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# Quality of Life and Sustainable Development

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## CATASTROPHIC RISK FINANCING MODELS FOR SUSTAINABLE DEVELOPMENT

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**Abstract:** Catastrophic risk financing system is of national economic relevance. Its positive contribution to sustainability depends on system meeting a number of conditions. In the article four models of catastrophic risk financing are identified: market model, transfer model, supported market model and public-private partnership model. Their comparative analysis is performed according to chosen criteria. The main conclusion is that there are a lot of situations in which aims that should carry out this system exclude each other. The author believes that catastrophic risk financing system serves sustainable development best when the system promotes prevention and when it assures sufficient compensation for victims. Thereof public-private partnership model seems to be the best solution for sustainable catastrophic risk financing.

**Keywords:** Risk of catastrophe, financing risk, insurance, sustainable development.

### 1. Introduction

Catastrophic risk should be understood as a possibility of an event (a catastrophe), which causes large and cumulative losses, both material and personal. This risk is believed to create a growing danger for modern economies. In order to reduce society vulnerability to the catastrophic risk diverse actions are taken. From among those actions catastrophic risk financing is one of most controversial. Nowadays a number of solutions for catastrophic risk financing are applied. This paper aims at distinguishing certain models of catastrophic risk financing and at performing a comparison of catastrophic risk financing models. The results could contribute to making recommendations on shaping catastrophic risk financing system. This requires a proper distinction of catastrophic risk financing models and the right selections of criteria for comparison. In this paper special attention is paid to a possible contribution of catastrophic risk financing system to sustainable development promotion. The method used in this paper is mainly literature analysis and comparative analysis.

## 2. Catastrophic risk and its impact on the economy

The typology of catastrophes is well developed and established [McDonald 2012, pp. 129–137; Bostrom, Cirkovic 2008, p. 2–32; Gunn 2008; Quarantelli et al. 2007, p. 24] (catastrophes are usually sectioned according to the peril, risk source, type of losses caused by catastrophe and severity of a catastrophe). However, two most often signalized kinds of catastrophes should be mentioned here: natural catastrophes and man-made disasters. Natural catastrophes are nature-driven and can be exemplified by floods, droughts, earthquakes, hurricanes, fires, tsunamis etc. Man-made disasters are caused by human actions and can be exemplified by terroristic attacks, nuclear accidents, sudden and large pollutants spillovers etc. Some studies maintain that for the recent decades the catastrophic risk has been on a rise. This is revealed in the growth of number of natural catastrophes, the growth of number of man-made disasters as well as in the growth of losses (insured and uninsured) caused by catastrophes [Kondratyev et al. 2006, p. 449 ff.; SwissRe 2013; Valyaev et al. 2012, p. 41; OECD 2005, p. 190 ff.; Hochrainer 2006, p. 30 ff.]. However, it has been noticed that the dynamics of catastrophic losses is much higher than dynamics of number of catastrophes [OECD 2005, p. 191]. This is due to two important trends: progressive concentration of inhabitancy (especially in coastal areas which are most fragile ones) and the growth of wealth.

From a perspective of a particular catastrophe it is important to notice that a catastrophe, unlike other types of risk realizations, could push a country backward in its development [Guha-Sapir et al. 2004, p. 39 ff.]. A disaster could reduce output (certainly in the affected area and possibly nationally) both because of physical damage and because of a disruption in normal economic activities [Doś 2013, p. 165]. However, tracking actual impact of a catastrophe on country's development is extremely difficult due to the complexity of networks within the economy [The World Bank 2010a; Hochrainer 2006, p. 40 ff.]. Nevertheless recent studies have revealed that catastrophes reduce country's GDP (the level of reduction depends mostly on country's type, severity of catastrophe, type of catastrophe and elasticity of substitution in production [Laframboise, Loko 2012, p. 8 ff.; The World Bank 2004, p. 81]) as well as they have an adverse effect on the distribution of income within a nation [The World Bank, 2010a].

