Demand Surge Following Earthquakes

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SUMMARY:
Demand surge is understood to be a socio-economic phenomenon where repair costs for the same damage are higher after large- versus small-scale natural disasters. It has reportedly increased monetary losses by 20 to 50%. In previous work, a model for the increased costs of reconstruction labor and materials was developed for hurricanes in the Southeast United States. The model showed that labor cost increases, rather than the material component, drove the total repair cost increases, and this finding could be extended to earthquakes. A study of past large-scale disasters suggested that there may be additional explanations for demand surge. Two such explanations specific to earthquakes are the exclusion of insurance coverage for earthquake damage and possible concurrent causation of damage from an earthquake followed by fire or tsunami. Additional research into these aspects might provide a better explanation for increased monetary losses after large- vs. small-scale earthquakes.

Keywords: demand surge; monetary losses; disaster reconstruction; insurance

1. INTRODUCTION

Demand surge is understood to be a socio-economic phenomenon of large-scale natural disasters: repair costs rise, locally and temporarily, through any of several possible demand- or supply-related mechanisms. As a result, the repair cost for a property damaged in a large event exceeds the repair cost for a similar property similarly damaged in a small event. Increased repair costs after past large-scale natural disasters have been reported in the range of 20 to 50%. For example, after the 1989 Newcastle Earthquake, rebuilding costs increased by 35% (Australian Securities & Investments Commission, 2005). After the 1994 Northridge Earthquake, insurers observed a 20% increase in the costs to settle claims (Kuzak and Larsen, 2005, p. 113). Commercial catastrophe modelers estimated demand surge of 10 to 40% after Hurricane Katrina (Guy Carpenter & Company, 2005).

Institutions that indemnify properties exposed to natural disasters, such as insurers, reinsurers, and governments, pay billions of U.S. dollars in claims after large-scale natural disasters; these payments can be even larger as a result of demand surge. Anticipating whether demand surge is 20 versus 30 versus 50% can affect how insurers, reinsurers, and governments plan for and respond to large-scale natural disasters. Understanding the socio-economic mechanisms of demand surge should result in better predictive models and is presumably a prerequisite to reducing the magnitude of demand surge after future disasters.

Olsen and Porter (2010) surveyed quantitative models for demand surge and updated the summary in Olsen and Porter (2011). The primary developers of demand surge models are commercial catastrophe modelers, e.g., AIR Worldwide, EQECAT, and Risk Management Solutions. Although these models are proprietary, the standard model of demand surge multiplies the ground-up loss—the loss at a property before applying insurance deductibles, co-payments, or limits—by a factor, typically between 1.0 and 1.6. This multiplicative factor can be based on the expected loss to the insurance industry as a whole, the affected region, the type of peril, the type of property, or some combination of these.

Olsen and Porter (2010) proposed seven general descriptions of socio-economic mechanisms that could result in increased repair costs after large- versus small-scale natural disasters. These explanations for demand surge followed from studies of the reconstruction periods after historical natural disasters, including earthquakes, hailstorms, cyclones, flooding, and wildfires, from the fourteenth, nineteenth, and twentieth centuries through the present day, in Australia, the United States, the United Kingdom, and continental Europe. Although the circumstances contributing to increased construction costs were unique to each disaster, there were common explanations for demand surge when the disasters were considered together. The seven possible explanations for demand surge were, briefly: (1) the total amount of repair work; (2) the costs of reconstruction materials, labor, and equipment; (3) reconstruction timing; (4) construction contractor fees; (5) general economic conditions; (6) insurance claims handling; and (7) decisions of an insurance company.

This paper collects the findings of previous studies that are relevant to understanding demand surge after earthquakes. Olsen and Porter (2011) developed models to predict changes in reconstruction costs caused by Atlantic hurricanes. Section 2 describes the key features of these models with particular attention to how the models might be interpreted for demand surge after earthquakes. Although the data used to develop the models were sparse, the hurricane data were available and consistent for multiple events. Similar data for damaging earthquakes are difficult to obtain and likely inconsistent across events. Section 3 identifies factors additional to labor wage and material price increases that might explain demand surge after earthquakes. These possible explanations remain speculative since I have not yet found a good source of data to test these hypotheses for any natural hazard.

