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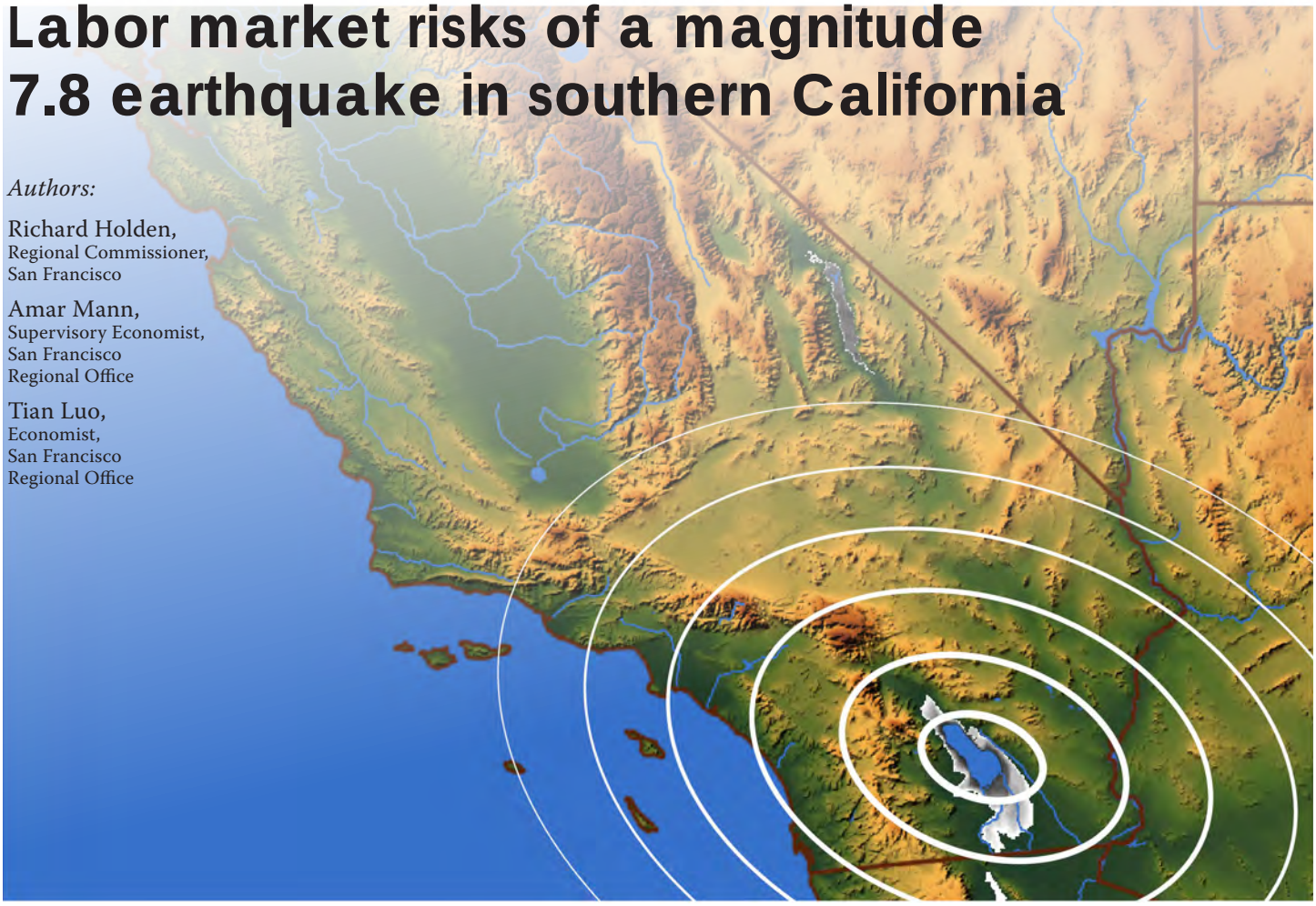
Labor market risks of a magnitude 7.8 earthquake in southern California

Authors:

