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Flood Risk Exposure in Austria – Options for Bearing Risk Efficiently

By Thomas Url and Franz Sinabell*

Abstract

Due to its topography, Austria is exposed to many natural hazards. Inadequate spatial planning aggravates natural exposure to risks, 12 % of all buildings are potentially exposed to flooding almost 9 % are considered to be at an extreme risk. Reinforcing precautionary measures is a prerequisite for an efficient risk management system that will be ready to meet future challenges. In an efficient risk management system the Austrian government's relief payments after catastrophic events should be substituted by a broad (mostly compulsory) insurance against natural hazards. The strong involvement of government in the provisions of precautionary measures against natural disasters and its role during emergencies should be better co-ordinated with private measures.

JEL Classifications: Q54, G28, G22

1. Introduction

Among the natural hazards that occur most frequently in Austria are floods, avalanches, storms, snow pressure and hail. In the past few years major flooding events caused significant damages (in 2002 about € 2.9 billion and in 2005 about € 0.6 billion). Earthquakes also present a great danger (above all in the south of Carinthia), but they rarely happen. Volcanic eruptions, storm flooding and tsunamis are major international threats that, however, do not directly affect Austria due to its geographical location. In industrialised countries such events mainly cause property damage, but particularly in developing countries, the death toll runs high every year. Natural disasters happen less frequently than catastrophic events caused by people (such as terrorist attacks, chemical accidents) but the damage (number of victims, property losses) is higher (*Swiss* Re, 2006).

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On a global scale, the trend in both the frequency of the occurrence of natural hazards and the damage of the events is rising. Changes in the world's climate nurse the fears that society will need to brace itself for more frequent and more serious climatic disasters. Human behaviour influences these natural processes to the worse (*IPPC,* 2007) and is at the same time resulting in an increasing vulnerability to natural hazards. Two developments are primarily responsible for this in developed countries: economic growth, which results in ever higher goods and property values, and the expansion of settlements and infrastructure area into at risk regions. In the less-developed countries these processes are eclipsed by the strong population growth.

Even if we assume that natural risk exposure did not change over time, this means that the economic damage potential is rising: In the last decade of the last century the per annum real growth rate of the capital stock of the Austrian national economy was 2.6 % (*Schwarz,* 2002). The sealed area of permanently populated space in Austria reached almost 6 % in the year 2006. The increase in sealed area has remained constant for years at a daily level of land consumption of about five hectares, although the Austrian strategy for sustainability targets a level of one hectare per day (*UBA,* 2007).

The question is how private and public players can take these developments into account in their plans and how they should adapt their behaviour correspondingly. Part of the efficient handling of natural hazards is keeping the level of damage low and, despite a certain risk exposure, to undertake as many economically profitable activities as possible. In this paper we will demonstrate how this goal can be achieved through a coordinated interweaving of public and private solutions.

Starting point for our considerations is the current risk management system for dealing with floods in Austria. We will focus in detail on flooding because this natural hazard has caused considerable damage over the last few years. In the following sections we review the literature to identify the preconditions of an efficient system for the management of natural hazards from an economic point of view. Then we will make a proposal to optimally meet the following requirements during the three phases before, during, and after a natural hazard occurs: in the first phase, farsighted damage prevention steps must be taken before a natural phenomenon strikes; in the second phase, as the event goes on, mitigation measures must be realised quickly; in the third phase after the natural disaster, repairs and reconstruction has to be financed and the persons affected must be compensated at terms that are known in advance. An efficient risk management system helps ensure that steps are taken in all three phases to keep the total extent of damages as low as possible. An important instrument for doing so is the risk transfer system which distributes the financial consequences of uncertain events within a collective. Although this is only fully felt after the damage has occurred, the concrete characteristics have a great influence on the efforts potential victims make to prevent and reduce damages.

2. Investments in Flood Protection and Flood Exposure in Austria

Numerous means of preventing natural hazards are actually pure public goods (cf. *Mueller,* 2003, 18 ff.). Such goods are characterised by the fact that the exclusion of other households from consumption is only possible at a high cost or not at all. Theoretically, the value of public goods is derived from the willingness to pay of those households that benefit from this good. Another characteristic of public good provision is that private households behave strategically. They indicate a low willingness to pay for a public good and can thus keep their financial contribution (e.g. for a dam) low. Therefore, the market does not provide public goods at all, or only insufficiently. This free riding behaviour on the side of private households can only be overcome through a public choice mechanism about the volume of the public good in question.

