour-Little et al., 2022, p. 2).

The Federal Reserve’s new climate mandate may shift this picture. The Fed’s recently launched Pilot Climate Scenario Analysis (similar to other central banks’ climate stress test exercises) will evaluate the aggregate credit risk relating to residential and commercial real estate by six of the U.S.’s biggest banks over a one-year horizon in 2023 (Federal Reserve, 2023). Similarly, under the Biden administration mandate the Office of the Comptroller of the Currency (OCC) has recently published draft principles for managing climate-related financial risks across almost every level of banking activity. Particularly relevant for mortgage lending is a draft requirement that banks should “consider climate-related financial risks as part of the underwriting and ongoing monitoring of (credit) risk” (OCC, 2022, p. 4). These principles also propose that such analysis should extend beyond banks’ “typical strategic planning horizon” (p. 2), acknowledging the potential for longer-term destabilizations under climate change. Such moves will increase the regulatory burden on mortgage lending.

More directly, Biden’s executive order pressures GSEs to incorporate placed-based risk pricing into their lending and risk management practices. In 2021, the FHFA and the Treasury Department’s Federal Insurance Office issued requests for public comment to gather information on GSEs’ climate-related financial risks. These risks are now included in the FHFA’s annual “scorecard” evaluating GSEs’ performance, under a mandate to improve “federal underwriting and lending program standards to better address the climate-related financial risks to . . . loan portfolios” (White House, 2021b). However, as of this writing more concrete actions by the FHFA and other regulators are still emerging. Fannie Mae is not yet rejecting mortgages based only on climate risk. In a recent interview (Olick, 2023), Fannie Mae’s chief climate officer argued that understanding the full risks to its current balance sheet and changing underwriting practices will take years:

The first step is understanding what the damage will be to each property. The second step is how is that going to change our behavior? And how is that going to change valuation of properties? . . . Is [that] five years away? I’m not sure.

Equally uncertain and pressing are the potential tensions growing between imperatives to protect GSEs’ solvency, the broader financial health of the U.S. federal government and economy, and homeowners like Françoise potentially locked into mortgages in high-risk locations. If GSEs begin to reject and divest these potentially risky mortgage loans, their withdrawal may spark broader devaluation in affected housing markets—a particular blow to working homeowners who risk losing lifetime investments and lack the resources to buy elsewhere. Agencies have voiced a commitment to “ensuring the safety and security of communities most impacted by climate change” (White House, 2021b), and the OCC is working to implement new community lending rules to avoid new “climate redlining” and disinvestment by banks (Weinberger, 2022). However, it is far from clear how these protections will be organized and guaranteed by GSEs: how will they reduce their exposures to risky cities and mortgage markets without simply abandoning the many people who still live in these places?

#### ***Moment IV: Credit risk transfer and capital market “off-takers”***

In the subprime crisis, financial derivatives and other risk management strategies sold in (and by) capital markets became a major problem. Boosters argued for such instruments’ ability to “off-take” and diffuse the risk of inherently shaky practices like predatory lending to financially precarious homeowners. These strategies backfired in the Global Financial Crisis, turning local collapses into a systemic failure. However, following the crisis, GSEs and their regulators did not abandon the idea of looking to capital markets to insure their, and by proxy the mortgage system’s risks. Instead, GSEs were compelled to turn to a new financial derivative, the “credit risk transfer” (CRT). How have CRTs coped with major weather disasters to date, and how might they deal with future abrupt and widespread devaluations due to climate change? How do such new financial(ized) practices obscure—or even heighten—the risks of vulnerable homeowners like Françoise?

During the Global Financial Crisis, Fannie Mae and Freddie Mac were left in crisis and unable to operate. In fall 2008, the FHFA took them over in a major bailout ultimately funded by taxpayers. As part of this federal takeover, the FHFA required both GSEs to undertake significant market-based “disciplining” intended to lower their risks, reduce systemic financial risk, and insulate U.S. taxpayers from another catastrophic default event. The key risk targeted in these reforms was “credit risk.” A major reason for GSEs’ overwhelming financial losses during the subprime crisis was that when these entities on-sell mortgages to broader capital markets in the form of MBSs, they historically have done so with the guarantee that they will absorb credit risk: losses due to nonpayment of any given mortgage pooled within a security. Regulators’ preferred solution to this problem was to double down on financial innovation via turning to CRTs.

