Background Paper prepared for the Global Assessment Report on
Disaster Risk Reduction 2013

Insurability of Catastrophe Risks and Government Participation in Insurance Solutions

Tristan Nguyen

WHL Graduate School of Business and Economics,
Department of Economics, Hohbergweg 15-17, 77933
Lahr/Germany, Email: tristan.nguyen@whl-lahr.de

Geneva, Switzerland, 2013

Abstract:

The ability to insure is essential for the welfare and growth of the society. However, catastrophic events with extremely high insured losses have increased significantly during the last decades so that catastrophe risks seem to become uninsurable in a free-market economy. Due to this development, most governments in the western world have established state guarantees or private-state insurance solutions for catastrophe risks. A key question that needs to be addressed is the factors that determine the insurability of a risk and the extent of coverage offered by the private sector to provide protection against extreme events where there is significant uncertainty surrounding the probability and consequences of a catastrophic loss.

In this contribution, we discuss the concepts of insurability and explore the potential reasons for lack of insurance, specifically for extreme events such as catastrophic environmental risks. Furthermore, we analyze the circumstances where a state's participation in insurance solutions can be justified. We found that in some extreme situations the government should give state guarantees or participate in private-state insurance solutions in order to avoid a collapse of insurance markets. But state risk sharing must not be used to subsidise certain enterprises or branches. This would lead to the false allocations of risks in society. In some cases, it seems to be better to prevent losses before they can happen. The optimal solution is usually a combination of the two, implementing preventative measures to reduce the loss frequency and the severity of damages, and then insuring against rarer and more costly events.

1. Insurability of Catastrophe Risks

The ability to insure, i.e. insurability, is essential for the welfare and growth of the society. However, catastrophic events with extremely high insured losses have increased significantly during the last decades (see *Figure 1*), so that catastrophe risks seem to become uninsurable in a free-market economy. Catastrophic risks are typically characterized by two features. First, many natural catastrophes, from earthquakes to hurricanes, have been shown to be "fat-tailed" (e.g., *Schoenberg et al.* 2003; *Newman* 2005). "Fat-tailed" loss distribution means that the probability of an event declines slowly relative to its severity. This implies that the premium must be much higher than the expected loss because the insurer has to provide a large amount of capital in case of catastrophic events. The second feature of catastrophic risks is that losses are correlated in space. This means that a large number of buildings and other assets in close proximity are simultaneously affected upon the occurrence of the catastrophe. Due to this high correlation between insured risks there is no or too little risk diversification among the insurance pool. Both these features of catastrophic risks (fat tails and spatially correlated losses) make them difficult to insure since they imply a larger risk of insolvency for the insurer.
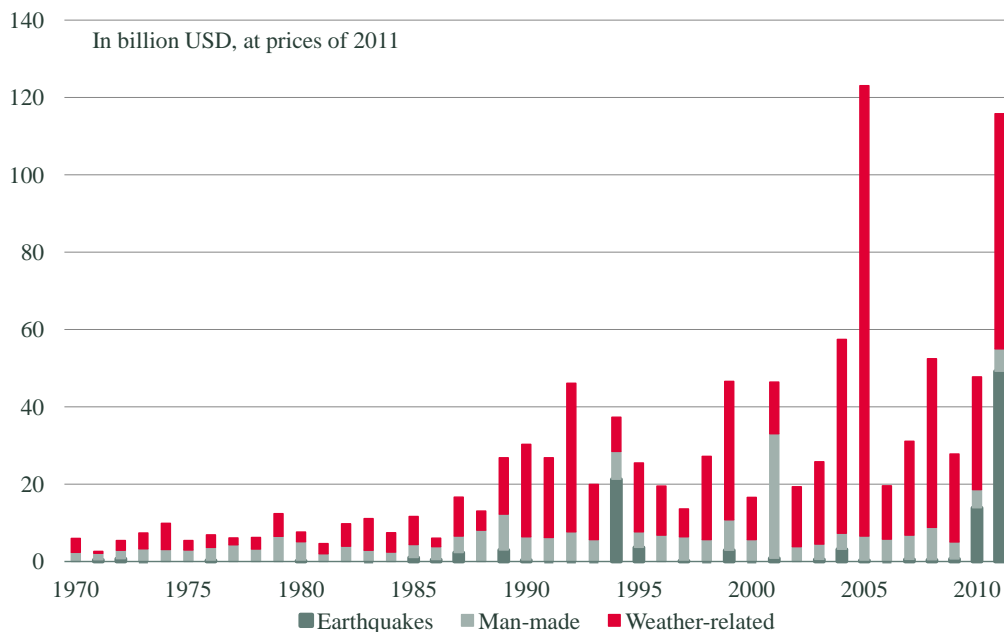