Richard Holden,
Regional Commissioner,
San Francisco

Amar Mann,
Supervisory Economist,
San Francisco
Regional Office

Tian Luo,
Economist,
San Francisco
Regional Office



The ShakeOut Scenario is a program developed by the U.S. Geological Survey (USGS) to examine the implications of a magnitude 7.8 earthquake in southern California and to help people and organizations become better prepared before the next big earthquake. According to USGS, the most likely source of a large earthquake in California is the southern segment of the San Andreas Fault, which runs through the heavily populated counties of Los Angeles, Riverside, and San Bernardino.[1] The southern section of the San Andreas Fault has not ruptured for more than 300 years, although evidence indicates that a large earthquake has occurred on the fault every 150 years, on average. The ShakeOut Scenario simulated a magnitude 7.8 earthquake on the southern San Andreas Fault, and the program's scientists determined this hypothetical earthquake would create very strong to severe shaking and cause moderate to heavy damage across seven southern California counties.

The 7 southern California counties that would be most affected by the earthquake are home to 621,000 business establishments, 6.3 million employees, and an annual payroll of $303.3 billion, according to data from the Quarterly Census of Employment and Wages (QCEW) published by the U.S. Bureau of Labor Statistics (BLS). The inset of map 1 delineates the shaking intensities that could occur as the result of a magnitude 7.8 earthquake on the southern San Andreas Fault, as measured by the Modified Mercalli Intensity

(MMI) scale. When employment and wages data from the QCEW are spatially integrated with the shaking intensity zones provided by the ShakeOut Scenario, we are able to tabulate the potential business and labor market risks from a major earthquake, as shown in the larger part of map 1. Our analysis includes both the exposure across the seven southern California counties and the impact on industry groupings. [2]

In this report, we analyze and map QCEW data to assess the potential business and economic losses if a 7.8 magnitude earthquake were to occur in southern California. This report may be used to inform individuals, schools, businesses, organizations, communities, and governments about the effects of a major earthquake in their communities.

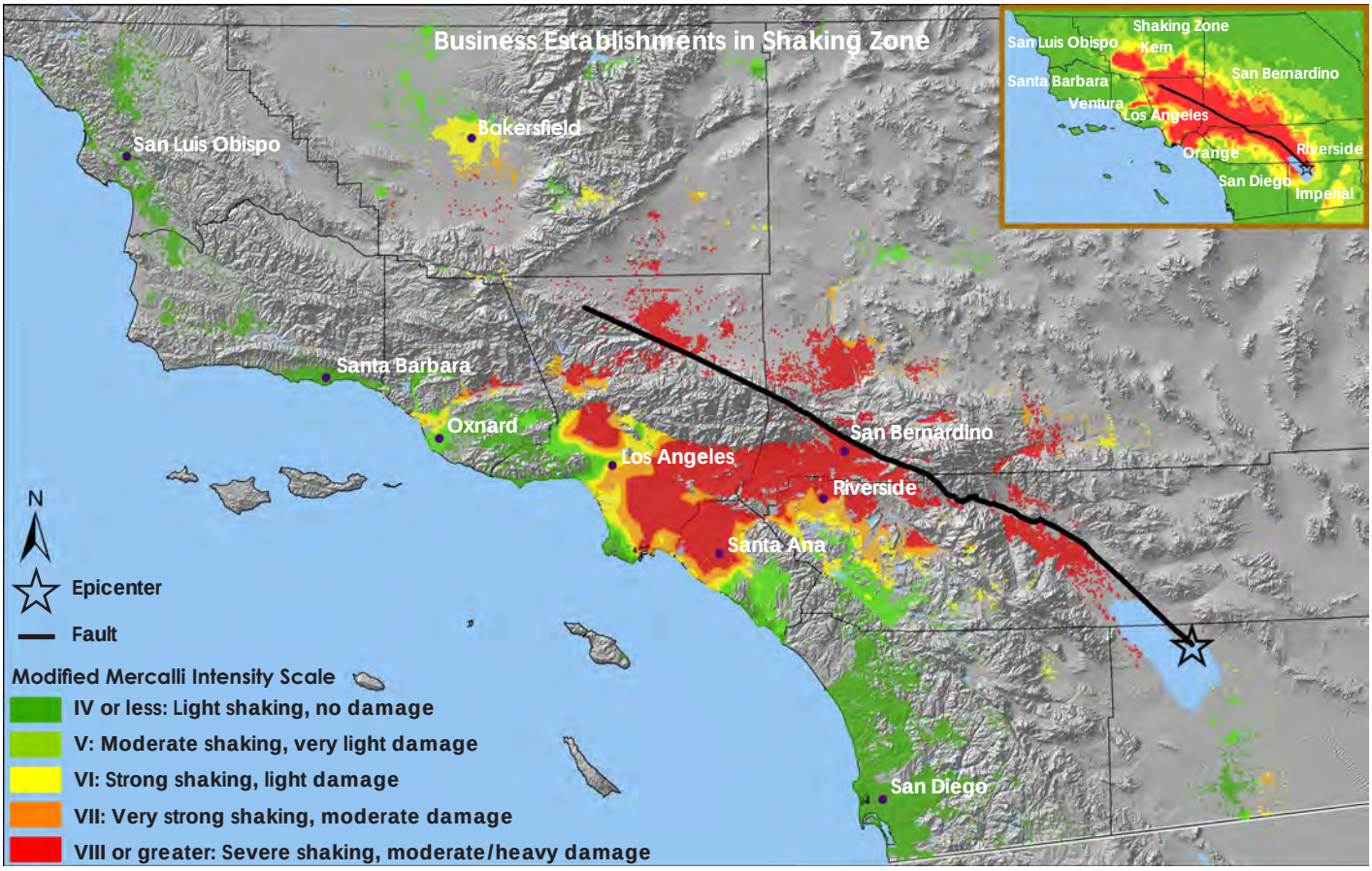
About the Modified Mercalli Intensity Scale