By issuing CRTs (see Figure 1), GSEs “sell” much of the risk of mortgage defaults to investors via capital markets (with varying contract lengths, distinct from the 30-year horizon of the conventional residential mortgage). Like credit default swaps and many other exotic instruments popularized during the subprime bubble, CRTs are financial derivative products. In other words (and unlike mortgage securitizations), they do not involve sale of the underlying loans, and are more accurately understood as a contract held between two parties. Effectively, third party off-takers profit from betting correctly about whether a series of loans will or will not default, in ways that impact the performance of loan pools—and more indirectly, in betting that underlying property markets will remain stable in the event of a major disruption, like an economic downturn. CRT issuance targets the range of potential losses which run between the GSE’s own retained risks and those costs expected to be paid by taxpayers in another “catastrophic” default event—specifically, one which exceeds the losses experienced during the subprime crisis. For Layton (2020) and other proponents of the approach, CRT complements the role of GSEs in handling mortgage risks.

At present, more than 70% of the credit risk on new single-family mortgages is transferred to private market investors via CRTs (Layton, 2020). Moreover, CRT strategies by GSEs like Freddie Mac have multiple pillars, from mortgage issuance and credit enhancement tools focused on individual household borrowers to sales of certain securities to institutional investors and (re)insurers. (Traditional mortgage insurers also increasingly leverage insurance-linked securitization, mentioned above, to manage their credit risk exposure; see Johnson, 2013; Taylor, 2020.) Overall, Freddie Mac transferred \$86 billion of credit risk against \$2.7 trillion of mortgages from 2013 to 2021.

As the new final moment in transfers of risk up mortgage value chains, CRT has increasingly become a climate risk management strategy for GSEs, and thus the broader U.S. residential mortgage system. Advocates argue that use of CRT as a “de-risking” strategy for GSEs means that the federal

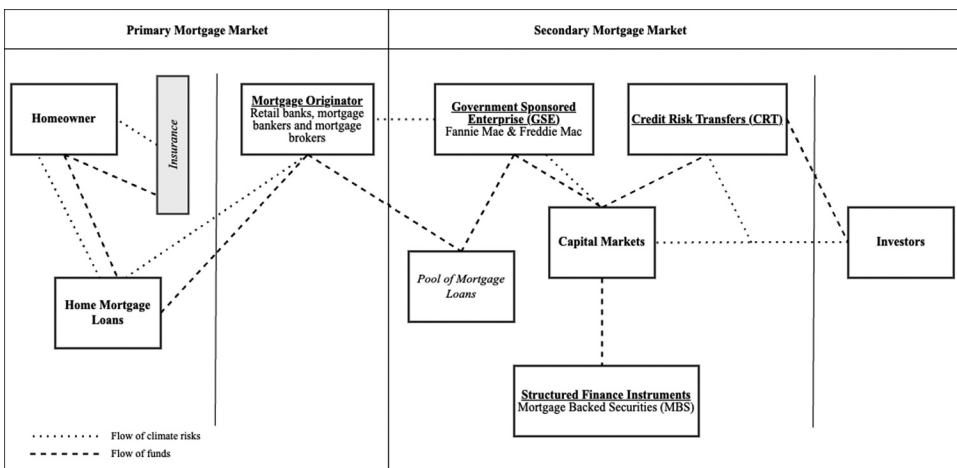


Figure 1. Circulations of value and risk in the U.S. residential mortgage market.

government and taxpayers should hold less responsibility for any given catastrophic loss due to climate change, as capital markets spread such climate risks to a more geographically and institutionally diverse network of investors. This financial innovation ostensibly makes it possible for GSEs and private mortgage lenders to continue to responsibly underwrite or buy mortgages made to homeowners like Françoise and in cities like Miami—thereby preventing capital flight and climate-related devaluation in those housing markets. During a recent U.S. House Financial Services subcommittee hearing on climate-related financial risk, one expert witness called on government regulators to expand the use of CRT for this purpose, alongside additional financial derivatives (e.g., a proposed “climate credit default swap”) to transfer mortgage credit risks from highly exposed places like South Florida (Rossi, 2021, p. 8).

Proposals to increase reliance on capital markets to mitigate climate risks demand critical scrutiny. These strategies embed serious potential vulnerabilities if disaster impacts are too expensive or widespread. Moreover, such bids to use capital markets to transfer and diffuse acute housing market risks failed for similar reasons in the Global Financial Crisis, to disastrous and systemic effect. Markets and regulators are increasingly tracking CRTs’ performance during weather disasters as large-scale loss events. Questions were particularly raised by Hurricane Harvey, which generated profound residential property losses when it hit Texas in 2017 (and was significant in spurring the climate risk disclosure initiatives discussed above). The hurricane caused a notable change in CRT security pricing due to private investor concerns that a significant number of properties would be damaged or destroyed at the same time (Colman, 2020), and brought GSEs’ use of CRTs under scrutiny by the Association of Mortgage Investors. In the aftermath of the storm, Freddie Mac began to issue surveillance reports on the performance of outstanding CRT instruments with underlying exposure to mortgaged homes in affected areas.<sup>5</sup> Underlying credit risks were indeed potentially significant, as Hurricane Harvey became one of the costliest disasters in U.S. history. In Harris County, Texas (Houston) alone, more than 204,000 single family homes and apartments were damaged or destroyed, largely due to flooding (Hunn et al., 2018). This led to significant rates of mortgage delinquency and loan modification (Kousky et al., 2020).