Figure 1: Insured loss by catastrophic event, source: Swiss Re 2012

In general, it is difficult to estimate the loss distribution of catastrophe risks (the so-called low-frequency but high-severity risks). Consequently, the insurers require higher risk premiums so that in the end the total premiums (expected loss + risk premiums) may be much larger than the expected loss. In some cases, insurance cover does exist but it is just unaffordable for the insured (see *Kousky/Cooke* 2012). This result is illustrated in *Figure 2* with a general equilibrium on insurance markets.[1] A Pareto improvement is possible in the hatched area since both policyholder

---

[1] The underlying theory is based on the seminar works of *Mossin* (1968), *Pauly* (1974), *Rothschild/Stiglitz*

and insurer reach a higher indifference curve compared to the initial situation A and are better off in this area than at the starting point A. Which point in this area is realized in the end depends on the market situation and the negotiating skills of the market participants. The slope of the insurance line gives a reference to level of the insurance premiums: the flatter the insurance line is, the higher the insurance premium.
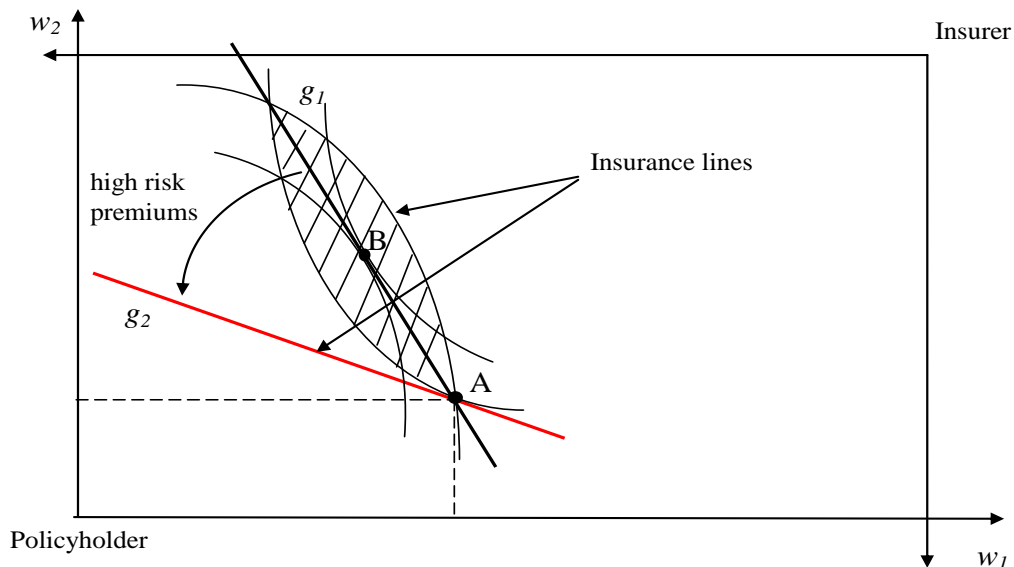
Figure 2: General equilibrium on insurance markets