Seismic intensity is a measure of the effects of an earthquake at different sites. Intensity differs from magnitude in that the effects of any one earthquake vary greatly from place to place, so there may be many intensity values measured from one earthquake. Each earthquake, on the other hand, should have just one magnitude (often measured by the moment magnitude scale or by the Richter scale). The Modified Mercalli Intensity (MMI) scale is commonly used to gauge the severity of earthquake effects. Intensity ratings are expressed as Roman numerals between I at the least destructive and XII at the most destructive. At MMI-VII, while damage may be slight in specially designed structures, there is often considerable damage and partial collapse even in substantial ordinary buildings.

Methodology

Two datasets were merged to prepare for the analysis: a geographic

Map1: **Employers in Shaking Intensity Zones for a hypothetical magnitude 7.8 Earthquake on the southern San Andreas Fault**



Note: The cluster of all colors on the main map denote density of establishments; the colors of the clusters denote intensity of shaking zone.

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Earnings and Wages (QCEW) program geocoded data

file with shaking intensities from the USGS and an establishment-level micro dataset containing employment and wages from QCEW. The geographic file of intensities, which uses MMI scale measurements, gauges the effects of an earthquake at various distances from the fault rupture. The MMI scale ranges from I (not felt) to XII (total damage).[3] The analysis in this report will focus on those areas with estimated shaking intensities of VII and higher on the MMI scale, that is, areas of very strong shaking and moderate damage to areas with severe shaking and moderate to heavy damage.

The QCEW microdata contain geocoded establishment data, including the employment and wages associated with individual business firms as of the first quarter of 2010. Approximately 92 percent of all businesses, employment, and wages in the microdata were geographically coded and used in this report, therefore the results of the presented analysis understate the actual labor market risks. This dataset is then overlaid by the USGS shaking intensity file to tabulate the exposures to establishments and the employment and wages attributed to those firms.

Limitations of the analysis

Our analysis of business exposures that are attributable to earthquakes has certain limitations. The MMI values describe damage levels ranging from predominately light damage to widespread heavy damage. Even in the most damaged areas, not all businesses will sustain damage that will soon curtail their activities and some businesses that lose capability will return to normal operations. Thus, gauging economic impact by projected MMI levels may overstate the business interruption or losses that will occur.

