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Do natural disasters cause an excessive fear of heights? Evidence from the Wenchuan earthquake

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ABSTRACT

This paper uses the 2008 Wenchuan earthquake in China to examine if the occurrence of a natural disaster can cause an excessive fear of living in upper floors. We rely on potential variations in earthquake risk perceptions by floor level to assess whether the pricing of apartments in lower versus upper floors is consistent with a disproportionate fear of heights. We use a unique transaction dataset for new apartment units in the affected area. We find that the relative price of low to high floor units, particularly units located in the first and second floor, considerably increased for several months after the earthquake and then returned back to the levels observed prior to the tremor. This temporal increase in relative prices is in line with a higher risk perception and fear, triggered after the earthquake, of living in upper floors, which gradually dissipated over time. The results are robust to alternative model estimations.

1. Introduction

The occurrence of natural disasters provides a unique setting to examine the potential overreaction of individuals to large, disruptive and generally unexpected events. According to the prospect theory, rare events tend to be overweighed in the absence of a risk-learning process with repeated experience (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Glaeser (2004) also notes that people may put enormous weight on ephemeral situations. Even under low-risk circumstances, a rare but "sharp" event can induce individuals to overestimate risk and exaggerate perceived risk (Tversky and Kahneman, 1974; Slovic, 1987; Viscusi, 1989, 1990). In this paper, we use the 2008 Wenchuan earthquake in China to analyze if the occurrence of the tremor results in an excessive fear of living in upper floors.

An earthquake is a traumatic event that increases the awareness of potential damages and risks among all residents in the affected area. The level of perceived risk, however, may be further dictated by the floor level where you live as people may feel safer at lower floor apartments in the occurrence of another earthquake. Individuals may prefer to live in lower floors as shocks are felt stronger in upper floors. Similarly, although individuals in the first floors may exit the building faster, people in lower floors are not always more likely to not get injured or survive. Our identification strategy relies on these likely variations in earthquake risk perceptions by floor level to evaluate the pricing behavior of units in lower versus upper floors and assess whether the observed pricing patterns are in line with an excessive fear of heights. Consistent with this overreaction hypothesis, risk perception biases should trigger a rise in the relative price of lower to upper floor units after the earthquake, but this increase should fade over time as the fear of risk gradually dissipates when people realize that the recurrence probability of a high magnitude tremor is small (Kreps, 1984; Wood et al., 1992).

The Wenchuan earthquake, measured at 7.9M (surface wave magnitude scale), occurred at 2:28 p.m. on May 12, 2008 along the Longmen Shan Fault in Sichuan province. The epicenter was located 90 kilometers northwest of the city of Chengdu, the provincial capital with about ten million residents. The earthquake caused severe damage to Chengdu and was felt across most of mainland China.[1] The State Council designated Chengdu as an earthquake-stricken area

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[1] According to official figures, the earthquake resulted in 69,197 deaths (68,636 in Sichuan province), 18,222 missing and 374,176 injured (www.sina.com). The earthquake also left more than 4.8 million people homeless. For additional details of the Wenchuan earthquake refer to EERI (2008a).

after the earthquake. Strong aftershocks continued to hit the area even a month after the main tremor.

We use an extensive daily transaction dataset for new apartment units purchased across different districts in Chengdu over a period of one year before and one year after the earthquake. We follow a hedonic price model approach and find that average housing prices generally decreased after the earthquake, which is consistent with the decrease in property values in the face of hazardous events and risks. We further find, however, that the relative price of low to high floor units, particularly units located in floors 1–2, significantly increased for several months after the earthquake and after approximately one year returned back to the levels observed prior to the tremor. We interpret our results as evidence of an increased risk perception and consequent fear of living in upper floors, which seemed to have lasted for numerous months. Additional estimations help to reduce the possibility of alternative explanations to the observed relative pricing behavior.

The progression of relative prices after the tremor resembles the evolution of stock prices after major unanticipated events, which has been extensively documented in financial markets (e.g., De Bondt and Thaler, 1985; Ederington and Lee, 1993 and 1995; Brooks, Patel and Su, 2003). In this literature, the psychological biases of investors under risky and uncertain situations result in abnormal investing behavior.[2] Prices follow a "normal-abnormal-normal" progression in the occurrence of a rare event: prices first decrease after a negative event as agents tend to overweight new information; when agents fully understand the situation, prices revert and ultimately return back to their normal levels.