The Austrian legislature has solved this challenge in such a way that only a small part of the costs of preventive protective constructions is borne by the beneficiaries. Federal and provincial governments pay the largest share (up to 80 % of total costs) of preventive measures. More than 200 Mio Euros have been spent annually on dams, plans and information systems that are important for assessing the hazards caused by natural phenomena during the last years. In addition, mitigating facilities such as fire brigades are co-financed by the public so they are able to undertake disaster rescue missions more effectively.

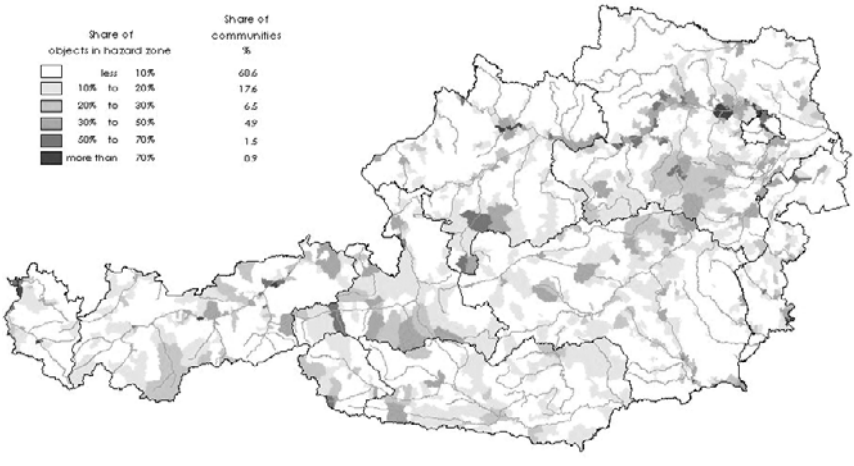
There are detailed hazard zone maps for almost all the areas that are exposed to torrents and avalanches (*die.Wildbach und Lawinenverbauung,* no date). They show the different degrees of risk exposure and the processes that cause them. The corresponding maps are filed in the municipalities and form an important base for decisions about which areas should be excluded from certain uses. Analogue hazard zone maps are also being worked out for rivers but they do not cover all the territory yet.

The municipalities play an important role in damage prevention. By dedicating zones as being suitable for development they determine where buildings and infrastructure can be built. Hazard zone maps are information systems that are relatively difficult to put together and working them out requires a great deal of time. One result of this is that the proper plans were not available in the past and local zoning did not give enough consideration to flood risk exposure. In addition, investigations following the floods of 2002 (cf. *Habersack* et al., 2004) discovered that existing maps had not been sufficiently considered in the local zoning regulation, meaning that the number of properties at risk of flooding in Austria is very high. This was identified as one reason for the high level of flood damages in 2002 (cf. *Sinabell / Trimmel,* 2004).

To find out more about the extent of flood risk exposure, HORA (Austrian flood risk zones, "HOchwasserRisikoflächen Austria") was published in the

summer of 2006. It is funded by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and the Austrian Insurance Association (VVO). With this information system it is now possible to better show the degree of flood risk exposure of individual objects throughout the entire territory. At the moment, the system is still lacking the precision of hazard zone maps. The reduction of flood risk due to dams and other protective measures is not yet accounted for. For many questions, however, this disadvantage is offset by its widespread availability and its accessibility over the internet with minimal efforts.

The extent of flood risk exposure in Austria is shown in Figure 1, disregarding protective constructions like dams. It shows the potential risk exposure on a municipal level if protective steps that have already been taken should fail, for example if a dam breaks. The different colours of the municipalities depict how many properties (buildings with valid addresses) in the respective municipality are within the zones of 200-year flooding events. The darker the colour, the higher the portion of properties that is at risk. In Table 2 the corresponding figures are summarised on the level of federal provinces (Länder). Additional information like settlement area and the percentage of sealed surfaces (streets, buildings, etc.) at the level of provinces shows that the number of properties in risk zones is very high in mountainous provinces where settlement concentrates along rivers in the valleys.



S: *Land-, forst- und wasserwirtschaftliches Rechenzentrum GmbH* (2006), own results.