However, direct damage to a region's businesses understates the interactional effects on customers or suppliers inside and outside the damaged areas. Some businesses cluster in regions to be near their customers and suppliers. If this relationship is interrupted by an earthquake, both customers and suppliers could be severely affected or even put out of business. The expected loss of life and damage to infrastructure and utilities may also interrupt the flow of goods and services in southern California and the United States as a whole because the area is a vital transportation hub for shipments by air, water, rail, and truck.

The earthquake in the ShakeOut Scenario would have broad impacts beyond the labor market, creating greater losses inside and outside the region than can be estimated using only MMI scales and damage zones. USGS has estimated the economic losses of the ShakeOut Scenario earthquake to be approximately $213 billion,[4] when accounting for the direct and indirect earthquake impacts.[5] In addition, as mentioned earlier, businesses that were not geocoded in the QCEW database were excluded from this analysis, so the results presented here represent a lower bound estimate of the at-risk labor market.

Analysis

The southern segment of the San Andreas Fault runs directly through the heavily populated Los Angeles, Riverside, and San Bernardino counties. These are 3 of the 4 most exposed counties in the region in terms of potential damage from earthquakes occurring on the fault. These counties comprise a population of 17 million inhabitants over a 32,000 square mile area, with most of the population and businesses located in Los Angeles and Orange Counties and the western parts of San Bernardino and Riverside Counties. (See table 1.)

Total exposures in the 7 counties in southern California that are in the very strong shaking zone (MMI VII) and destructive shaking zone (MMI VIII or higher) include 434,000 employers, over 4.5 million jobs, and annual wages of $206.5 billion. In the wide area circumscribed by both zones, the business, employment, and earnings exposures would fall primarily upon the counties of Los Angeles, Orange, San Bernardino, and Riverside, with Los Angeles County having the most exposures and Riverside County having the least. These four counties account for more than 99 percent of all exposures in the shaking zones. More than half of the employment and earnings exposure in the destructive shaking zone (MMI VIII or higher) would fall in Los Angeles County alone. Approximately 3 of every 5 businesses affected in the destructive shaking zone are also in Los Angeles County.

As shown in table 2, the percentage of each county's economic base that is considered to be at risk during an earthquake varies greatly. Although about 70 percent of all businesses, employment, and wages across the 7-county area are exposed, 4 of the 7 counties in the scenario are estimated to have business and labor-market

Table 1. **Potential exposure from a magnitude 7.8 earthquake along the southern San Andreas Fault, 7 southern California counties, first quarter of 2010**

County	Located in very strong shaking zone (MMI VII)			Located in destructive shaking zone (MMI VIII+)			Proportion of Total Affected Employment
	Business establishments	Employment	Annual wages (in millions)	Business establishments	Employment	Annual wages (in millions)	
Imperial	230	1,200	$40	140	800	$20	0.0
Kern	900	14,300	510	480	7,000	290	.5
Los Angeles	98,290	922,000	53,420	188,750	1,692,700	69,670	57.6
Orange	13,600	153,100	8,230	54,570	812,300	39,340	21.3
Riverside	9,050	106,700	4,020	23,570	299,000	11,280	8.9
San Bernardino	560	5,100	220	42,620	507,300	19,030	11.3
Ventura	970	11,000	350	360	3,900	120	.3
TOTAL	**123,600**	**1,213,400**	**66,780**	**310,480**	**3,323,100**	**139,760**	

Note: May not sum to total due to rounding. Due to unavailability of geocoded fields for approximately 8 percent of the dataset, figures presented in this table for establishment, employment, and wages are a lower bound for potential exposures from a MMI-VII+ shaking.