Figure 2 shows exemplarily a possible insurance line g_1. The indifference curves of the policyholder and the insurance company are tangent in point B in which both policyholder and insurer are better off. Therefore, the Pareto improvement compared to the initial point A is possible in a general equilibrium. However, it can happen in case of catastrophe risks that the insurer cannot estimate the loss probability properly and requires, consequently, a too-high risk premium (expressed by the very flat insurance line g_2).[2] The new insurance line g_2 has no more common points with the hatched area. In this case the insurance market will collapse, since it is not optimal for the policyholder to buy insurance because of too high premiums. The policyholder would reach at all points on g_2 a lower indifference curve than at the initial point A. In order to avoid this inefficiency of the market outcome, a state is required so that the insurance market does not collapse completely.

Due to higher risk premiums, insurance cover for catastrophe risks does exist but it is just unaffordable for the individuals. Without state participation, the private insurance markets would collapse for some catastrophe risks. Therefore, governments around the world participate in insurance solutions on form of state insurance programs generally designed to offer insurance to individuals who are unable to buy policies in the private insurance market.

(1974), *Shavell* (1986) *and Kaplow* (1991).

[2] It is important to emphasize that the required insurance premium expressed by the insurance line g_3 is not risk-adequate, but reflects merely the misjudgment of the new risk situation by the insurer.

2. Government Participation in Flood Insurance Programs

a) Citizens Property Insurance Corporation and Florida Hurricane Catastrophe Fund

The Florida Legislature created Citizens Property Insurance Corporation in August 2002 because it found that private insurers were unwilling or unable to provide affordable property insurance coverage in this state to the extent sought and needed. Furthermore, the absence of affordable property insurance threatens the public health, safety, and welfare and likewise threatens the economic health of the state. Therefore, the state has a compelling public interest and a public purpose to assist in assuring that property in the state is insured and that it is insured at affordable rates. The Florida legislature passed a law that expanded the scope of the Citizens Property Insurance Corporation (CPIC), a state-run primary insurer, and the Florida Hurricane Catastrophe Fund (FHCF), a state-run reinsurer. By 2009, CPIC had 1.1 million policies with a total exposure of USD 414 billion and wrote USD 2.2 billion direct premiums.[3] CPIC's premiums for risks located near the coast are below risk-based market prices. A study revealed that owners of houses worth USD one million or more made up only 2% of policyholders, but represented approximately 10% of CPIC's exposure.

Policyholders owning lower value inland homes subsidise coverage for owners of higher value homes along the coast. By 2009, the FHCF had USD 2 162 billion reinsurance exposure with 184 participating insurers and collected USD 1.3 billion premiums.[4] As with CPIC, the premiums are typically below risk-based market premiums. Both programs are capitalised primarily with taxpayer guarantees. A potential shortfall would have to be financed by additional premiums or taxes after the loss event.

b) National Flood Insurance Program (NFIP)

The United States is involved in flood insurance at the federal level. The National Flood Insurance Act of 1968 established the National Flood Insurance Program (NFIP), which enables property owners in participating communities to purchase flood insurance at heavily subsidised rates in exchange for state and community floodplain management, regulation and enforcement that reduce future flood risks. The NFIP is administered by the Federal Emergency Agency (FEMA), which is responsible for covering the risks. Insurers play only the role of financial intermediary in the NFIP through the so called "Write Your Own" (WYO) program. Individuals or companies can buy flood insurance from the NFIP or purchase more expensive commercial insurance. Insurance is designed to provide an alternative to disaster relief after an event. In 2009, NFIP had 5.7 million policies outstanding with USD 1 233 billion sum insured. Coverage is concentrated in states along the Gulf of Mexico. The biggest loss paid out by NFIP was USD 17.7 billion in 2005, mainly for damages caused by Hurricane Katrina, driving the loss ratio that year to 789%. As of August 2010, NFIP's debt to Treasury stood at USD 18.8 billion.[5]

---

[3] Citizens Property Insurance Corporation, Financial Statements 2009.

[4] Florida Hurricane Catastrophe Fund, Annual Report, Fiscal Year 2008-2009.

