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MODELING GENERAL EQUILIBRIUM ECONOMIC IMPACTS OF EARTHQUAKE-INDUCED LIFELINE DISRUPTIONS USING MPSGE APPROACH

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There are several different economic techniques that can be used to assess the economic impacts of "shocks" to a regional economy, including partial equilibrium analyses, econometric models, and general equilibrium analysis. However, a major shortcoming of the first two methods is that they fail to capture the interacting relationships between different economic agents and may thus provide biased economic loss estimates. In contrast, general equilibrium models, which embody the interactions between different economic agents, have been widely applied in evaluating the economic impacts of policy issues such as tax and trading policy reforms. Therefore, a general equilibrium model should be a better economic technique to capture the indirect and indirect economic losses of earthquake-induced lifeline disruptions.

Two different programming languages are commonly used in modeling general equilibrium problems. One is the "Generalized Algebraic Modeling System (GAMS)" developed by Alex Meeraus. The other one is " Mathematical Programming System for General Equilibrium (MPSGE)" developed by Thomas Rutherford. GAMS has been widely used in programming large-scale general equilibrium models since late 1980s, however, it becomes a cumbersome programming environment for the specification of complex nonlinear equations, such as nested CES functions. It needs a complex and tedious procedure to correctly translate a nested CES function into algebraic relations. In contrast, the MPSGE has a built-in translation procedure, which is not difficult to specify. Overall, the setup cost of producing a large-scale general equilibrium model and the cost of testing alternative specifications is much lower in MPSGE compared to GAMS.

The major objectives of this study include: (1) construct a well-defined computable general equilibrium (CGE) model to evaluate the general economic impacts of earthquake-induced lifeline disruptions; (2) develop appropriate procedures to test alternative scenarios, mainly focus on finding what assumptions and constraints should be included in the model to reflect possible

economic situations associated with earthquake-induced lifeline disruptions and how to translate them into algebraic relations.

In this study, the original programming approach used to model general equilibrium economic impacts of earthquake-induced lifeline disruptions was GAMS. We have found that it was hard to correctly translate our complex nested CES functions into algebraic relations and conduct counterfactual simulations after setting up the model, especially for the very-short-run and short-run general economic impacts of lifeline disruptions. This was highlighted in cases where we needed to specify very low substitution elasticities, reflecting the very short-term reality. The GAMS system runs into infeasibilities at very low elasticity levels, since the system tends to evaluate some divisors as arbitrarily close to zero. The MPSGE approach avoids this by automatically dropping infeasible terms and providing local solutions. So after switching to MPSGE, we are able to do a wide variety of counterfactual simulations, including fixed prices of electricity supply, minimum electricity supply to households and sectoral differential electricity supply in both very short run and short run scenarios.