Resource and Energy Economics 36 (2014) 209–228

Contents lists available at ScienceDirect

Resource and Energy Economics

journal homepage: www.elsevier.com/locate/ree

Regulating land development in a natural disaster-prone area: The roles of building codes ☆

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ARTICLE INFO

Article history:
Received 26 March 2011
Received in revised form 19 October 2012
Accepted 28 October 2012
Available online 5 November 2012

JEL classification:
R12
R52
Q54

Keywords:
Natural disaster
Building codes
Self-insurance
Self-protection
Spatial equilibrium

ABSTRACT

Implementing mandatory building codes is a major approach to preparing for natural disasters. Using a simple hybrid model which considers expected utility and spatial equilibrium, this paper analyzes the roles as self-insurance and self-protection played by building codes for regulating land development in a disaster-prone area. Positive externalities of self-insurance and self-protection justify the implementation of mandatory building codes. The net benefits of building codes are capitalized into land rents which, in turn, require responses in the design of optimal codes. Through impacting land market, community-wide socioeconomic characteristics of the area such as population, wage, and land area share of the risky region are found to have effects on the optimal levels of expenditure on self-insurance and self-protection. It is shown that consumer preferences and production functions for self-insurance and self-protection determine the signs of such effects which are reinforced or offset by competition for locations in the land market. Effects from changes in productivity levels and risk structure are also described.

1. Introduction

High consequences caused by recent natural disasters such as Hurricane Katrina in U.S. and the Great Sichuan Earthquake in China raised many public concerns again about insufficient human

☆ I thank Munisamy Gopinath, William Jaeger, and JunJie Wu for their helpful comments. Thanks to editor Richard Horan and two anonymous reviewers for valuable comments and suggestions on earlier versions of the paper. The usual disclaimer applies.

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http://dx.doi.org/10.1016/j.reseneeco.2012.10.002

preparation for disasters. One lesson learnt is that implementing mandatory building codes is an important approach to preparation (Ripley, 2006).[1] The potential benefits of building codes are evident by comparing some raw facts. Earthquakes with similar strength in California killed quite fewer people than that in some developing countries because California has strict building codes in seismic zones. Florida may have experienced greater loss from hurricanes if there were no strict building codes which require structures built under it are the ones left standing after a 120 miles-per-hour wind rips through.

Although the benefits are widely realized and observed, protection level and stringency of building codes are criticized by many authors who argue that they are arbitrary,[2] not justified, and too costly (Green et al., 2000; Listokin and Hattis, 2005; Stein and Tomasello, 2004). This paper tries to construct a simple hybrid model which considers both expected utility and spatial equilibrium to derive optimal protection level and stringency set by government when implementing mandatory building codes for regulating housing development in a disaster-prone area. Clearly, the costs and potential benefits of building codes would certainly have impacts on land market (e.g. rent payment) through competition for locations within the area and thus alter the spatial pattern of land development which, in turn, affects the design of optimal building codes. Optimal building codes should account for the effects of relevant socioeconomic conditions, such as population and commuting costs which affect land rents, and their own effects on land market.

In a general sense, the purpose of building codes is to protect housing consumers and the society at large. There are many reasons for designing and implementing mandatory building codes. A major one is that the lack of sufficient knowledge the individuals and households may have to check the safety and other conditions of their houses. Another important reason is to prevent endangerment to adjacent properties (Oster and Quigley, 1977). From an efficiency standpoint, individuals may underinvest in voluntary self-protection and self-insurance without government intervention (Muermann and Kunreuther, 2008). Beyond general-purpose codes, those designed for properties in disaster-prone areas contain special requirements about preparation for disaster. Lewis and Nickerson (1989) present a model that predicts optimal private expenditures on self-insurance will be excessive or insufficient according to the nature of the technology by which individuals protect their assets.

Through establishing structural standards of properties built in the disaster-prone area, building codes are implemented with the purposes of reducing the size of the loss from a disaster and/or reduces the probability of occurrence of the disaster. These two different effects can be termed as self-insurance and self-protection, respectively (Ehrlich and Becker, 1972). For example, earthquake codes in a seismic zone require builders to use techniques that allow structures to flex without breaking when the ground shakes, thus reduce the loss from earthquake if it happens. Some flood codes are designed with aim of reducing the building's probability of being flooded by requiring development not lower than a certain elevation[3]; the implementation of some other flood codes can reduce the loss from flooding by requiring builders to use waterproof building materials. The present paper focuses on the roles as self-insurance and self-protection played by mandatory building codes. A household's investment in self-protecting its own property may also help reduce the probability of her neighbors' being hit when a disaster occurs. For example, an individual's investment to reduce the likelihood of a fire occurring in her house can also reduce likelihood of the forest fire spreading to her neighbors. Positive externalities of self-insurance and self-protection are considered in the present paper.

In this paper, we derive a number of comparative statics to describe the impacts of city-level socio-economic variables such as wage, population, commuting cost, land area share of the risky region, and technological improvements in self-protection and self-insurance on designing optimal codes. We find that the properties of consumer preferences and the production functions for self-insurance and

[1] A set of mandatory building codes was managed to be passed by the Governor and the state legislature in Louisiana in 2006. Other protective measures such as government protection and zoning laws also receive increasing attention in the literature. See, for example, Kousky et al. (2006).

[2] The "1%" annual chance is chosen by many regulation agencies in the U.S., at least for regulating development in some regions which are subject to natural hazards such as floods (Green et al., 2000) and storms (Dehring, 2006).

[3] Base Flood Elevation defined by the Federal Emergency Management Agency is the one associated with the flood having 1% annual chance of being equal or exceed in any given year.