Presented information suggests that the economy is exposed to the growing risk of catastrophes occurrence. Vulnerability is certainly not desired, thereof catastrophic risk should be managed in order to reduce the exposition of economy to risk. Further deliberation will be limited to catastrophic risk financing solutions.

### 3. Catastrophic risk financing system and its models

Catastrophic events are unpredictable, therefore they are connected with risk. All actions aimed at limiting exposition to risk are embraced by the term risk management. Usually three phases of such management are distinguished:

1. risk assessment (gathering information on risk),
2. risk mitigation/prevention (limiting probability of losses technically, e.g. by applying building codes),
3. risk financing (programming sources of losses compensation).

Risk assessment is necessary for appropriate design of risk prevention and financing. Risk prevention can reduce risk, but it will never eliminate it totally (or its cost can exceed benefits resulting from obtained risk reduction). Therefore risk financing is necessary. Lack of it leads to the escalation of losses and pushes a country backwards in its development.

In order to finance catastrophic risk households, enterprises and governments exploit diverse risk financing instruments, what results in the existence of some system of catastrophic risk financing, which is a sum of individual decisions shaping risk financing and actions of government oriented towards providing capital for catastrophic losses compensation. Catastrophic risk financing system embraces structures included in public sector, capital markets, corporate finance, economics of households and insurance sector. However, it is useful to construct a map of the system, because it allows recognizing the main interdependencies within the system. Catastrophic risk financing system map is presented in Figure 1.

The graphical presentation of the system allows recognizing the main actors (households, enterprises, government, insurance and reinsurance companies, investors on capital market, international organizations) and interdependencies (expressed by the flow of capital).

The actors can have different individual goals related to participation in the system. However it should be stressed that the main purpose of the system is to provide funds sufficient to compensate losses caused by a catastrophe. This goal is not always reached. The system sufficiency depends on appropriate risk-layering. The concept of risk-layering is that risk financing instruments should be selected on the basis of the frequency and severity of disasters [Punkdrik 2010]. Risk layering is performed by risk aggregators, which operate at different levels. There are [SwissRe 2011]:

- 1) subnational risk aggregators (individuals, commercial entities), which provide low level of aggregation,
- 2) national risk aggregators (national insurance companies, governments), which provide middle level of aggregation,
- 3) multinational risk aggregators (international insurance companies), which provide higher level of aggregation,

4) global risk aggregators (global reinsurance companies, bond markets), which provide the highest level of aggregation.

