

Assessing GSE Mortgage Portfolios' Exposure to Past and Future Flood Risk

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Economic Brief

July 2024, No. 24-22

This article evaluates the exposure of government-sponsored enterprises' (GSEs) mortgage portfolios to flood risks as projected by the First Street Foundation and analyzes the realized impact of Hurricane Irma on mortgage defaults. The analysis leverages extensive GSE data spanning from 1999 to 2023 and utilizes risk projections through 2050 to provide a comprehensive view of both potential future risks and actual past outcomes.

The increasing frequency and intensity of extreme weather events present potential risks to real estate finance. It has been argued that mortgage lenders may be able to securitize and sell mortgages that are more exposed to risks of flooding to government-sponsored enterprises (GSEs). This possibility arises from two factors: the limited spatial variation in GSE guarantee fees (e.g., the fees are similar between houses with different flood risks) and the fact that GSE insurance mandates rely on outdated floodplain maps (which may fail to account for predicted increases in flood risks over the next 30 years).¹ If this is the case, then there may be a concentration of flood risks at the GSEs, which play an important role in guaranteeing the stability of the mortgage market.

However, the flood risk exposure of the portfolios of mortgages backed (purchased or guaranteed) by GSEs — specifically Fannie Mae and Freddie Mac — remains unknown. This article summarizes my examination of projected flood-risk exposures and the actual impacts of Hurricane Irma on mortgage defaults, documented in detail in my recent working paper "[Leveraging the Disagreement on Climate Change: Theory and Evidence](#)," co-authored with Laura Bakkensen and Russell Wong.

How We Examined Weather Events and Mortgages

For this paper, we use GSE mortgage data for the period 1999 to 2023. This database includes over 100 million mortgage loans (fully amortizing single-family fixed-rate mortgages) that Fannie Mae and Freddie Mac backed between 1999 and 2023 across the whole U.S. The database also provides the history of each loan's performance over time, including the timing of missed payments and defaults.

We then combine the GSE data with projected flood risks provided by First Street Foundation.² The projected risks are analyzed using geographical matching at the three-digit ZIP code level.³ The risk is summarized by a flood factor, which assigns each property a score between 1 (safe/minimal risk) to 10 (extreme risk).⁴

To study the historical impact of a hurricane on mortgage default, the GSE data are also combined with Disaster Declaration Summary data from the Federal Emergency Management Agency to identify areas in Florida affected by Hurricane Irma in 2017.

How Extreme Weather Affects Mortgages

Our first finding focuses on the GSE exposure to future flood risks. Restricting our attention to mortgages outstanding in 2023, the following table summarizes GSE portfolio exposure to future flood risk. We estimate that more than a quarter of outstanding mortgages — or more than 23 million loans, with a total outstanding balance of more than \$2 trillion dollars — are at risk of future flooding, defined in this subsection as lying in a ZIP code with an average flood factor of at least 2.⁵ A smaller fraction (nearly 6 percent) are at higher risk, defined as lying in a ZIP code with an average flood factor of at least 3.

Table 1: Summary Statistics of GSE Exposure to Future Flood Risk

	Outstanding GSE Loans in 2023	% at Risk	\$ at Higher Risk
Number of Loans	89.58 million	26.1% (23.34 million)	5.7% (5.10 million)
Total Balances	\$8.17 trillion	27.2% (\$2.22 trillion)	5.0% (\$0.41 trillion)

Notes: The sample includes outstanding (as of January 2023) single-family fixed-rate mortgages that Fannie Mae and Freddie Mac purchased or guaranteed since 1999. A loan is classified as at risk (at higher risk) if it lies in a three-digit ZIP that has an average *flood factor* of at least 2 (at least 3).

A natural question is how much flooding matters for mortgage performance. Hence, our next finding focuses on the *realized* impact of a hurricane (namely, Hurricane Irma) on mortgage defaults. We conduct an event study focusing on the sample of more than 0.5 million GSE loans in coastal Florida 1.5 years before and 1.5 years after Irma, a Category 4 hurricane that made landfall in the state on Sept. 10, 2017. The analysis uses a difference-in-differences regression of the default dummy, including a stringent set of loan-fixed effects and time-fixed effects.

