

Mitigation of Natural and Industrial Disasters: The Roles of Insurance and Land Use Regulation

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Work in progress

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- 2 Model
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A study of major risks

Our questions

- How do insurance and urbanization policies interact ?
- What is the impact of liability rules on this interaction ?

Our framework

- Urban model;
- Perfect information;
- Risk averse households;
- Compulsory insurance.



France, Xynthia, February 2010.



France, AZF, September 2001.

Liability and insurance

Natural disasters

Industrial disasters

Liability

Public responsibility

Firm's liability

Insurance system

In several countries, state insurance
Uniform premium in France
Actuarial flood insurance in the US

Victims' insurance for households
Or no insurance

Cost to insurers in France (property damage)

1982-2006: Bn€ 8.3 (flooding & clay)

AZF (2001): Bn€ 1.5

French state guarantee: M€ 263 (2000)

Grande Paroisse: Bn€ 2

Urban choices



France, Xynthia, February 2010.

Source: Reuters

1930's



2001



France, ONIA/AZF plant and neighborhoods.

Source: IGN

Urbanization and insurance

- By pricing risk (or not), insurance impacts urban choices.
- In turn, location choices impact cost for insurance system.
I.e. households create externalities on the liable part, that is

Natural disasters	Industrial disasters
The whole society	The firm

⇒ The liable part wants to limit space availability.

Literature

Urban economics and risk.

- Theoretical urban models:
Fujita and Thisse (2002), Tatano et al. (2004);
With insurance: Frame (1998), Frame (2001).
- Applications of the hedonic prices method:
Natural risks: Harrison et al. (2001), Bin et al. (2008);
Industrial risks: Sauvage (1997), Travers (2007).

Insurance and prevention.

- Insurance and mitigation of natural disasters: Picard (2008);
- Law and economics: Sanseverino-Godfrin (1996), Shavell (1982), Demougin and Fluet (2007).

Main results

Natural disasters

- Actuarial insurance pricing implements a Pareto optimum.
- *Insurance policy.* Switch from uniform to actuarial insurance without relocation.
Necessary conditions on risk for the approbation by majority voting.
- *Urbanization policy.* Under uniform insurance, building prohibition or expropriation do not achieve optimality by itself.

Industrial disasters

- Despite of firm's strategy of land purchase, risk remains imperfectly internalized. Thus, there is a rationale for state intervention.
- *Compensation policy.* The state can implement the optimal allocation by organizing transfers between households and the firm.

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Timing

Stage 0: Regulation.

Restrictions are imposed on insurance tariffs and (in some versions) on land use.

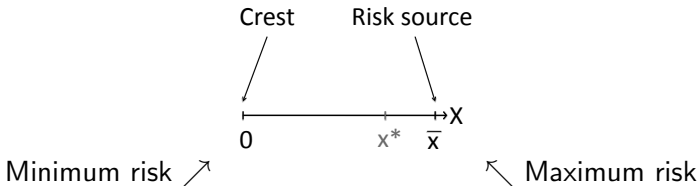
Stage 1: Markets.

Insurers choose a pricing in these tariffs.

Stage 2: Individual choices.

Households decide their location.

Space and risk



Space.

- Surface per house at each location;
- Density of households;
- Space constraints: local and global.

Risk.

- Loss probability depends on location;
- Cost of damage depends on location and surface used.

Insurance

- Instantaneous repairs;
- Complete insurance.

Natural disasters: state insurance.

- Risk correlated inside a community. Mutualization between numerous communities \Rightarrow we assume risk neutrality.
- Insurance premium depends on location and surface used;
- Zero profit.

Industrial disasters: free insurance by the firm.

- Risk neutrality of the firm;
- Firm identified and solvent \Rightarrow null premium for households.

Households

N households.

- Same income;
- Risk averse households;
- Utility function: concave with respect to the quantity of the composite good and to housing surface.

Rent.

- No opportunity land cost. In empty areas, rent is null.
- Redistributed rent.

Equilibrium

People compete for space and less risky locations

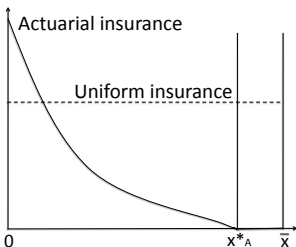
- Density, rents, risk exposure, insurance prices
- Budget constraints: individual, insurance sector, state
- Liability rules:
 - Natural disasters: state insurance
 - Technological disasters: free insurance by the firm

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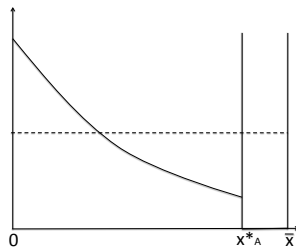
Equilibrium

If insurance is ...