Figure 1: Exposure of public, commercial and private properties to flood risks in Austria in 2005

Altogether, slightly more than 242,000 properties are regarded as potentially at risk (they are within the zone of 200-year floods, should protective constructions fail). This corresponds to about 12 % of the total. The majority of

these (8 %) are in the zone of 30-year events (zone 1 in Table 1), meaning they are at a potentially high risk.

In Austria, despite the build up of HORA, information is not being gathered systematically about the economic consequences of natural disasters. Although the number of properties at risk is now known well enough, we still do not know what the economic value of these properties is. The only source published regularly is the report of the disaster fund which finances public relief payments after catastrophes and precautionary measures. However, this report only lists the sum of the federal grants that have been awarded, without distinguishing between event categories (e.g. floods, avalanches) or breaking down the total damages. In general, knowledge about the economic effects of natural disasters is therefore very limited.

Exceptions are the floods of 2002 and 2005 that are well documented (*Habersack* et al., 2004; *Rudolf-Miklau,* 2006, *Sinabell / Url,* 2006). Studies on these events allow conclusions as to what portion of private damages is covered by state aid, insurance and private donations. Across all the claimants, an average of about 80 percent of their private damages has been covered; i.e. the "insured's share of the risk" amounted to about one fifth of economic losses. Around this mean there is substantial variation in the coverage rates. For some households the share of the damage they had to carry was existence-threatening, on the other hand, depending on local governments, it was also possible to have the damage fully compensated.

Table 1

Investments in flood prevention measures in Austria real annual expenditures (average 2001 – 2005) at prices 2005

Länder	total Mio. €	per household €	per capita €	per Mio € gross value added	per object in a hazard zone[1] €
Burgenland	20	191	71	4,206	2,387
Kärnten	23	104	41	1,904	1,465
Niederösterreich	28	47	18	884	383
Oberösterreich	28	52	20	841	768
Salzburg	26	128	51	1,784	1,329
Steiermark	28	62	24	1,102	1,056
Tirol	30	118	45	1,749	1,376
Vorarlberg	17	128	49	1,840	1,096
Wien	19	25	12	342	779
Austria	219	67	27	1,072	906

Sources: Estimates based on *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006A); Landesrechnungsabschlüsse (Budget-Ansatz 1 / 63).

[1] Hazard zones according to HORA.

Since different institutions are entrusted with the processes, and flooding can be caused both by natural streams that break their banks as well as by torrents and other waterways, it is not always possible to clearly allocate the steps that need to be taken for preventive flood protection. One example is that measures to improve rivers for shipping traffic are carried out simultaneously with flood protection improvements. The numbers presented are therefore confined to public investments that can be assigned unambiguously. In Table 1, the expenses cited for flood protection measures are also compared to the number of properties that HORA identifies as being potentially at risk. The table shows that funds for preventive measures are not distributed evenly across the country. The largest expenditures per household or per capita are in the region with the lowest number of properties in flood risk zones (Burgenland) whereas investments in preventive measures are relatively low in the province with the most properties in risk zones (Niederösterreich).

Table 2

Number of properties in hazard zones and sealed up area in the Austrian Länder 2005

	properties		settlement area		properties in risk zones[1]	
	total	in hazard zones	total 1,000 km^2	sealed up[2] share in %	zone 1 to 3 share in %	zone 1 (high risk) share in %
	number					
Burgenland	114,831	8,254	2.5	5.2	7.2	5.6
Kärnten	150,708	15,594	2.3	6.8	10.3	8.8
Niederösterreich	545,801	73,531	11.3	5.0	13.5	9.7
Oberösterreich	354,861	35,755	6.6	5.0	10.1	7.6
Salzburg	114,330	19,732	1.4	7.0	17.3	13.9
Steiermark	319,083	26,785	5.0	6.6	8.4	6.2
Tirol	153,196	22,044	1.5	7.9	14.4	11.4
Vorarlberg	88,181	15,527	0.6	8.0	17.6	15.5
Wien	174,407	24,829	0.3	28.0	14.2	6.2
Austria	2,015,398	242,051	31.5	5.9	12.0	8.8

Source: Statistik Austria, Gebäudezählung 2001, *Land-, forst- und wasserwirtschaftliches Rechenzentrum GmbH* (2006); *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006A). According to "Hochwasserrisikozonierung Austria – HORA" properties are potentially at risk ("potentiell gefährdet") ignoring protection due to dams and other constructions (*Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft,* 2006A, detailed definitions are available at http: // www.hochwasserrisiko.at.