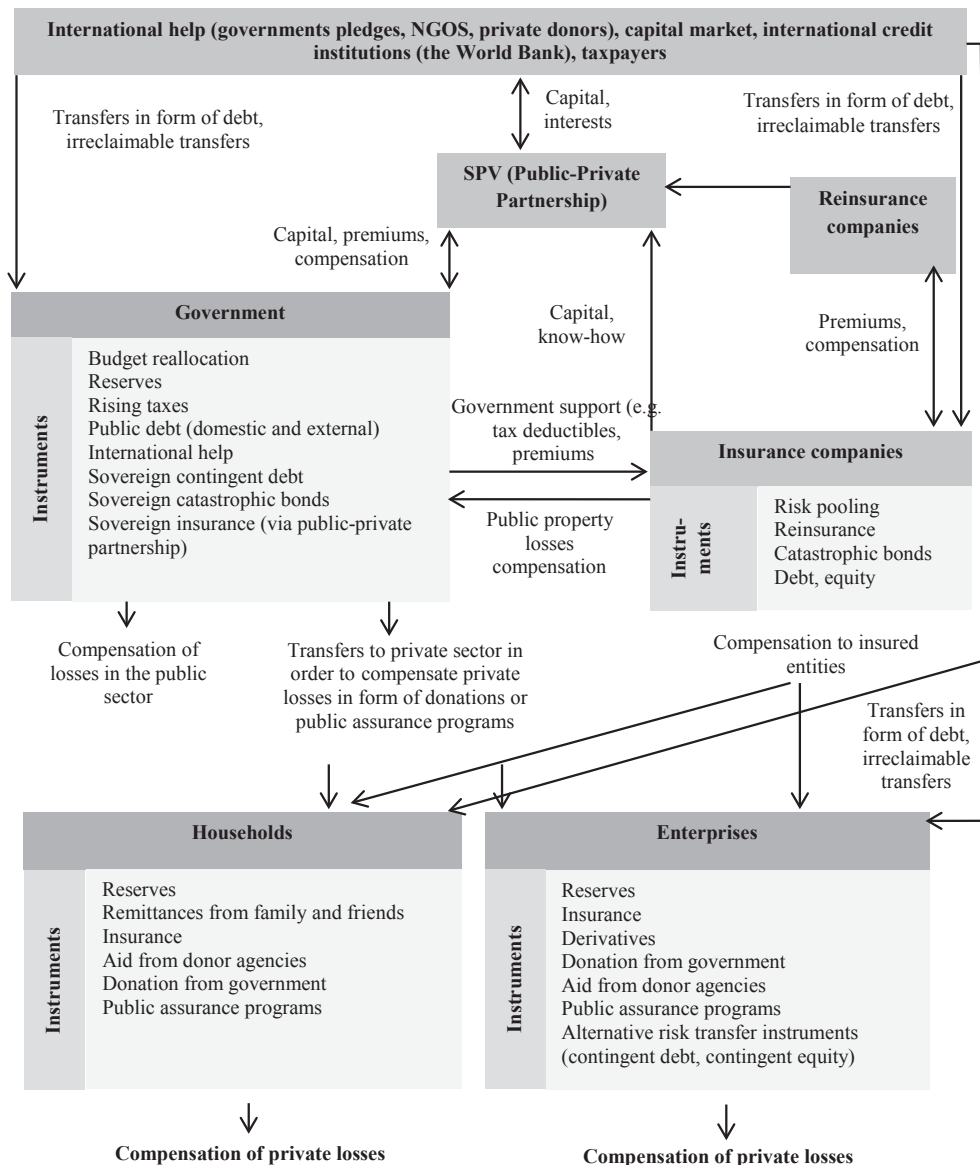


Figure 1. Catastrophic risk financing system: possible elements and links

Source: own study.



More severe and less possible is a catastrophe of higher level of aggregation (needed in order to secure system's ability to provide sufficient funds). It should be emphasized that each-level aggregators spread the risk on a certain community of risk. Insurance companies spread catastrophic risk among insured, reinsurance companies and investors delivering equity or buying catastrophic bonds issued by an insurer. Governments spread catastrophic risk among taxpayers, international community (asking for international help) and investors on capital market (incurring debt, issuing catastrophic bonds). Reinsurance companies spread the risk among insurance companies from around the globe and investors on capital market. Individuals can spread the risk only among family and friends. Investors on capital market diversify it. The greater the community of risk, the higher the level of aggregation. It should be stressed that in reality all risk aggregators face some obstacles in spreading the risk,<sup>1</sup> which determine their actual potential to ensure sufficient funds in case of catastrophic event.

Schematic overlooking the catastrophic risk financing system (Figure 1) allows distinguishing the most important elements of the system and links that connect those elements. It should be stressed that not every system includes each of presented elements. Additionally in some countries certain connections in the system are stronger and other weaker. Thereof multiple types of risk financing system exist. Generally, basing on the criterion of the most often exploited instrument of compensating catastrophic losses, a few contemporary applied catastrophic risk financing models can be distinguished.<sup>2</sup>

Insurance is the first instrument that comes to mind when risk is taken into consideration. Nevertheless insurance can turn out to be scarce in case of catastrophic risk. Insurance companies usually pay their commitments, thus the problem is reflected in catastrophic insurance products availability on the market, low level of absorbed catastrophic risk (determined by deductibles) and the price of insurance (premiums can be of barrier). There is significant evidence of catastrophic insurance products withdrawal from the market in the last decades [Grace, Klein 2009; Gerrish 2011], premiums augmentation and deductibles increase [Committee on Financial Services 2005], what reduces insurability of catastrophic risk<sup>3</sup>. The reasons for such withdrawal are: poor technical outcomes due to a catastrophic event and hard reinsurance market [Cummins 2006]. Poor technical outcomes result from problems with spreading catastrophic risk, what in turn has a more complex ground.