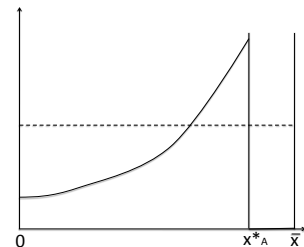
- *Actuarial*: Trade-off between insurance cost and land price.
- *Uniform*: Rent, density and housing surface are constant across locations.



Rent



Density



Surface per dwelling

Insurance policy recommendations (1/2)

Pareto optimality

Actuarial insurance pricing implements a Pareto optimum.

- Actuarial insurance internalizes risk externalities.
- Actuarial insurance Pareto dominates uniform insurance: in the case of loss, the same total housing surface is affected, but the number of damaged houses is higher under uniform insurance.

Recommandation

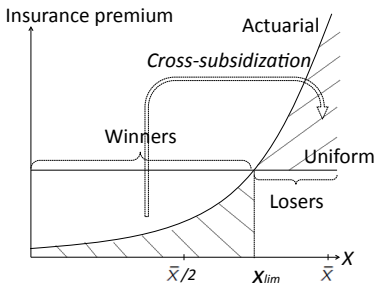
Reform swichting from uniform to actuarial insurance.

- Long term: if the moving costs are lower than the utility gain, this reform is a Pareto improving policy.
- Short term, where nobody relocates: winners and losers.

Insurance policy recommendations (2/2)

Acceptance of the reform

- If loss probability is strictly convex, acceptance.
- If loss probability is strictly concave, rejection.
- If loss probability is linear, undetermined result of the vote.



Urbanization policy recommendations

Recommendations

- ① Density constraints implement the optimal allocation.
 - ② Building prohibition does not.
 - ③ Expropriation is equivalent to prohibition.
- Equivalence between smooth density constraints and actuarial pricing of insurance.
 - Building prohibition does not implement the optimal allocation. For a given land restriction, uniform insurance is Pareto dominated by actuarial one. + Under actuarial insurance, bans decrease the utility level.
 - Building prohibition is equivalent to expropriation, since rents are redistributed. Same space limit (x_{BP}^*).

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Firm's strategy of land purchase

A new industrial project is rendered public

The households were in equilibrium

New households equilibrium under free insurance

Households do not perceive risk and create external effect on firm (the ultimate responsible for damages): no reason to move.

⇒ Land purchase by the firm.

Two market mechanisms / two compensation principles

- 1 Competition for land between the firm and households (x_0^*): compensation for rent increase, but not for “compaction”;
- 2 Full compensation for moving (x_{FC}^*).

⇒ Different rules give predictable differences in efficiency and on who wins and who loses.

Rationale for state intervention

Comparison of space limits

- Land is more expensive in the case of full compensation.
- Limiting space is more expensive for the firm than for the state.

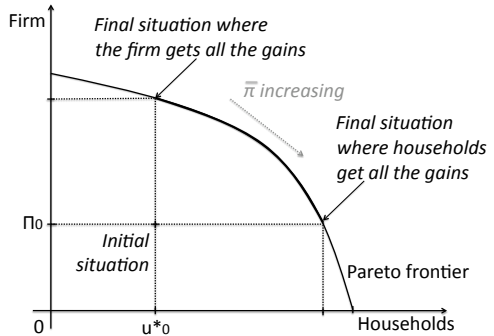
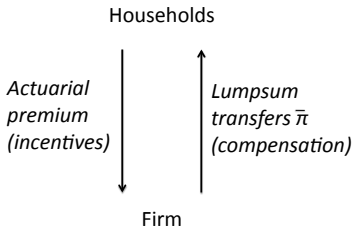
$$x_{BP}^* \leq x_0^* \leq x_{FC}^*$$

- Under exposure to natural disasters, the spared amount is entirely redistributed by the state among households, whereas only a fraction of it is given by the firm; households are poorer.
- Despite of firm's strategy, risk remains imperfectly internalized.

Transfers policy recommendation

Recommendation

To implement the optimal allocation, the state could organize transfers between households and the firm.



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Liability, insurance and urbanization

- *Liability* → *insurance*.
Liability determines insurance scheme.
- *Insurance* → *urbanization*.
Insurance pricing impacts location choices.
These choices determine liable part's financial exposure.
- *Urbanization* → *liable party*.
Liable party tries to limit space availability via markets or coercion.

Public policies

A general equivalence of insurance or transfers policies and urbanization policies.

Public policies perspectives in different countries

In many countries, insurance and urbanization policies have been built separately (France, United States, Netherlands...).

Main limitation: burden of past choices.

- Insurance system;
- Urbanization policies and difficult expropriations.



New Orleans, August 2005 after Hurricane Katrina.

Source: Colligan Wordpress