[5] Federal Emergency Management Agency, http://www.fema.gov/about/index.shtm

In addition to NFIP compensation, after a large flood disaster the U.S. President can issue an official disaster declaration. Such a declaration is a needed for disaster assistance under a variety of federal programs. During the past 50 years, the number of Presidential disaster declarations has significantly increased from 162 over the period 1955–1965 to 545 during 1996–2005. In response to Hurricane Katrina in 2005 and in the subsequent year, three emergency supplemental appropriations bills of about U.S. $ 88.4 billion were enacted by Congress (Michel-Kerjan et al., 2012).

c) French Catastrophes Naturelles (CatNat)

In France, the natural catastrophe insurance "Catastrophes Naturelles" (CatNat) was founded in 1982 after major floods in the valleys of the Saône and Rhône and in the South-West of France. This insurance program is a mandatory arrangement based on national solidarity. The private insurers are responsible for covering the flood risks, while the main role of the government is to provide reinsurance and establish natural disaster prevention and mitigation plans. Due to mandatory nature, the program has a high market penetration. However, there is some uncertainty about whether victims of flood damage can receive compensation from the insurance because an official natural disaster declaration is which is not based on a pre-defined damage level.

The French CatNat provides coverage to most natural hazards, for example earthquakes, landslides, drought, volcanic eruptions and floods, with an exception for damage caused by wind, storm, hail, weight of snow, and damage to unsorted harvest and crops. The deductible is fixed at 10 per cent of the direct property damage (with a minimum of U.S. $1 436) if the community has a Natural Risks Prevention Plan (PPR), and this is a variable amount for properties located in communities without a PPR (Letremy/Grislain, 2009). Premiums are set by the governmental institute "The Central Tariffs Office" at a flat rate. Private insurers collect premiums, process and manage claims, and provide indemnifications in accordance with the limits defined in the insurance policy.

Reinsurance is provided by a public reinsurer Caisse Centrale de Reassurance (CCR) which is public limited company with capital of 60 million euros, 100% owned by the French state. The CCR transfers a part of the reinsurance premium to the French government. The French system allows insurers to reduce risk by purchasing reinsurance voluntarily, either from the public reinsurance CCR or in the private reinsurance market. The unlimited state guarantee provided to the CCR and the relatively low reinsurance prices charged by the CCR give insurers an incentive to reinsure especially the higher risk policies with the CCR. This may result in risk selection in the sense that good risks are privately reinsured, while bad risks are publicly reinsured (Jametti/Ungern-Sternberg, 2010).

d) Flood insurance in the UK

The summer of 2007 was the wettest in England and Wales since records began in 1914. Extensive rainfall and river floods in north-eastern England in June and central and south-western England in July caused widespread, severe damage. The geographic scope of the floods, physical and economic damage were on a scale not seen for sixty years. The city of Hull was hit particularly hard. Insured losses estimated at over GBP 3 billion (USD 4.8 billion), the most costly UK insurance event ever, were largely borne by

private UK insurers. As discussed above for the insurance programs in the U.S. and France, most industrialised countries retain the majority of flood risk in public programs or respond after the catastrophes with disaster relief. The UK, however, developed a private flood insurance program. Flood insurance is a standard part of typical property insurance products that are purchased on a voluntary basis and without government subsidy.

About two thirds of the summer 2007 flood damage was caused by surface water flooding, because rainfall overwhelmed drainage systems. The risk of surface water and groundwater flooding had been almost completely overlooked by the flood-defence infrastructure, which focused almost exclusively on river and coastal flooding. The value of properties in areas subject to newly-appreciated groundwater flooding risk had greatly increased the exposure of the industry, testing its capacity. The flood resulted in sharply higher flood insurance premiums in these areas. At the urging of the Association of British Insurers (ABI), the government is now strengthening surface water management infrastructure so that adequate private flood insurance capacity is available at an affordable price.