[1] Number of properties in zone 1 (high risk: expected T = 30-year flood level). Lower risks are in zone 2 (T = 100-year flood level) and zone 3 (T = 200-year flood level).

[2] *Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft* (2006B).

Sinabell / Trimmel (2004) examined the factors on which decisions were based on when judging specific protection measures. They found that the criteria used to judge the cost-benefits of river engineering projects in the year 2004 did not reflect the standards of cost-benefit analysis. The estimate of the costs of projects was relatively reliable. However, the assessment of the benefits of river engineering projects was flawed because estimates were often based on standardised rates without recognising actual conditions. In addition, project assessments did not take external effects on downstream riparian into account.

3. Risk Management and the Risk Transfer in Austria

There are some obvious imperfections in Austria's current risk management and risk transfer systems (cf. *Sinabell,* 2004; *Hyll / Vetters / Prettenthaler,* 2004; *Prettenthaler / Hyll / Türk / Vetters,* 2004). Particularly the coordination between risk management and the risk transfer system appears inefficient. In addition, the risk transfer system exhibits the following deficits:

- The majority of private households is insufficiently insured against damages caused by natural hazards (including floods).
- In some Austrian provinces the indemnities paid by private insurances reduce the amount of public disaster relief granted. This lessens people's incentive to take out private insurance policies.
- Many people who would like to take out insurance but live in risky zones (such as areas that were flooded within the past five years) do not find an insurance company that is willing to cover the risk completely. If insurance policies do offer coverage it is usually restricted – either to a percentage of the sum insured (e.g. 50 %) or a flat payout (between 4,000 and 7,000 Euros). Insurance companies set an upper limit to their total indemnity by including clauses against accumulated risks (e.g. 15 million Euros per event). This means the actual claims payments depend on the total number of people affected by a flood and are therefore not known in advance. Summing up, low cost damages occurring more frequently are fully covered by standard household policies while large damages occurring less frequently are incompletely covered.

These observations indicate a market failure. On the demand side households in risk zones only look for insurance when they are – subjectively – worried enough. One reason for the low demand could be the subjective underestimation of the actual flood risk. HORA should have removed this problem, because this information system provides a risk assessment concerning floods and earthquakes in the form of easily comprehensible *T*-year flood levels. Yet a lack of information search or limited interest still may lead to a huge gap between perceived and objective risk.

On the supply side, the insurance industry is mainly selling contracts which leave the policyholders extremely underinsured (flat sum). An important reason for this lies in the nature of risks from flood. Floods affect a large number of people simultaneously. Large events thus can overstrain the liquidity of individual insurance companies because the risk can only partially be diversified within the insurance pool and reinsurance is costly (*Froot,* 2001).

In Austria the federal government makes up for this market failure by providing disaster relief to victims. Over the last few years roughly 80 million Euros in state aid have been paid out annually to claimants (*Sinabell / Url,* 2006). Financial assistance granted from the disaster fund and the budgets of the provinces are funded by tax money.

The deficiencies above show that the Austrian government's efforts to remedy low insurance coverage by taking over the risk transfer system have only been partially effective. Some 40 percent of private losses have been covered by public disaster relief after recent floods but there is no legal entitlement to claim compensation, and the share of damage after accounting for private insurance indemnities and relief payments is still very high in individual cases. Another weakness is the missing link between the risk transfer system on the one hand, and the risk exposure of households on the other. This means that an important criterion of an efficient risk transfer system, i.e. a risk adequate financing of indemnities is not fulfilled. This problem is reinforced by the fact that some federal provinces offset private insurance payouts against public relief payments. As a consequence, households do not spend enough effort to avoid damages and take out too low an insurance coverage. Before presenting a proposal how to modify the Austrian risk transfer system for natural hazards we will briefly discuss requirements for an efficient risk transfer system in the case of large scale events.

4. Requirements Placed on an Efficient Risk Management or Risk Transfer System

Risk management of natural hazards sums up all the measures for information and prevention or for damage reduction before and during a natural disaster. The risk transfer system, on the other hand, only describes the transfer of individual risks to risk collectives such as insurance companies or public relief funds. This can be a transfer system financed by taxes, as in the case of the disaster fund or, as in the case of storm insurance, an insurance system financed by premium payments. The Austrian hail insurance can be described as a mixed system because private premium payments are subsidised by public transfers. Risk management and risk transfer are not independent of each other. The instruments from the two areas can either strengthen or weaken each other.