2. FROM HURRICANES TO EARTHQUAKES: MODELS FOR RECONSTRUCTION COST CHANGES

Olsen and Porter (2011) studied to what extent demand surge could be explained by higher repair costs resulting from higher labor wages and material prices. The authors considered cost changes for sets of specific repairs to damage caused by Atlantic hurricanes making landfall on the mainland United States. These repairs included roofing, reglazing, carpet installation, etc. The six sets of repair costs represented the total repair cost, and material and labor components, each for a typical residential or commercial property. The authors collected cost data from the leading provider of these data to insurance claims adjusters in the United States, and they calculated the cost changes from before to after nine Atlantic hurricane seasons (that is, from July to January) at fifty-two cities on the Atlantic and Gulf Coasts. A cost change was defined as the difference between the cost in January and the previous July normalized by the cost in July.

The cost change data suggested how to construct the models. The total-repair cost changes were up to $\pm$ 0.2 in the absence of a tropical storm or when surface winds were less than 50 km/hr. When winds exceeded this threshold, the total cost changes could exceed 0.2. Also, the cost changes increased at least linearly, possibly quadratically, with the number of storms passing within 200 km of the city in a hurricane season. The cost changes in the labor component followed these patterns, but the cost changes in the material component were almost insensitive to the peak wind speed and number of tropical storms. Thus, the labor cost changes appeared to drive the total cost changes, and there was a threshold wind speed above which total cost changes might exceed those below the threshold.

Olsen and Porter (2011) proposed a series of multilevel regression models for the cost changes by considering several combinations of the following explanatory variables: the largest gradient wind speed at a city in a hurricane season; the number of tropical storms in a season whose center passes within 200 km of a city; and cost changes in the first two quarters of the year. Olsen and Porter allowed the coefficients of the regression models to be stochastic, varying across groups of data defined by region of the Southeastern United States and year. For the best models of the total repair and the labor component cost changes, wind speed, number of proximate storms, and a cost change in the first half of the year were all significant explanatory variables. For the best models of the material component cost changes, wind speed and the number of proximate storms were *not* significant explanatory variables, whereas cost changes in the first half of the year were significant.

These findings might be applied to earthquakes: the availability of labor within the affected area might be a more important predictor of cost changes, but only if the earthquake is sufficiently intense or part of a series of earthquakes. A detailed understanding of the labor market, rather than reconstruction material price fluctuations, might better explain cost increases during rebuilding.

The labor cost changes in Florida in 2004 were distinct from the cost changes in any other state and hurricane season between 2002 and 2010. Specifically, as a group, these cost changes were larger than the cost changes from any other region or year given the same wind speeds. These data were anomalous likely because: in 2004, many tropical storms made landfall in the state; several of these storms were major hurricanes; and there was high demand for construction before the hurricane season. An analogous situation for seismic hazard is a large earthquake with a damaging aftershock occurring in a time of high demand for construction. If this sequence happens and the hurricane model provides insight, then repair-cost increases might be larger than if there is no damaging aftershock or there is no existing demand for construction.

Cost changes for the set of residential repairs were different than those for commercial repairs. The residential cost changes were more extreme, that is, had a larger range of values, than the commercial cost changes. Thus, costs to repair a commercial property after a damaging earthquake might increase less than the costs to repair a residential property. Although not specifically studied, other types of properties, such as industrial or governmental properties, might have different amounts of cost change, depending on the type of skilled labor and set of materials required or on the availability of reconstruction financing. In other words, the amount of demand surge might depend on the type of property, as opposed to a uniform value for all properties.

The multilevel regression models for reconstruction cost changes resulted in uncertainties at two levels. First, there is a constant residual variance within a group of data defined by region and year. For a given group, say cities in Florida in 2005, the cost changes given fixed values of the explanatory variables do not vary much from city to city. This within-group variance was, however, different for each group. The second source of uncertainty in the cost-change models was the stochastic parameters. Depending on the region and year, the coefficients of the explanatory variables were different. This uncertainty resulted in much more variability in cost changes than did the residual variance. If these findings can be applied to earthquake-induced disasters, I would expect a much greater uncertainty in determining the mean cost change for a given event than the uncertainty in determining cost changes at several cities affected by the same event.

3. DEMAND SURGE AFTER PAST EARTHQUAKES

A study of past large-scale disasters suggested that higher labor and material costs were not the only explanations for the presence of demand surge (Olsen and Porter, 2010). Thus, additional explanations for demand surge after earthquakes—such as construction contractor overhead and profit, the exclusion of insurance coverage for earthquake damage, and possible concurrent causation of damage from fire or tsunami—might be studied to understand fully why monetary losses increase after large- versus small-scale earthquakes. The following sections describe specific observations from past earthquakes that help to explain the mechanisms causing demand surge.