f) Inefficient risk allocation

By design, the three discussed state insurance schemes in the US and in France subsidise property insurance in high risk areas and crowd out private insurance participation. The main purpose of these state programs is to provide affordable property insurance coverage for citizens. Therefore, the required premiums are in general too low and not risk-adequate. This fact leads false allocations of risks in society because policyholders do not take fully account of the risks. The Government Accountability Office (GAO), an auditing unit of the US federal government, highlighted this inefficient risk allocation in a recent report to the US Congress on state natural catastrophe insurance programs. The GAO recommended not providing federal support for these programs unless they charge risk-adequate premiums. In the report's main findings:

- "*most state programs in our review had grown since 2005, and … most … charged rates that do not fully reflect risk of loss, potentially discouraging private market involvement and mitigation…*

- *while [federal natural catastrophe] proposals could lower premium rates for and increase public participation in state natural catastrophe programs, they could discourage private market participation and mitigation efforts and increase taxpayer exposure to potential costs. In particular, a federal guarantee of state bonds could give state programs access to capital at reduced or below-market costs, allowing state programs to continue to charge premium rates that do not fully reflect risks or even to lower their premium rates. Furthermore, it could result in decreased reinsurance purchases by some state programs and increased reliance on post-event funding, which could increase taxpayers' exposure to the potential costs in the event of state financial difficulties. In addition, a federal reinsurance program could reduce costs for state programs, but unless the federal program charged premiums that fully reflect the risk of*

> *loss, it could inadvertently encourage further development and population growth in areas with high natural catastrophe risk.*"[6]

The central problem of any government participation in insurance solutions is that governments are in general not able or willing to charge risk-adequate premiums. This results in crowding out private insurance participation and discouraging mitigation efforts. In order to provide insurance coverage at affordable premiums, the flood insurance program in the UK might be the better solution. Insurance coverage should be purchased on a voluntary basis and without government subsidy. This guarantees that the required premiums are risk-adequate. On the hand, governments can take and subsidise suitable measures to mitigate the risks.

3. Government Participation in Earthquake Insurance Programs

In the first two examples (earthquake insurance in Japan and Taiwan) the government provides a backstop, in the third (earthquake insurance in Turkey) the state mandates private insurance. The fourth example describes a publicly managed partnership with private insurers set up by the State of California to provide residential earthquake coverage without reliance on public funding.

a) Japan Earthquake Reinsurance

The Japan Earthquake Reinsurance Co Ltd (JER), which is owned by Japanese non-life insurance companies, covers losses to residential buildings and contents due to earthquake, volcanic eruption or tsunami, including fire following such an event. Premium rates vary according to location, building age and standard. In 2009, 12.3 million policies were outstanding with aggregate insured values of USD 1 098 billion, roughly USD 90 000 per policy. About 46% of residential property insurance policies included earthquake insurance coverage.[7]

Private insurers and the JER pay first losses per event up to an aggregate USD 1.4 billion. The Japanese government pays half of the losses exceeding USD 1.4 billion and 95% of losses exceeding USD 10.5 billion up to USD 66.3 billion (see *Figure 3*). Government liability within the program is limited to USD 57.5 billion. Insurers and JER's combined liability is capped at USD 8.7 billion. The liability of JER and private insurers was lowered from USD 14.4 billion to USD 8.7 billion after the devastating earthquake in March 2011 to alleviate private insurers' concerns about future earthquake payments. In fiscal year 2009, JER collected USD 0.772 billion in net premiums and had assets of USD 11.670 billion.

---

[6]   Report of the United States Government Accountability Office, May 17, 2010.