An efficient system of risk management and risk transfer for natural hazards must take into account the interaction between all the different instruments in all the phases of natural disasters:

During the **phase before a natural disaster hits** the potential level of damage should be kept low by adequate land use, building protective measures and through foresighted use. The potential damage can be greatly reduced by avoiding risk zones and by compliance with adequate building standards. The government's task is to provide public goods like identifying the hazard zones, co-financing dams and other protective measures that help reduce the risk of damage. It also means running information systems and warning services, as well as the preventative support of fire brigades and emergency services. Another important responsibility of the state is the allocation of property rights, which also provides incentives for preventing damage. If owners of oil tanks are liable for damage caused by an oil leak then they will take the appropriate steps to prevent those damages should a disaster occur.

During the **phase when the damage is occurring** government and private parties can also help keep the damage level down. The federal government has the task of central coordination and makes its own facilities (e.g. the military) available to safeguard body and soul and minimise property damage. In this phase the civil services take on an important function (e.g. rescue squads and fire brigades) in averting dangers. Depending on the kind of natural event, the persons affected can help limit the damages by taking action on their own. When there is sufficient advance warning, damages can be considerably reduced, for example by evacuating people, moving vehicles out of the danger zone, putting up mobile dams, removing furniture and equipment from areas in the house that are at risk.

During the **phase after the damage has occurred** it is important to remove the damages as quickly and as completely as possible, on terms which were laid down before the event. Both public bodies and private agents are involved in limiting damage during this phase as well. The government's task is to protect the population from a state of emergency, to quickly repair destroyed public infrastructure and to accelerate the resumption of business activities. The risk transfer system plays a central role during this phase because it pays out loss compensations. However, the influence of the risk transfer system is not confined to this phase alone.

4.1 The Demand for Catastrophe Insurance

When they take out insurance, private households voluntarily exchange a possible loss, L, due to property damage for the advance payment of a fixed insurance premium. As an example, we will use a simple model suggested by *Kunreuther / Pauly* (2006) to show the decision problem of private households

with wealth, *W,* over the demand for insurance coverage, *I.* There are only two states of nature: with probability p a flood occurs, causing damage and with probability $(1-p)$ no damage will occur. The cost of insurance per Euro of insurance coverage is z. According to the Austrian income tax law the financial burden from natural disaster not covered by indemnities or disaster relief can be written off on the household's current income at the marginal tax rate t. In the case of a flood, the household can expect payments from the disaster fund, *D(I, L),* depending on insurance coverage and loss size. We assume that higher insurance coverage reduces and higher losses increase public disaster relief. For simplicity we rule out a relation between disaster relief and the tax deductibility of uncovered losses.

If there is symmetric information about risk between insurer and private household and the insurer charges risk-based premiums there will be no adverse selection problem. If the magnitude of the damage cannot be influenced by the behaviour of the insured we can exclude moral hazard. Then we can determine the optimal amount of insurance, I^{opt}, by maximizing the expected utility, $E(U(I))$, of the rational household:

$$(1) \quad E[U(I)] = pU[W - L + I(1-z) + t(L-I) + D(I,L)] + (1-p)U[W - zI]\,,$$

with respect to insurance coverage, *I,* where

$$0 \leq I \leq L\,,$$

must hold. The utility function is twice differentiable in wealth with positive, $\partial U/\partial W = U_W > 0$, but diminishing marginal utility, $\partial^2 U/\partial W^2 = U_{WW} < 0$. The resulting first order condition is

$$(2) \quad \frac{(1-p)z}{p[1-z-t+D_I(I^{opt},L)]} = \frac{U_I[W - L + I^{opt}(1-z) + t(L-I^{opt}) + D(I^{opt},L)]}{U_I[W - zI^{opt}]}\,,$$

where sub index I indicates a partial derivative with respect to I and all partial derivatives are valued at the optimal amount of insurance, I^{opt}. The left hand side of the first order condition shows the relative marginal cost between the states of nature "non-flood" (numerator) versus "flood" (denominator) and the left hand side gives the ratio of corresponding marginal benefits in the case of "flood" (numerator) and "non-flood" (denominator). Optimal insurance coverage requires that equation (2) holds.