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<sup>1</sup> Obstacles for spreading the catastrophic risk faced by insurance and reinsurance companies are market conditions and regulations. Obstacles for spreading the catastrophic risk faced by the government are push-and-pulls of different interests groups.

<sup>2</sup> Some authors mark out only two models [Bac 2006], but this approach is too simplified regarding contemporary applied solutions.

<sup>3</sup> In this paper insurable risk is understood in terms of market conditions, as a risk that can be transferred to an insurance company through transactions possible to perform on insurance market [Gollier 2005].

Some analysis show that people tend to underestimate catastrophic risk, they do not acquire insurance thus the community of risk is too little and premiums rise. In such a situation, the occurrence of disaster causes losses, which cannot be compensated unless the government intervenes. However, when government grants aid to victims, insurance acquisition becomes less reasonable (insured victims are paid the premium, and uninsured victims receive compensation without paying the price). This results in risk community shrinking and insurance premiums augmentation or products withdrawal (catastrophic insurance density becomes small). This mechanism is called in the literature a “disaster syndrome” [Kunreuther 2000]. Answers to that problem are diverse.

I. In some countries the problem is left aside and as a result uninsured<sup>4</sup> victims are granted ad hoc donations – capital flow from the government to households and enterprises (see Figure 1) is higher. Insurance density is low and the majority of losses are compensated by the government (Poland, Germany, Italy). Government can help victims in the more ordained way –like in Belgium, the Netherlands or Austria, where public assurance programs have been developed. This is a kind of catastrophic risk financing system, where losses are compensated mostly by the government. Here such a type of system will be called a “transfer model.” Within “transfer model” costs of the system (costs of risk) are spread among taxpayers.

It is interesting that on some insurance markets disaster syndrome seems to be much less significant. There are three possible kinds of causation for this phenomenon (not necessarily exceptive). First – maintained market density. This means that entities exposed to catastrophic risk acquire enough insurance products due to their attractiveness or due to appropriate risk consciousness. The second possible cause is insurance companies’ belief that recent trends in catastrophic risk are just a random concentration, not the growth of probability and thereof they price their products lower. The third ground is the application of innovative solutions, which increases insurers’ capacity. All mentioned causations require deeper examination, which is beyond the scope of this paper. However, the third one will be described in more detail, because it has been better argued in the literature.

II. Especially in the USA some insurance companies have tested a number of innovate solutions which consist in providing them with capital in case of a disaster. Such solutions are first of all: issuing insurance-linked securities (ILS) or establishing sidecars [Cummins, Weiss 2009; Froot 2008; Mutengaa, Staikouras 2007]. This has improved market capacity and enhanced insurability of catastrophic risk. This improvement seems to be proved by some signals of the cycles of insurance and reinsurance market in the USA smoothening proof [Cummins 2007; O’Connor 2005]<sup>5</sup>. A system where the majority of losses is compensated by the insurance

<sup>4</sup> Those entities can be uninsured due to psychological or social reasons, large premiums or insurance unavailability.

<sup>5</sup> Another recommendations are to make long-term insurance agreements or to bind insurance policies rather to property than to an owner [Kunreuther 2008].

provided by private companies can be called a “market model”. Catastrophic risk in this model is spread among the insured.

The analysis reveals that insurance is primarily a developed market phenomenon [Cummins, Mahul 2009]. In developing countries insurance companies face paucity of markets, political resistance<sup>6</sup> and inadequate institutional framework [Cavallo, Noy 2011], which makes it impossible to create large communities of risk and to reach capital market potential. Thereof in developing countries catastrophic insurance is almost unavailable, what forces government to be the insurer of the last resort.