[7]   Non-Life Insurance Rating Organization of Japan, http://www.nliro.or.jp/english/data.html
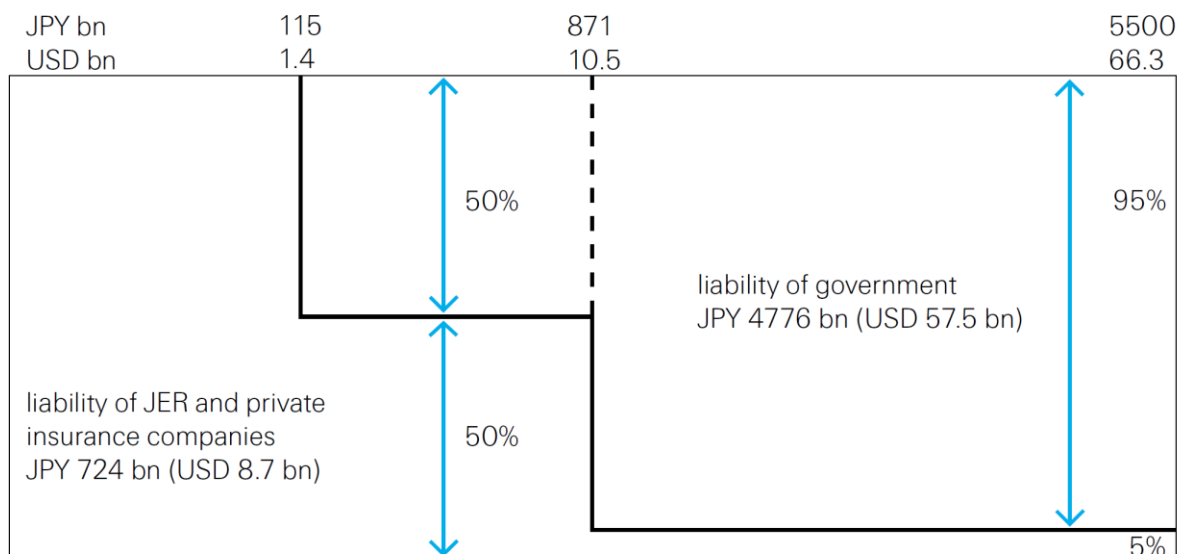
Figure 3: Japan's earthquake risk sharing,
Source: Non-Life Insurance Rating Organization of Japan

The design provides for insurance premiums that are affordable for households and businesses. The Japanese government remains the insurer of last resort for rare loss events over USD 66.3 billion, although the earthquake law stipulates that insurance payouts can be reduced in accordance with the proportion of total claims to the maximum limit of JPY 5 500 billion. The design of the loss profile brings substantial insurance capacity for smaller, more frequent losses that otherwise might not be available on economic terms.

b) Taiwan Residential Earthquake Insurance Fund (TREIF)

After the Chi-chi earthquake on 21 September 1999, the Taiwan Residential Earthquake Insurance Fund (TREIF) was created as a public non-profit organization on 9 July 2001, and began operations on 1 April 2002. The TREIF insures residential buildings against fire, explosion, landslide, land subsidence, land movement, land rupture, tidal wave, surge and flood caused by earthquake. Policies are sold by insurance companies. At the end of 2010, TREIF had 2.3 million policies in force covering 28% of all households with USD 98.3 billion sum insured (average USD 42 800 per policy).[8]

The program's liability structure is as follows. P & C insurance companies assume the first USD 85 million in losses. TREIF is liable for the next USD 520 million. Losses between USD 605 million and USD 1.21 billion are ceded to the private reinsurance and capital markets. The third tranche of losses up to an additional USD 484 million is again borne by the fund and the final portion, up to USD 2.1 billion, is retained by the Taiwanese government. The program provides tranches for more than USD 1 billion in local insurance capacity and USD 605 million global reinsurer participation that might not otherwise be available on terms affordable for policyholders. Further refinements could improve on the relatively low 28% homeowner uptake.