3.1. 1886 Charleston, South Carolina

The earthquake that occurred north of Charleston, South Carolina, on 31 August 1886 was the largest earthquake to affect the Eastern United States since permanent European settlement in the Seventeenth Century. Almost every building in the city of Charleston was damaged, and many buildings sustained damage so severe that they were later demolished. The loss from property damage was estimated at US$5-6 million in 1886 value; several fires ignited following the earthquake, and the estimated property loss from the earthquake and fire damage was $8 million (Pinckney, 1906).

The extent of destruction in Charleston created a demand for labor that far exceeded the local supply. Wage rates for skilled and unskilled labor increased dramatically above the pre-earthquake levels. Union bricklayers would work for no less than US$5 per day, a 67% increase above the pre-earthquake rate (News and Courier, 1886a). Skilled and unskilled laborers could, however, command wage rates more than double the pre-earthquake rates. Wage increases of 67 to 100% are consistent with the largest observed labor cost-changes in the 2004 hurricane season in Florida. In response to hikes in wages such as these, some homeowners chose to wait to re-plaster their houses until the rates returned to pre-earthquake levels, and the city shut down its relief efforts to pressure laborers to reduce their wage rates (Stephen Hoffius, personal communication, January 2009).

In addition to heightened wage rates, the labor shortage also created a waiting list for repairs in the city. One observer noted that a delay in repairs, while certainly causing a hardship on the owners, may also increase the loss at the property (News and Courier, 1886b). The observer made this reference to increased loss in passing while calling for labor to quickly respond to the reconstruction demand without "selfish consideration." The source did not elaborate on how delayed repairs might increase property loss. However, depending on the type of damage, a damaged building might be vulnerable to water infiltration or wind damage, causing additional loss at the property.

3.2. 1906 San Francisco, California

On 18 April 1906, an earthquake struck the San Francisco Bay area, followed by a fire that consumed much of the city. Reports often cite 700 deaths caused by the earthquake and resulting fire, but the true figure may have been closer to 2,000 (Ellsworth, 1990). On the first anniversary of the disaster, a former mayor, James D. Phelan, described the state of reconstruction (Evening Post, 1907, p. 1). He noted that "the abundance of work" to rebuild the city had artificially raised material prices as well as labor wages, even though a "large army of laborers" had travelled to San Francisco from other areas of California and from other states. Phelan stated that emergency repairs had been made but that financing to continue permanent reconstruction was not forthcoming. The financiers were concerned that the elevated labor wages and material prices made the repairs unnecessarily expensive.

The experiences of the insurance industry after the 1906 disaster are particularly well documented. G.H. Marks of the London Assurance Corporation described the task of adjusting insurance claims after the earthquake and fire (Marks, n.d., pp. 6, 8). Records maintained by the insurance companies were lost, so the companies could not independently verify that they insured a particular property and to what value. The companies required additional people from across the country to receive, handle, and adjust the large number of claims on policies. Most claims, however, could not be verified as a loss to the policyholder because "all usual means were absent." There was little, if any, evidence of specific items lost at the property. Neighbors could not be interviewed because often they had relocated. Receipts of the original sale could not be checked because they had burned in the fire, too. Observations such as these prompted the Committee of Five (a group of adjusters charged with resolving claims involving multiple insurance companies) to note that, in their haste to submit claims, policyholders often "innocently exaggerated their statements," since the prevailing conditions made an accurate claim "almost impossible" (Hosford et al., 1906).

The Committee of Five reported several additional reasons insurance companies paid more on claims than was necessary. From its position of resolving claims on multiple companies, the Committee found that insurance companies would have realized better and less expensive results if they had agreed on a common way to settle the claims much sooner. Also, the Committee noted two cases in which "expert accountants" identified intentional fraud and reduced the total insurance payment by US$100,000.

Losses caused by earthquake shaking versus fire are treated differently under standard insurance policies. In general, earthquake losses are specifically excluded from coverage while fire losses are insured. At a meeting in New York on 31 May 1906 of United States fire insurance companies, the companies' representatives stated that "clearly segregating losses for which companies are liable from those from which they are exempt" created a uniquely difficult situation (quoted in Hosford et al., 1906, p. 13). It can be difficult to know if a loss was *originally* caused by an earthquake or fire (or tsunami). However, policyholders pressured their insurance companies to pay for their losses. Insurance companies feared a reputation for not paying claims if they rigidly enforced the earthquake exclusion. The General Manager of Munich Re observed: "In San Francisco we have experienced that companies which had stipulated in their policies the exclusion of all direct and indirect earthquake losses were, due to competition with other companies, obliged to pay their losses in order not to lose their business for all future" (quoted in Hoffman, 1928). Although insurance companies tried to exclude earthquake-caused losses in their policies, many companies chose not to strictly enforce the exclusion.