III. It has been noticed that the relevance of insurance against natural hazards is beyond the scope of individual coverage and attains national economic importance [Quinto 2011]. Thereof some governments have undertaken efforts to increase insurance products accessibility. Such interventions in insurance markets de facto form another type of catastrophic risk financing model: model where losses are mostly compensated by insurance, but catastrophic insurance market is significantly supported by the exploitation of public finance instruments and regulation. This model of catastrophic risk financing system can be called “supported market model.” Generally there are two ways of supporting insurance market: supporting supply side or supporting demand side. The supply of catastrophic insurance increases when the capital capacity of insurers is risen due to new possibilities of financing. Presently governments enhance insurance industry capacity, i.e., by encouraging creating catastrophic reserves through tax deductibles, modernizing accounting rules [Klein, Wang 2009; Cummins et al. 1999] or acting as reinsurance companies (USA – for risk of terrorism, France, Japan).

Demand on catastrophic insurance market can be supported by subsidizing insurance premiums or by making catastrophic insurance compulsory. Subsidizing premiums (Florida, USA) has large social costs, implies inequalities and enhances moral hazard leading to the augmentation of losses [Cummins 2006; Klein, Wang 2009; Cummins et al. 1999] (moral hazard consists in risk exposed entities careless behaviour toward risk due to the belief that someone else will pay the bill). Compulsory catastrophic insurance is sufficient, encourages prevention and eliminates moral hazard. Mandatory insurance can be provided by private insurance companies (Switzerland, Liechtenstein) or by state monopoly insurance (Spain).<sup>7</sup> Compulsory insurance should be multi-peril and premiums should be risk-adjusted in order to increase the efficiency of risk coverage and to remain insurance instead of becoming another tax. Usually government remains an insurer of the last resort. Thereof risk is spread among insured and taxpayers.

IV. Recently the fourth way to organize catastrophic risk financing system has been developed. Some governments enter public-private partnership (PPP) with

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<sup>6</sup> For example when domestic government forces insurance companies to locate their reserves in treasury bonds it makes running the business in such country unprofitable.

<sup>7</sup> Proposals to implement it in Germany failed due to political objections [Schwarze, Wagner 2007].

insurance or reinsurance company. Such partnership consists in building fund for which initial capital is provided by the government (with optional participation of private partner). The fund is managed by special purpose vehicle (with the participation of private partner, its knowledge, experience, procedures, business contacts, etc.). Such SPV acts as an insurance company and has an access to reinsurance and capital markets. Insurance can be compulsory (Caribbean countries) or voluntary. Specified catastrophic event is a disbursement trigger. This model of catastrophic risk financing system can be called “public-private partnership model” (PPP model). Catastrophic risk is spread among the insured and taxpayers.

In spite of appearances the PPP model differs significantly from supported market model, because the government has a fixed exposition and the system is centralized. Public agendas help distribute insurance, what enlarges community of risk and entails premiums decrease. The examples of implementing PPP in catastrophic risk financing are: South East Europe and Caucasus Regional Risk Insurance Facility Project, Pacific Catastrophe Risk Assessment and Financing Initiative and Caribbean Catastrophe Risk Insurance Facility.

Distinguished models are related to the structure of catastrophic risk financing system presented in Figure 1. Only the PPP model (IV) includes mechanisms which stipulate all actors to cooperate for the development of the system.

#### **4. Catastrophic risk financing models features**

Four models of catastrophic risk financing system have been recognized: market model (I), transfer model (II), supported market model (III) and public-private partnership model (IV). These models are characterized by a set of features. The most important features will be indicated and exploited here as criteria for making comparisons of distinguished models.

An obvious characteristic of catastrophic risk financing model is its sufficiency – capacity for assuring enough sources to compensate losses. System’s sufficiency depends on efficient risk aggregation. Other important features are:

- certainty – entities exposed to risk should obtain money necessary to perform recovery,
- timing – funds should be delivered at a proper moment,
- price – risk financing should be cheap.

Nevertheless it should be stressed that the purpose of risk financing is not only to assure appropriate funds, but to improve catastrophic risk management (integrity of the management must be preserved). Thereof the purpose of risk financing system should be also giving incentives for risk prevention, which is crucial, because the costs of prevention can be four to eight times lower than losses caused by disaster [Mechler 2004; SwissRe 2013].