---

[8] More detailed information about TREIF can be found on http://www.treif.org.tw/treif/index.asp.

c) The Turkish Catastrophe Insurance Pool (TCIP)

After two major earthquakes in 1999, the Turkish government created in 2000 the Turkish Catastrophe Insurance Pool (TCIP), initially funded by the World Bank. The government made earthquake insurance through TCIP compulsory for all residential buildings that fall within municipal boundaries. The program covers building damage due to earthquake and fire, explosions, landslide and tsunami following earthquake. To provide a further incentive to purchase coverage through the program, on 27 March 2001 the government cancelled its obligation to pay building reconstructing costs in the area covered by the mandate of the TCIP. Insurance companies and their agents market and distribute TCIP policies. TCIP coverage limit was equivalent to USD 100 000 as of January 2011 and is indexed to increase with the construction price index. There are 15 different premium rates according to 5 seismic risk regions and 3 construction types that vary from 0.44‰ to 5.5‰ of the amount insured. Homeowners retain the first 2% deductible. [9]

To ensure compliance with the coverage mandate, homeowners must present proof of insurance a) at real estate registration offices for all real estate transactions, b) to subscribe to services like water, natural gas, electricity and telephone, and c) when applying for compensation following an earthquake. The TCIP continues to invest in customer educational campaigns to further increase the number of policyholders. In 2010, TCIP had 3.3 million policyholders, a figure that translates into a penetration rate of only about 25% (policies in % of the mandated building stock). The low penetration rate, despite the fact that annual premiums averaging USD 62 per policy are not overly burdensome, attests to the need for raising awareness. The program has USD 0.7 billion in reserves and an additional USD 2 billion in reinsurance support. TCIP is a good example of how to introduce a modern earthquake insurance scheme into a country.

d) The California Earthquake Authority

The California Earthquake Authority (CEA) is a publicly managed, privately funded entity providing residential insurance coverage for earthquake losses in California. [10] It was set up in 1996 by the state legislature as a response to the drying up of homeowners' insurance capacity in the market following the Northridge Earthquake in 1994. The magnitude 6.7 temblor in January 1994 cost more in claims paid for the insurance industry than it had collected in earthquake premiums over the preceding 30 years, so many companies severely restricted new homeowner policies following the event. The purpose of the CEA was to relieve the capacity shortage. The CEA did not receive any funds or guarantees from the California state budget or the federal government. Instead, seed capital was provided by participating private insurers. The CEA's claims-paying capacity is comprised of its capital, a private reinsurance program, and the statutory right to borrow funds and assess its member companies for the payback of such bonds.

The CEA, through its participating insurers, writes over 65% of all residential earthquake policies that are sold in California. According to the CEA website, around 800 000 policyholders are covered by participating policies throughout the state. California insurers who do not participate in the CEA have to offer their own earthquake coverage to residential

---

[9]   For more information about TCIP with detailed statistics see http://www.tcip.gov.tr/

[10]   More detailed information about CEA can be found on the website, http://www.earthquakeauthority.com/ index.aspx?id=33.

property policyholders, since California state law mandates that all insurance companies writing homeowner policies in the state must offer earthquake coverage. Despite this mandate, only 12% of California homeowners had earthquake coverage in 2009 according to the Insurance Information Institute. Based on data from the California Department of Insurance, premiums written for residential earthquake coverage in California totalled USD 970 million in 2010, with USD 583 million (60%) written by CEA participants. As of December 30, 2010, the CEA had claims paying capacity of around USD 9.7 billion, with USD 3.8 billion in available capital, USD 3.1 billion in reinsurance, and the rest from industry assessments and revenue bonds.

4. Discussion

Catastrophic events have increased enormously during the last decades. Our analysis of insurability concepts shows that catastrophic event as low frequency/high severity risks do have some characteristics that make them uninsurable. Most of the actuarial and market-determined criteria for insurability are not fulfilled by catastrophe risks to a certain degree. This explains the fact that private insurers are reluctant to give insurance coverage for catastrophe risks. In some cases, there is no private insurance solution for catastrophe risks or even if insurance does exist, its premium is too high and therefore unaffordable for the insured. Due to this market failure, governments around the world have participated in insurance programs in order to make insurance available and affordable.