3.3. 1994 Northridge, California

An earthquake ruptured in the San Fernando Valley of Los Angeles on 17 January 1994, causing widespread damage. The Insurance Information Institute (2009) estimated the insured loss to be US$12.5 billion in 1994 value. Insurers later informed the California Earthquake Authority that they saw a 20% increase of loss because of demand surge (Kuzak and Larsen, 2005, p. 113).

In personal communication, John Osteraas, a structural engineer, described his observations of claims adjusters and construction contractors after the Northridge Earthquake. There were an insufficient number of claims adjusters in the local area, and insurance companies brought in adjusters from other parts of the United States. Adjusters from seismically inactive areas may not have had proper training or any experience with seismic damage, and thus they may not have been able to adjust claims properly for this type of damage. Also, the demand for contractors to repair damage exceeded the supply, resulting in a less-competitive environment. Construction contractors would significantly raise their bids on reconstruction projects, maybe as much as twice what they would have bid in a competitive environment. If the bid was accepted, the contractor could sub-contract the work and keep some of the profit, but if the bid was not accepted, there was plenty of other work available (John Osteraas, personal communication, September/October 2008).

Seismic Safety, a seismic retrofit company in the Los Angeles area, hired additional workers to keep pace with the demand for its services after the Northridge Earthquake (Seismic Safety, personal communication, March 2009). The company could not find new workers at the pre-earthquake wage rate, and so the owner raised the wage rates for both new and existing labor. To finish a job quickly, they would add a fourth or fifth worker to the job. Adding the fourth worker decreased the overall efficiency of the crew, but the job was completed faster. Adding a fifth worker further speeded completion of the job but required the additional expense of sending a second truck to the job site.

Although there was heightened demand for reconstruction materials after the Northridge Earthquake, construction material prices in the Los Angeles area did not increase. Materials suppliers could not increase prices, even if they had wanted to do so, because of competition from other suppliers (Setzer, 1994). Thus, even though insurers told the California Earthquake Authority of 20% increased loss because of demand surge, the evidence suggests that the supply constraint was on the number of available construction workers and construction contracting firms, rather than on materials prices.

4. DISCUSSION

Demand surge is not simply an economic process in which sudden demands for reconstruction labor and materials are met with adequate supplies as wages and prices rise. Rather, demand surge appears to be the end result of complex, socio-economic processes of reconstruction after a large-scale natural disaster. In the course of repairing or rebuilding damaged properties, there are several necessary inputs: financing must be available to pay for the needed construction materials, labor, and equipment. The unique circumstances of each disaster, though, can constrain one or more of these supplies, disrupting a reconstruction process that might otherwise progress without additional costs.

Olsen and Porter (2010) showed that there is no standard and precise definition of demand surge, but there are features of reconstruction periods common to large-scale disasters from different hazards, in different regions, and at different times. One of these features—the availability of reconstruction labor and materials—was studied in the context of Atlantic hurricanes, disasters which, unfortunately, provide more and consistent data than those caused by other hazards. Since damaging earthquakes happen infrequently and, when they do, they affect areas with very different economies, consistent data in sufficient numbers are difficult to collect. In the study, Olsen and Porter (2011) found that changes in labor wage rates drove changes in total repair costs and that year-to-year variability in cost changes was greater than region-to-region or city-to-city variability.

The findings from the hurricane models for cost changes are only applicable to earthquakes to the extent that hurricanes and earthquakes share the same underlying, economic drivers of labor wages and material prices. If the findings can be transferred to earthquakes, then specific knowledge of the labor market and underlying economic conditions might help predict the extent of demand surge. This knowledge might include: the number of skilled and unskilled laborers in the affected area compared to the need for their particular skills; their willingness or ability to work on reconstruction projects as opposed to any existing new-construction projects; any barriers to labor from outside areas, such as local licensing requirements; and demand for construction existing before the earthquake, both inside and outside the affected area. The hurricane data also make clear that cost increases of up to 0.2 can occur in the absence of an intense hurricane (Olsen and Porter, 2011). Observations of cost increases after a disaster do not necessarily imply that the disaster caused the cost change. The costs might have increased and gone unnoticed had the disaster not occurred; the disaster might simply draw attention to the increase rather than cause it. Finally, the large year-to-year variability observed in the cost changes during hurricane seasons would be equivalent to large earthquake-to-earthquake variability.

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