The above mentioned purposes are discussed in the literature [Cummins, Mahul 2009]. However, there is another issue which should be considered, and which is

rarely deliberated. A catastrophe is a type of crisis, which means it can be exploited as a chance to switch the direction of country's progress. It can be seen as an opportunity to implement or to strengthen sustainable development. The way of rebuilding infrastructure, housing and livelihoods is important because it can influence social and environmental dimensions of the development. Thereof it should be deliberated if and when catastrophic risk financing system can be exploited to reach the goals of social and environmental development. Hence a comparison should take also into consideration:

- possibility of implementing strategy in post-disaster recovery process – moving towards sustainable development,
- problem of inequality in bearing the costs of catastrophic financing as well as in receiving compensation.

There seems to be tension between recurrent sustainable development policy (protected by prevention measures) and new, revised sustainable development policy possible to be implemented after catastrophic event. It should be stressed that prevention should not be abandoned in favour of targeted loss compensation. This would be cost-inefficient as well as it would give ambiguous signals on governments policy. Thereby enhancing prevention is a more desired feature of catastrophic risk financing than the possibility of targeting compensation.

Sufficiency is a basic feature of distinguished models. It seems that a transfer model is the most sufficient, because government has an incomparable financial power. However, in some cases it can turn out that government has less money (due to fiscal constrains) than well standing insurance sector. Practically systems sufficiency depends on the specific situation of a country and changes overtime. For the recommendation on constructing certain countries system of catastrophic risk financing fiscal space as well as insurance industry capacity under a number of conditions (like regulation) should be examined.

Entities exposed to the disaster risk need certainty that possible losses will be compensated. Insurance, as well as complex public assurance programs and public private partnerships, give that certainty, because they rely on *ex-ante* made agreements or are regulated. One exception is a parametric insurance – in case of which a claim is paid accordingly to chosen parameter of catastrophe (e.g. the power of earthquake, speed of wind) not accordingly to losses caused by such catastrophes (contingent debt, sovereign and private catastrophic bonds and derivatives work the same way). This implies so called “basis risk” consisting in possibility that payment will not compensate actual losses (however, payment may exceed actual losses). Parametric insurance has a very low market penetration ratio. It is more feasible when government or insurance company buys it [The World Bank 2010a] – thereof it can be assumed that parametric insurance is applied in public-private partnership model, just like in Caribbean countries.

When aid is granted *ad hoc* victims are at risk of not receiving anything or too little comparing to expectations. The magnitude of *ad hoc* aid is not regulated – it has

been proved that it rather depends on media concern and political factors [Jha et al. 2012; The World Bank 2010a]. Hence transfer model of *ad hoc* aid does not assure certainty for victims.

For catastrophe victims it is very important to receive compensation as soon as possible in order to minimize further losses. Traditional insurance requires a loss assessment before payments are forthcoming. In case of catastrophe the process of loss liquidation is much longer than in case of other types of risk realization. After catastrophic events insurance agents have so much work to do that claims analysis is delayed. Additionally catastrophes destroy infrastructure and it is difficult for agents to reach insured property and assess the losses. The solution for this problem is parametric insurance. Eliminating the necessity of loss assessment speeds the repayment of claims.

Transfer model implies that compensation is financed from public funds. Donations granted by the government can be well time-adjusted if government creates enough reserves, if it acquires contingent debt or when international help is provided. On the other hand if making payments requires budget reallocation or incurring debt, the disbursement of donations can be delayed.

Financial protection against catastrophic risk should be cheap. Theory implies that for households and enterprises it is advantageous to make risk transfer to an insurer because households and enterprises are risk adverse and are willing to pay insurance premium even if it exceeds possible losses. However, traditional catastrophic insurance can be even seven times more expensive than other types of insurance due to necessity of maintaining reserves and high costs of catastrophic losses liquidation [The World Bank 2010a]. Parametric catastrophic insurance, which does not require the proof of loss, is cheaper than traditional insurance – which is another advantage of PPP models based on parametric insurance. Transfer model is expensive mostly due to high alternative costs.<sup>8</sup> High alternative costs characterize also supported market model, when government acts as a reinsurance company and has unlimited exposition to risk.