Our study is also related to the studies of Beron et al. (1997), Wong (2008), and Abadie and Dermisi (2008), which follow different approaches to examine the response of the housing market to extreme events and find mixed results. Beron et al. use a hedonic model to analyze sale prices for single-family dwellings before and after the 1989 Loma Prieta earthquake and find results consistent with the notion that individuals initially overestimate the probability of damage from earthquakes. Wong uses a panel of housing estates in Hong Kong and does not find evidence, when compared to the predictions of a standard asset-pricing model, of an excessive reaction of prices in secondary residential properties after the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic.[3] Abadie and Dermisi use a quarterly panel of buildings in downtown Chicago and conclude that office location decisions (vacancy rates) appear to have been affected by the increased perception of terrorist risk after the 9/11 attacks.[4]

In contrast to these papers, we exploit a unique transaction dataset of new apartment units in residential buildings to examine if the occurrence of an earthquake can cause an excessive fear of living in upper floors. These data allow us to concentrate on price differentials before and after the earthquake of comparable housing units located in lower- versus upper-floor levels and assess whether the observed relative pricing patterns can be linked to likely variations in the level of perceived earthquake risk and fear. Focusing on relative price differences further helps us to better control for other unobserved changes (if any) in housing demand and supply factors affecting prices, provided that these changes occur across all apartments and not in units located at specific floor levels. For instance, we do not expect systematic variations in the quality of the structures and the amenities of units located in lower versus upper floors. Still, we recognize that our analysis is based on a before-after comparison such that we cannot completely rule out alternative explanations to the results obtained, but we are also unaware of other plausible explanations.

The remainder of the paper is organized as follows. Section 2 further discusses earthquake risks by floor level and the potential fear of living in upper floors. Section 3 describes the data and methodology. Section 4 presents the estimation results. Section 5 concludes.

2. Earthquake risks and fear of living in upper floors

Large disruptive events such as high magnitude earthquakes may have an important psychological effect on people in the affected areas and raise their awareness of potential risks.[5] "High-signal" events, however, may also induce individuals to overestimate risk and amplify perceived risk. As noted by Slovic (1987), the level of perceived risk will increase with how unusual, uncontainable and fatal the risk is as well as with the degree of exposure to the risk. In the case of an earthquake, the level of perceived risk may depend on the floor level where you are located as people may feel safer in lower floors, although the likelihood of getting injured or not surviving does not necessarily increase with height.

One reason why individuals may feel more exposed to earthquakes in upper levels is that shocks are felt more strongly in upper floors, thereby increasing their fear. Side-to-side shacking is felt stronger in upper floors because most of the mass in buildings is typically lumped at the floor levels, such that a significant inertia force is added at each floor level with the shacking of the building's foundation (Murty, 2007).[6] Taller buildings may also undergo several modes of vibration besides their "natural period" of vibration (rate at which they move back and forth), although these additional vibrations are less critical (FEMA, 2006).[7]

Another reason for preferring lower floors is the possibility of exiting the building faster. In several situations, being able to exit a building in a faster and easier way can significantly increase your chances of survival; for example, when there is a fire or gas leak in the building or in the case of an explosion or terrorist attack such as the 9/11 events where height was a crucial determinant of surviving.[8] In the case of earthquakes, however, people in lower floors are not always more likely to not get injured or survive. First, as pointed by the Earthquake Country Alliance, research on injuries and fatalities during earthquakes and the experiences of search and rescue teams, indicate that building collapse is generally less of a danger as a small number of buildings partially or completely fail.[9] You are safer finding shelter inside your apartment rather than trying to run for exits, doorways or jumping from a window; moving during a tremor puts you at more risk as the shaking can be so strong that it is very difficult to move far enough without falling down and objects also fall (areas near the exterior walls of a building are actually the most dangerous places). Second, even if a building fails, dynamic forces and the direction and frequency of shaking are unpredictable such that displacements and structure failures can occur at any floor. Similarly, while some buildings may collapse sideways others may collapse downwards ("pancaking") where the first floors get demolished

[2] See also Kahneman and Riepe (1998), Hirshleifer (2001) and Baker and Nofsinger (2002).

[3] Related to this study, Davis (2004) examines the effect of health risks, resulting from an outbreak of pediatric leukemia in a county in Nevada, on local housing values and finds a decrease in housing prices.

[4] Other studies that analyze the impact of natural events (earthquakes) on housing markets include Brookshire et al. (1985), Murdoch, Singh and Thayer (1993), Bin and Polasky (2004), and Nakagawa, Saito and Yamaga (2007, 2009).

[5] Cassar, Healy, and von Kessler (2011) and Cameron and Shah (2015) find that exposure to disruptive natural events leads to an increase in observed aversion to risk.

[6] Bachmann (2003) explains that during an earthquake the foundations of the building follow the ground movements, but the upper part "would prefer" to remain where it is because of its mass of inertia; this results in strong vibrations of the structure with resonance phenomena between the structure and the ground, and large internal forces.

[7] Taller buildings are also not more prone to collapse. In Mexico City earthquake of 1985, for example, the majority of the buildings that collapsed were 20 stories tall; other buildings of higher and lower height were undamaged.

[8] In other disasters, such as a flooding or tsunami, being in an upper floor will be safer (i.e. "vertical evacuation").

[9] www.earthquakecountry.info.