

# Protect your Chicago water heater against earthquakes? There's a better bet

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California water heater secured against earthquake damage. Credit: seismic.ca.gov

Chicago homeowners, take note: you'll get a better return on your investment if you buy a lottery ticket when the jackpot is high, rather than pay to secure your water heater against earthquake damage.

That's the conclusion of a Northwestern University class of geosciences and civil engineering students who decided to estimate these costs and benefits after an Illinois Emergency Management Agency spokesperson urged Illinois residents to protect their water heaters against earthquakes.

Led by Northwestern professor and seismologist Seth Stein, the class estimated that there would be a net benefit to strapping the water heater to wall studs if there was a high probability that the heater would suffer major damage due to an earthquake during its ten-year average lifespan. But this would require earthquake shaking strong enough to topple heavy furniture, which as far as anyone knows, has never happened in northern Illinois. Even in the southernmost part of the state, such strong shaking hasn't happened since the New Madrid earthquakes of 1811-1812.

You'll get a better rate of return on your money, the class suggests, if you buy a ticket for a big-jackpot lottery like Powerball. When jackpots are high—over \$288 million—there is a net benefit to buying a ticket, because the odds are such that you are likely to win at least some money with your ticket. And those big jackpots come around much more often than big Chicago earthquakes—about 5% of the biweekly Powerball drawings are for a jackpot of \$288 million or more, including the recent \$1.5 billion Powerball drawing on January 13.

The water heater study was guided by Stein's textbook *Playing against Nature: Integrating Science and Economics to Mitigate Natural Hazards in an Uncertain World*, written with his father, the late Jerome Stein, a professor emeritus of economics at Brown University. The book demonstrates how combining science, economics and risk analysis can aid policymakers as they prepare for floods, earthquakes and droughts.

This approach was just what Edward Brooks, a graduate student in seismology and lead author on the paper, was looking for after shifting his research interests from physics to geophysics in the wake of the devastation caused by the 2011 Tohoku earthquake in Japan. "This course perfectly captured what I personally think are the most interesting questions in earth science," he said. "How do we prepare for an uncertain future? What is the best way to invest our present resources? How can we improve our models and predictions in the future?"

In the case of the water heaters, the students used Fermi estimation techniques, named after physicist and Nobel Prize winner Enrico Fermi. Fermi was famous for simple estimates of complex quantities, such as the problem that he posed to students: how many piano tuners are there in Chicago? His technique breaks down the problem into estimating simpler quantities—How many Chicago households have a piano? How many times a year are pianos tuned?—that can be combined to produce a good estimate for the original question.

"The idea of using the Fermi approach is that you know that you can't get these things exactly right, because you're dealing with unknowns in the future," Stein said. "But you can make reasonable estimates, and what's nice is that the answers are pretty robust; you can put different values in but general answer is about the same."

The class divided the water heater question into smaller inquiries, including how much it would cost to secure a water heater, how often and in what ways might water heaters be damaged, whether insurance would cover these costs, and how often earthquake shaking of a specific level might occur in Chicago.

"Before this class I had not thought about how I would explain a scientific decision to a policymaker or how that scientific decision needed to be weighed against other potential costs and hazards," said Molly Diggory, a civil engineering student and paper co-author who focused on [earthquake damage](#) to water heaters in her part of the study. "It really opened up my thought process to anticipate this type of real-world analysis."

The students also learned that "most natural hazard mitigation policies are derived without cost-benefit analysis" Stein said. The complicated decision of whether to build a seawall to protect against a tsunami, for example, requires input from multiple scientific and economic studies,

and most agencies aren't equipped to take that multidisciplinary approach, he said.

Stein hopes the paper will encourage other classes to take a deeper look at real-world natural hazards policy.

"Our results aren't surprising, since as far as we know no [water heaters](#) in Illinois have ever been seriously damaged by an earthquake. But what's important is the way the class tackled this complicated issue," he said.

"Typical natural hazards classes show great pictures of destroyed buildings and lava flowing and so on, but don't encourage the students to ask the really interesting but hard policy questions," Stein continued. "Students can handle tough problems, and we should teach them do that."

**More information:** [dx.doi.org/10.1785/0220150180](https://dx.doi.org/10.1785/0220150180)

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