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Earnings and Wages (QCEW) program.

exposures of 72 percent or more. The county with the greatest exposure as a percent of its total businesses, employment, and wages is San Bernardino, with 96 percent of its businesses, employees, and wages located in the very strong or severe shaking zones in the modeled earthquake. Riverside County is at risk for the next greatest exposure, with 75 percent of all businesses in the very strong or severe shaking zones. Los Angeles and Orange counties both have 73 percent of their businesses, employees, and wages located in the very strong to severe shaking zones. Imperial County overlies a portion of the southern San Andreas Fault, but has relatively little exposure in the scenario analyzed here, as the earthquake's waves are expected to radiate towards the northwest, away from Imperial County.

Just as the exposure to various counties ranges widely, the exposures for southern California industries vary across the board. The earthquake would affect a large number of jobs in health care (522,000), retail trade (504,000), manufacturing (480,000), and educational services (409,000). (See table 3.) After a disaster, functioning hospitals and medical facilities will be critical. The shaking zone map tabulations show that 72 percent of health care workers are located in the shaking zones that are expected to experience the most damage. In addition to this geographic hazard, a recent study found structural weaknesses in many hospitals in California, particularly in the southern part of the state.[6] With the exception of the agriculture and mining industries, every industry within the seven-county area could have more than half of their total employment located in the very strong to severe shaking zones. The potential economic consequences to employers and workers in southern California are widespread and are likely to have an effect on the state economy and, in turn, the national economy because of the far-reaching economic ties between firms and industries in California and beyond. This strong relationship between the southern California economy and the rest of the world is demonstrated by the large percentage of international shipments that come through the Los Angeles and Long Beach

Table 2. **Percent of total businesses, employment, and wages exposed to a destructive shaking zone (MMI-VII+), first quarter of 2010**

County	Business establishments	Employment	Wages
Imperial	6	4	4
Kern	8	9	9
Los Angeles	73	74	69
Orange	73	77	74
Riverside	75	79	79
San Bernardino	96	96	97
Ventura	6	6	4
TOTAL	**70**	**71**	**68**

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Earnings and Wages (QCEW) program.

Table 3. **Potential industry exposure to destructive shaking (MMI-VII+), first quarter of 2010**

Industry	Business establishments	Employment	Annual wages (in millions)	Percent of total exposed employment	Percent of industry employment
Health care and social assistance	29,000	521,900	23,740	12	72
Retail trade	32,120	503,700	14,060	11	71
Manufacturing	18,150	479,600	23,560	11	77
Educational services	6,960	408,600	20,120	9	71
Accommodation and food services	21,210	370,100	6,480	8	66
Administrative and waste services	12,630	306,500	9,100	7	76
Wholesale trade	23,280	257,800	13,550	6	79
Other services, except public administration	179,400	255,300	6,120	6	72
Professional and technical services	29,380	233,400	16,480	5	61
Public Administration	1,230	201,200	13,160	4	83
Transportation and warehousing	6,840	190,500	8,420	4	74
Construction	19,200	177,000	8,740	4	75
Finance and insurance	12,860	155,700	12,850	3	68
Information	5,540	152,600	12,760	3	68
Arts, entertainment, and recreation	5,560	102,800	3,940	2	74
Real estate and rental and leasing	12,120	77,600	3,400	2	64
Management of companies and enterprises	1,220	63,600	5,020	1	76
Utilities	460	36,000	3,570	1	81
Agriculture, forestry, fishing and hunting	1,040	23,100	530	1	27
Unclassified	15,750	16,300	560	0	68
Mining, quarrying, and oil and gas extraction	150	3,400	380	0	23
TOTAL	**434,080**	**4,536,500**	**206,540**	**100**	**71**

Note: Figures may not sum to total due to rounding. Due to unavailability of geocoded fields for approximately 8 percent of the dataset, figures presented in this table for establishment, employment, and wages are a lower bound for potential exposures from a MMI-VII+ shaking.

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Earnings and Wages (QCEW) program.

ports—more than 23 percent of the total U.S. value of goods passed through them in 2009, making it the largest U.S. port district.[7]

Conclusion

With this report, we do not claim to make a specific earthquake prediction of expected losses. However, we are able to estimate the exposure to the labor market in the event of a "highly probable" earthquake scenario in which the southern segment of the San Andreas Fault ruptures, generating a magnitude 7.8 earthquake.[8] By using geocoded employment data and shape files generated by earthquake shake modeling, this analysis concludes that a magnitude 7.8 earthquake on the southern San Andreas Fault could have wide-ranging effects on businesses, jobs, and payrolls in the southern California area.