A very important purpose of catastrophic risk financing is enhancing prevention. It lowers overall costs of catastrophic risk (immeasurable costs too). Insurance companies have developed a number of measures stimulating the insured to mitigate catastrophic risk (the most popular are deductibles and coinsurance). These measures help insurance companies to deal with moral hazard. Deductibles and coinsurance force the insured to reduce risk, because part of risk realization consequences is not transferred to an insurance company. Parametric insurance (applied in PPP models) reduces moral hazard and encourages prevention even stronger than traditional insurance, because compensation does not depend on losses, but only on disaster strength and thereof entities which successfully protect their property against disaster can even earn. It should be stressed that PPP model encourages not

<sup>8</sup> Social costs of retaining risk by the government (*de facto* bearing costs of risk realization by taxpayers) is well presented by F. Ghesquiere and O. Mahul [2007].

only individuals and commercial entities to reduce risk. Engaged government is interested in prevention too because loss reduction is reflected in lower losses in SPV fund. Additionally – sharing information, knowledge and know-how among partners lowers the costs of prevention.

Transfer models suffer from severe problems of moral hazard. Catastrophe donations provide little incentive for citizens to change behaviour to reduce risk. Risk-exposed entities no longer engage in systematic risk management due to their trust in aid being granted by the state. Moral hazard increases the cost of risk that becomes reflected in escalating costs of the catastrophic risk financing system. Moreover – granting aid discourages the acquisition of insurance,<sup>9</sup> instrument which enhances prevention, and thereof the country's exposition to risk rises.

In the end the possibility of switching toward sustainable development after a disaster should be deliberated.

Although it is possible, insurance compensation very rarely exceeds the value of destroyed property. Thereof rebuilding a house with a better and more sustainable technology (e.g. including solar heating), is possible only when its costs do not span compensation. Insurance has no capacity to create incentives for environment-friendly reconstruction, because it does not influence the decisions of the insured on spending received compensation. Since decisions on how to spend it are individual they cannot be subordinated to any kind of general strategy, unless other incentives are used (e.g. revised urban development plan). Lack of incentives for environmental-friendly reconstruction is a disadvantage of the market model, supported market model as well as public-private partnership model.

Additionally it has been proved that when it comes to insurance there exists a trade-off between equity (or equality in the burden of natural disasters) and providing more incentives to prevention [Picard 2008]. Risk adjusted insurance is not only more expensive but also less available for the poor [Mendoza 2011]. This is a disadvantage of market model as well as supported market model and PPP model, where premiums are not subsidized. Some authors even argue that insurance industry as a catastrophic risk financing tool consolidates the domination of the rich North over the poor South leading to global society's stratification escalation [Grove 2010]. However, like it has been stressed, replacing insurance with donations undermines desired prevention. It can be advised to finance from public funds not only losses compensation, but prevention too. Such a solution is a centralized solution – country's and society's risk exposure reduction is no more an effect of the number of individual initiatives, but an effect of political decision. Hence there is important tension between the centralization and decentralization of risk management. Decentralization promotes efficiency of actions but centralization protects common good; thereof it comes to another efficiency – equality tension.

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<sup>9</sup> Turkey is a good example of insurance density decrease after proclaiming government's help for all victims irrespective of whether they were insured or not.

Realizing that granting aid depends on one, central authority, transfer model makes implementing strategy in post-disaster recovery process possible. Opportunities are numerous: donations can be granted in form of vouchers which allow buying certain type of materials, it is possible to support the poor more intensively than the rich, the location of dwellings can be changed. A good example of such a policy are terms of granting donations by the World Bank: through giving money to women their position in the society is strengthened. Nevertheless it should be stressed that donations system should be programmed much before any catastrophe occurs, so to be efficient. Being only responsive does not create successful sustainable redevelopment.