In contrast to the pain that Hurricane Harvey caused to communities on the ground, it became influentially marketed as a success story for CRT as a system-stabilizing tool. Freddie Mac found that the sum of Harvey-related defaults was ultimately not large enough to trigger losses, counter to initial concerns raised by CRT investors (see again Colman, 2020). In this sense, Freddie Mac’s CRT strategy worked as planned. It is “designed to pool 100,000 or more mortgages together on a national scale. As a result, when disasters strike the net impact on a mortgage pool is very small. Even large-scale events result in losses of only a couple of basis points” (Global Capital, 2021). However, scrutiny of CRT remains heightened in Hurricane Harvey’s wake, notably from Freddie Mac. For example, after Harvey, access to insurance capital—in that instance, flood insurance—was crucial to containing the rate and severity of mortgage distress (Kousky et al., 2020). Climate-related disruptions to property (re)insurance thus remain a serious concern here. For example, if a major Japanese typhoon, Australian bushfire, Florida hurricane, and European flood play out in close succession and all demand insurance payouts, they could wipe out existing pools of public and private capital available to finance catastrophe risks, while also scaring off would-be replacement investors—a form of (re) insurance crisis that would leave homeowners, and in turn, the mortgage-financial system, more directly exposed to losses (Taylor, 2020).

The contrast between CRTs’ “success” (and see Gete & Tsouderou, 2022) and the grueling frontline experiences of post-Harvey households illustrates serious inequalities and injustices that financial(-ized) strategies to mitigate climate risk may be poorly positioned to address—and the concern does not end there. For example, via their promised ability to secure housing values and business-as-usual lending practices (and to do so via complex financial market strategies that households on the ground are unlikely to fully understand or even be aware of), interventions like CRT invite working households to continue to call risky places home. At the same time, calls to further incorporate climate risks into mortgage finance may very well make things *worse* for frontline communities in high-risk areas,

as these “protections” incur higher risk management costs across the mortgage value chain—ultimately reflected in higher borrowing costs to households.

Finally, CRTs create an additional ethical concern and very real danger. Via this tool, the federal government gives speculative financial investors a powerful platform for betting on—and *against*—communities and cities’ futures under climate change. For example, opportunities for investors come in CRTs’ varying contract lengths. Some CRT notes issued by Freddie Mac have a 20-year maturity, while others have 12.5-year maturity. These differing maturities reflect quite different underlying bets on how long housing markets will remain viable and valuable. Moreover, neither of these terms match up with climate change’s longer-term potential effects in cities, or even the full 30-year investment homeowners risk with standard mortgages. Further variation within the structures of instruments—e.g., varying term lengths of individual tranches, differing coverage provided, more or less “liquid” investment types—also shape horizons over which investors can strategically craft and trade specific exposures and bets on uncertain climate futures. In these practices, major financial actors are not simply speculating on how residential markets will encounter uncertain natural events. Their strategic investments and divestments have significant power to reshape those underlying markets *preemptively*, perhaps heightening risks for many (Taylor & Aalbers, 2022).

## Conclusion

How the climate change exposures and potential breakdowns discussed here will manifest, and whose interests will be privileged in efforts to manage such risks, are key questions for climate justice. Familiar and pressing justice questions—what, for whom, where, and when—are crucial as we watch new frontiers of financial practice emerge in relation to climate risk. Such queries take us to a more normative, necessarily political set of questions about what, exactly, the underlying housing risks are that we want to manage. This appraisal is less about whether emerging risk management efforts are “good” or “bad,” although certainly above all else they prioritize preserving the existing order of mortgage finance and broader financial system. It is more about whether underlying mortgages—and borrowers and the communities in which they live—are also meaningfully “de-risked” (or not) through whatever larger combination of policies, programs, and strategies emerge to govern climate risk across U.S. neighborhoods, cities, and regions.