The earthquake scenario used to estimate the exposures modeled here may never happen. Major and devastating earthquakes on the San Andreas Fault are widely believed to be inevitable and, by geologic standards, extremely common, but they may not occur as projected in the ShakeOut Scenario. Evidence

suggests that the next damaging earthquake could easily be on one of the many other faults that riddle the Los Angeles basin, permanently changing the lives and livelihoods of residents and local businesses. The results of this regional report should serve as a reminder to public officials, employers, and residents of the vital importance of taking preventive actions to mitigate the potential losses from an earthquake, and to prepare for the potential disruption to businesses and employees.

Data presented here are for all workers covered by state and federal unemployment insurance programs. For additional information, contact Richard Holden, Regional Commissioner, U.S. Bureau of Labor Statistics. Email: holden.richard@bls.gov. Telephone: 415-625-2245.

Coauthors of this report were Amar Mann, Supervisory Economist, U.S. Bureau of Labor Statistics, and Tian Luo, Economist, U.S. Bureau of Labor Statistics.
Information in this report will be made available to sensory-impaired individuals upon request. Voice phone: (202) 691-5200; Federal Relay Service: 1-800-877-8339.

Notes

[1] An earlier Regional Report presented data on the labor market risks of a hypothetical earthquake along the Hayward Fault in Alameda County California. See "Labor market risks of a magnitude 6.9 earthquake in Alameda County," **http://www.bls.gov/opub/regional_reports/200709_alameda.pdf**.

[2] Exposure refers to potential labor-market losses and risks. Exposure is how much of the area's employment and earnings base is in the severe shaking zone.

[3] United States Geological Survey, "Magnitude/Intensity Comparison," **http://earthquake.usgs.gov/learn/topics/mag_vs_int.php**.

[4] Lucile M. Jones, et al., "The ShakeOut Scenario," USGS Open File Report 2008-115 (U.S. Department of the Interior, U.S. Geological Survey, 2008), pg. 10, **http://pubs.usgs.gov/of/2008/1150/of2008-1150.pdf.**

[5] Although USGS did estimate economic losses (along with casualties and injuries), they did not estimate the labor market risks in terms of jobs and wages as this study has done.

[6] According to a recent report, state and hospital officials have found significant structural weaknesses in more than 20 hospital buildings throughout California. More than a dozen of the seismic targets are located in southern California. See Erin Richard, "California Hospitals Deemed Seismically Unstable," NBC Los Angeles, Nov. 5, 2010, **http://www.nbclosangeles.com/news/local-beat/California-Hopsitals-Deemed-Seismically-Unstable-106795938.html?wwparam=1290126554**.

[7] Ronald D. White, "Ports of L.A. and Long Beach post 18% growth in container traffic," Los Angeles Times, November 16, 2010, **http://articles.latimes.com/2010/nov/16/business/la-fi-ports-20101116**.

See also "U.S. Waterborne Foreign Trade by U.S. Customs Districts," (U.S. Department of Transportation, Maritime Administration, August 20, 2010), **http://www.marad.dot.gov/library_landing_page/data_and_statistics/Data_and_Statistics.htm**.

[8] Suzanne Perry, et al., "The ShakeOut Earthquake Scenario—A Story That Southern Californians Are Writing," Circular 1324, (U.S. Department of the Interior, U.S. Geological Survey, 2008), p. 2, **http://pubs.usgs.gov/circ/1324/c1324.pdf**.

U.S. Bureau of Labor Statistics
San Francisco Regional Office
90 7th Street, Suite 14-100
San Francisco, CA 94103

U.S. Bureau of Labor Statistics
National Office
Postal Square Building, Rm. 2850
2 Massachusetts Avenue, NE
Washington, DC 20212-0001