It is also important to notice that not only the way of granting victims matters when it comes to sustainable redevelopment. The instruments for financing the aid matter too. It has been revealed that in some cases when budget reallocation is exploited almost all of the reconstruction activities are financed through the planned capital expenditures of future years [The World Bank 2010b]. If so it undermines planned investment in sustainable infrastructure. International aid for governments of affected countries seems to create great possibilities to move towards sustainable development, because developed countries predominate among donors and their help could include know-how and technological support. However, help often turns to a “beauty contest,” which means that donors compete in vying for spectacular aid pledges instead of concentrating on needs identification and recovery strategy [Telford 2007; Ghesquiere, Mahul 2007; Mechler 2004].

Above arguments contribute to the notion that even though transfer model creates possibility to shift toward more sustainable path of development, instruments of compensating losses and system financing should be carefully designed in order to meet the goal of sustainable redevelopment.

The very complex problem related to transfer model is the problem of inequalities in bearing costs of financing risk, which are contradictory to sustainability concept. If the system of collecting public incomes (taxes and debt) creates such inequalities, financing post-disaster aid by the government only increases them. Given that among modern public income systems there are cases of impeding equality (through tax system implying inequalities [Kaplanoglou, Newbery 2008; Sung, Park 2011; Pellegrino, Vernizzi 2007] or exorbitant debt unduly burdening future generations [Walasik 2008]) the costs of transfer model cannot be admittedly regarded as better distributed than the costs of market model. However, the level of inequalities caused by each model in certain circumstances should be carefully examined and compared.

## 5. Conclusions

The deliberation over catastrophic risk financing models reveals that there are multifaceted tradeoffs among multiple purposes that risk financing system can realize. There is: market – state, equality – efficiency, centralization – decentralization tension, which makes giving unequivocal opinions and recommendations difficult.



Hence some goals must be prioritized. Basing on preliminary analysis we believe that most needed features of catastrophic risk financing model are: sufficiency encouragement and prevention encouragement, which characterize market model, supported market model and public-private partnership model (however, a profound examination of the mentioned kinds of tension is needed). The deliberation reveals that targeted funds (donations), helpful in performing sustainable redevelopment, can be applied only at the cost of prevention, which is inadvisable regarding costs and transparency requirements. Thereof it can be stated that catastrophic risk financing model serves sustainable development best when it promotes prevention and when it assures sufficient compensation for victims. Parametric insurance is most effective in enhancing prevention, it is cheap and time-adjusted. It can be sufficient too when insurance is mandatory. Because of this public-private partnership model seems to be the most appropriate for catastrophic risk financing.

## Literature

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## MODELE FINANSOWANIA RYZYKA KATASTROFICZNEGO NA ŚCIEŻCE ROZWOJU ZRÓWNOWAŻONEGO

**Streszczenie:** System finansowania ryzyka katastroficznego ma istotne znaczenie w perspektywie gospodarki narodowej. Pozytywny wkład systemu finansowania ryzyka katastroficznego w rozwój zrównoważony zależy od spełnienia przez system szeregu warunków. W artykule zidentyfikowano cztery modele finansowania ryzyka katastroficznego: model rynkowy, transferowy, model wspieranego rynku oraz model partnerstwa publiczno-prywatnego. Przeprowadzono ich analizę porównawczą, uwzględniając wybrane kryteria. Głównym wnioskiem jest to, iż istnieje wiele sytuacji, w których cele, jakie powinny takie system realizować, wzajemnie się wykluczają. Według autora system finansowania ryzyka katastroficznego służy zrównoważonemu rozwojowi najlepiej wtedy, gdy promuje prewencję oraz zapewnia wystarczającą kompensację dla ofiar. Z tej perspektywy model partnerstwa publiczno-prywatnego wydaje się najwłaściwszym rozwiązaniem.

**Słowa kluczowe:** ryzyko katastrofy, ryzyko finansowe, ubezpieczenia, zrównoważony rozwój.