The regression reveals that Hurricane Irma increased the default frequency in affected ZIP codes by 0.40 percentage points (40 basis points) in the subsequent six quarters. To put in context, the baseline cumulative default frequency was 0.80 percent in the preceding six quarters. This impact is comparable to the [independent estimates of the impacts of hurricanes](#) Harvey in Texas (approximately 0.10 percentage points) and Maria in Puerto Rico (approximately 0.86 percentage points) in the subsequent year.

The analysis underscores the importance of integrating forward-looking flood-risk assessments with empirical data on past disaster impacts to comprehensively understand the financial risks faced by GSEs. While the projection data from the First Street Foundation offer a long-term view of potential risks, the historical analysis of Hurricane Irma provides actionable insights into the actual impacts of such events on mortgage defaults.

Challenges and Limitations of Our Study

It should be noted that there are a few limitations with our analysis. The use of three-digit ZIP codes for risk matching introduces limitations in accurately pinpointing risk at a more localized level. Long-term flood risk projections carry inherent uncertainties (including changes in climatic conditions and mitigation efforts), which may affect their accuracy.

Conclusion

The distribution of disaster risks among financial institutions in the mortgage market is an important open question for academics and policymakers. This article aims to take a first step and provide a balanced view of both the past impacts and future risks of flooding on GSE mortgage portfolios. I hope that future research can utilize data with higher resolution of spatial variation to better estimate the risk exposure of the GSEs and other important financial institutions.

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¹ For example, the 2016 paper "[Regional Redistribution Through the U.S. Mortgage Market](#)" by Erik Hurst, Benjamin Keys, Amit Seru and Joseph Vavra documents that GSE fees do not vary spatially and generally depend only on credit scores and loan-to-value ratios. A pair of papers by Amine Ouazad and Matthew Kahn — the 2022 paper "[Mortgage Finance and Climate Change: Securitization Dynamics in the Aftermath of Natural Disasters](#)" and the 2023 paper "[Mortgage Securitization Dynamics in the Aftermath of Natural Disasters: A Reply](#)" — argue that this lack of spatial variation is especially pronounced for flood risks and that the GSE insurance mandates depend on floodplain maps that do not fully capture future flood risks.

² These risks cover both coastal and inland flooding, are cumulative between 2020 and 2050 and assume the Shared Socioeconomic Pathways 2-4.5 for climate change. For more about the

SSP, see Figure 4 in the 2021 [Summary for Policymakers \(PDF\)](#) in "[Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change](#)."

- 3 The three-digit ZIP code level refers to the first three numbers of a traditional five-digit ZIP code and encompasses a larger area than the more granular five-digit code. This lack of precision may lead to a biased estimate of a loan's risk. Specifically, to the extent that there is adverse selection into the GSE loan sample — that is, all else equal, mortgages with higher flood risks may be more likely to be sold to the GSEs — the average at the ZIP code level likely underestimates the loan's actual flood risk. See the working paper for more detail and context.*
- 4 The distribution of flood factor is quite skewed, with about 80 percent of properties considered safe (that is, having a flood factor of 1) and 20 percent considered at risk (that is, having a flood factor of 2 or higher).*
- 5 In the First Street Foundation data, the average probability of having at least one flood in the next 30 years is more than 18 percent among at-risk properties (flood factor of 2 or higher) and more than 32 percent among at-higher-risk properties (flood factor of 3 or higher). In contrast, safe properties (flood factor of 1) have a zero probability.*

To cite this Economic Brief, please use the following format: Phan, T oan. (July 2024) "Assessing GSE Mortgage Portfolios' Exposure to Past and Future Flood Risk." [Federal Reserve Bank of Richmond Economic Brief](#), No. 24-22.

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