A major issue suggested by the discussion above is that financial risk strategies being proposed by mainstream regulators, no matter how innovative and well capitalized, may not perceive climate risks in a form and scale which matches the kinds of experienced personal dilemmas and precarity illustrated in this exploration. As discussed above, a major risk of new “success stories” like CRT is that they may fail to account for multiple and ongoing catastrophe shocks due to climate change. They may also inadequately mobilize sufficient concern and resources for everyday climate risks and more gradual yet profound shifts: for example, erosion of property values due to mounting nuisance flooding, or progressively climbing property-level expenses related to climate risk management (e.g., in increasing insurance premiums or property taxes to finance risk management). These financial strategies sustain dependence on insurance-based risk transfer tools (or optional, patchy building-level retrofitting) rather than opening up a more profound rethinking of today’s urban infrastructures and planning norms. This is so even as the fragilities of such insurance-centric approaches are increasingly being questioned in the United States, Germany, Australia, and other financialized property states struggling to “build back better” in the wake of recent major disasters (e.g., Hofmann, 2022; Taylor, 2020; Zavareh & Winder, 2021). Moreover, they reproduce the primacy of property value as the priority *object* of risk mitigation (Kear et al., 2022), foreclosing more expansive, just, and socially transformative notions of climate adaptation (Shi & Moser, 2021).

Finally, critical urban scholars and organizers have been taught by bitter past experience—notably during the Global Financial Crisis—that when financial value chains rupture at scale and powerful actors muster to protect the system, restabilization often comes at the cost of the most precarious. Indeed, new forms of climate redlining and governmental-financial abandonment of communities are a very real

potential outcome of governmental risk disclosure regimes and financialized risk management strategies. While regulatory protections have been put in place against known historical forms of redlining, patterns of capital withdrawal conditioned by public policy (and its selective absences) will unevenly affect homeowners particularly reliant on this governmental support, in ways which inevitably will be racialized as well as classed. Meanwhile, the many households who are already compelled to rent or who are unhoused may be systematically excluded if their personal risks do not ascend to the level of official state concern. They will require more affirmative protections like government-managed and -resourced retreat, and larger scale public planning and investment to reshape communities' risks on the ground. All go far beyond the scope of the financial market mechanisms centered here. Ultimately, the strategies discussed in this paper are speculative in key ways, and so must critical interventions be: there is still time to make alternative climate futures, and to imagine how more just housing and urban strategies can advance them.

## Notes

1. Miami is becoming a high-profile example of this vulnerability: (1) since its economy is backed by (luxury) property values, climate-linked devaluations like we describe here stand to decimate it, and because (2) (extra-) local responses to these prospects are contributing, intentionally or not, to what some term “climate gentrification” in the city’s most topographically elevated, low-resource neighborhoods (Taylor & Aalbers, 2022).
2. From the perspective of mortgage lenders and other institutional users, such models have numerous documented shortfalls that limit their application to asset- and community-level risk assessment (Taylor & Erasmus, 2022). More broadly, Keenan and Bradt (2020), Z. J. Taylor and Weinkle (2020) and Condon (2023) alike have raised alarms about the need for more transparent and rigorous reflection on the data and analytical techniques used to produce and deploy risk assessments within asset pricing and underwriting techniques.
3. For example, Keenan and Bradt (2020) note that securities investors may increasingly demand a risk premium on loans backed with risk-exposed collateral, leading to declines in the availability of mortgage credit in risk-exposed areas—and, in turn, waves of asset devaluation. In contrast, more local housing actors are less likely to immediately change behavior and reappraise asset values. After presenting South Florida real estate professionals with physical climate risk maps, Palm and Bolsen (2021) observe limited actor concern: even in a high-risk, high profile setting, countervailing market forces (like sustained buyer interest and capital accessibility) are eroding the extent to which climate risks are being fully capitalized into pricing and actor behavior (see also Hino & Burke, 2020; Kousky et al., 2020; Taylor & Erasmus, 2022).
4. For example, Freddie Mac has disaster relief options that are available to homeowners with mortgages that it owns or guarantees falling within federally declared major disaster areas, alongside other forbearance programs for affected homeowners (e.g., Freddie Mac, 2017).
5. This judgment on what areas qualify as “affected” was based on counties and parishes FEMA identified as in need of individual assistance during the disaster, a view that stops short of the broader geographic connections discussed in this paper.

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## Author's contribution

All authors contributed to the conceptualization, analysis, writing, and editing of the overall paper. Sarah Knuth organized the collaboration; she led/co-led analysis and writing of the framing sections and "Moment III" section particularly. Savannah Cox led analysis and writing of the "Moment I" section particularly. Sahar Zavareh Hofmann led analysis and writing of the "Moment II" section particularly and co-led figure design. John Hogan Morris contributed to the literature review and co-led analysis and writing of the "Moment III" section particularly. Zac Taylor led analysis and writing of the "Moment IV" section particularly. Beki McElvain supported analysis and writing of the "Moment IV" section particularly and co-led figure design.

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