A key question that needs to be addressed is the circumstances where a state's participation in insurance solutions can be justified. The majority of state catastrophe insurance programs were established following an extreme event that severely taxed the private insurance market. In some extreme situations (for example, directly after a hurricane with extreme losses) the government should give state guarantees or participate in private-state insurance solutions in order to avoid a collapse of insurance markets. Premiums can be kept more affordable if the government covers part of the extreme damage because in a private market, premiums often considerably exceed "actuarially fair" values. But government risk sharing must not be used to subsidise certain enterprises or branches. Subsidised low premiums remove important incentives for preventative measures and directing building activity toward less risky areas. Lax prevention and building in high risk areas ultimately leads to higher losses that in the end all taxpayers are forced to bear. This results in an inefficient allocation of risks in the society.

Insurance is a means of providing compensation for financial losses in case of an adverse event. In some cases, it seems to be better to prevent losses before they can happen. The optimal solution is usually a combination of the two, implementing preventative measures to reduce the loss frequency and the severity of damages, and then insuring against rarer and more costly events. Government preventative infrastructure spending can reduce future losses and the need for subsidised property insurance schemes. Providing financial incentives to prevent damage can be regarded as a public good that is likely to be undersupplied by private insurers, because the benefits of prevention, in terms of lower flood or earthquake damage and hazard to human lives accrue to the broader community that is protected, while such benefits cannot be completely captured by an insurer in a competitive market.

References

Berliner, B (1982), Limits of Insurability of Risks, Englewood-Cliffs (NJ): Prentice Hall,

Charpentier, A. (2008), Insurability of Climate Risks, in: Geneva Papers of Risk and Insurance – Issues and Practice, Vol. 33, pp. 91–109.

Faure, M. G. (1995), The Limits to Insurability from a Law and Economics Perspective, in: Geneva Papers on Risk and Insurance – Issues and Practice, Vol. 20, pp. 454–462.

Gollier, C. (1997), About the Insurability of Catastrophic Risks, in: Geneva Papers on Risk and Insurance – Issues and Practice, Vol. 22, pp. 177–186.

Jaffee, D. M./ Russell, T. (1997), Catastrophe insurance, capital markets, and uninsurable risks, in: Journal of Risk and Insurance, Vol. 64, pp. 205–230.

Jametti, M./Ungern-Sternberg, T. (2010), Risk selection in natural-disaster insurance, in: Journal of Institutional and Theoretical Economics, Vol. 166, Iss. 2, pp. 344–364.

Kousky, C. (2011), Managing the risk of natural catastrophes: The role and functioning of state insurance programs, in: Review of Environmental Economics and Policy, Vol. 5 (1), pp. 153–171.

Kousky, C./Cooke, R. (2012), Explaining the failure to insure catastrophic risks, in: Geneva Papers of Risk and Insurance – Issues and Practice, Vol. 37, pp. 206–227.

Letremy, C./Grislain, N. (2009), Assurances des risques naturels en France: Sous quelles conditions les assureurs peuvent-ils inciter à la prévention des catastrophes naturelles?, Paris, www.developpement-durable.gouv.fr/Assurance-des-risques-naturels-en,5524.html

Michel-Kerjan, E./Lemoyne de Forges, S./Kunreuther, H. (2012), Policy tenure under the US National Flood Insurance Program (NFIP) USA, in: Risk Analysis, Vol. 32, Iss. 4, pp. 644–658.

Newman M. E. J. (2005), Power laws, Pareto distributions, and Zipf 's law, in: Contemporary Physics, Vol. 46 (5), p. 323–51.

Schoenberg F. P./Peng, R./Woods J. (2003), On the distribution of wildfire sizes, in: Environmetrics, Vol. 14 (6), pp. 583–92.

Swiss Re (2005), Innovating to Insure the Uninsurable, sigma No. 4/2005, Zurich.

Swiss Re (2011), State involvement in insurance markets, sigma No. 3/2011, Zurich.

Swiss Re (2012), Natural catastrophes and man-made disasters in 2011: Historic losses surface from record earthquakes and floods, sigma No. 2/2012, Zurich.