The optimal amount of insurance coverage is bounded from below by zero. This boundary would be hit if the solution to (2) is smaller than zero and the household will not demand any coverage. On the other hand, the loss, *L,* forms an upper bound if the first order condition (2) delivers a value $I^{opt} > L$, which would occur in the case of subsidised premiums. If the solution to (2) lies

between these boundaries, this is the optimal amount of insurance coverage. If the probability of disaster, *p,* is low relative to the premium, *z,* it is clear from (2) that the household will reduce demand for insurance coverage. Such a situation would occur with subjective underestimation of risk by private households, while insurers still charge risk-based premiums. For very low values of *p* the left hand side of (2) gets very big, which implies that the marginal cost of insurance in the non-flood case is very high relative to flooding. High relative marginal costs can only be compensated on the left hand side by low values of insurance coverage. This corresponds to a high endowment in the case of non-flood with correspondingly low marginal utility in the denominator and a low endowment in the case of a flood with correspondingly high marginal utility.

By establishing a disaster fund the government is able to partially restore the endowment level of private households after a disaster but at the same time private insurance demand will be crowded out. Within this simple model demand for insurance is smaller if disaster relief is granted and if uncovered losses can be used as tax deductibles. In both cases the numerator of the right hand side of (2) gets smaller because a bigger endowment in the flood case lowers cet. par. marginal utility in the case of a flood. Given that insurance coverage reduces the amount of disaster relief, i.e. $D_i < 0$, in a linear way, the denominator on the left hand side can only be increased by reducing insurance coverage which finally restores equality of (2). A similar argument holds with respect to the tax deductibility of uncovered losses.

Given subjective underestimation of risks we expect low rates of private insurance and low rates of coverage in a set up without government intervention. *Coate* (1995) shows that under the assumption of altruism a public transfer mechanism shifting funds towards poor victims of disaster will be established. This Samaritan's dilemma of the Buchanan (1975) type arises because the rich cannot credibly commit themselves not to help poor households struck by disaster. In anticipation of private charity or public transfers private households will fail to take out private insurance intensifying the problem of underinsurance, see also *Kim / Schlesinger* (2005).

One way to solve the downward bias in personal risk assessment would be to engage in public information campaigns or training programs that reduce over-confidence. Indeed, *Sandroni / Sqintani* (2007) show that training programs in a setting with asymmetric information about risk and downward biased beliefs are welfare increasing given that training costs are low. If training programs are voluntary, attendance rates are likely to be low and over-confidence will remain widespread. By making flood insurance compulsory, the government can force private households to join an insurance scheme irrespective of their risk perception and thus achieve complete coverage. Since the information about the risk characteristics of a property is public, insurance companies can provide policies with risk adequate premiums which would avoid transfers between low and high risk properties in the insurance scheme.

From the first order condition (2) it is clear that an underestimate of the probability p relative to the cost of insurance z results in low coverage rates. In the extreme case of a perceived probability of zero, $p = 0$, households would not sign an insurance contract at all. The same result would happen if households follow a sequential choice rule as proposed by *Kunreuther / Pauly* (2006). Given the risk averse shape of the utility function households prefer outcomes with more equally distributed wealth over states of nature over outcomes with unequal distributions. Thus under both choice rules compulsory insurance with risk adequate premiums would improve welfare. Compulsory insurance is also a commitment device for the government to credibly withdraw from paying disaster relief in the third phase.

Insurance policies are characterised by a fundamental conflict: They provide policy holders with financial safety but this influences their incentive to avoid damages during the three phases before, during, and after a disaster. *Ehrlich / Becker* (1972) show in an expected utility framework how self-insurance, self-protection and market insurance are related. By engaging in self-insurance households invest into loss reducing measures that have no bearing on the probability of the loss; an example would be anchoring underground oil tanks to avoid oil spills. Self-protective measures, on the other hand, directly reduce the probability of damage rather than the size of a loss. An example for this would be planning for an elevated ground floor of buildings within designated flood areas. Self-insurance and market insurance are substitutes in the sense that purchase of market insurance reduces the amount of self-insurance. Substitutability arises from the equality of the price of market insurance to the shadow price of self-insurance in equilibrium. The relation between market insurance and self-protection is more complex. If the price of insurance does not respond to expenditures on self-protection, *Ehrlich / Becker* (1972) prove that the classic moral hazard case applies with market insurance discouraging self-protection. If the price for insurance reacts to the amount spent on protection those two instruments may even become complements.

4.2 The Supply of Catastrophe Insurance

Extensive natural phenomena, such as flooding, affect many households at the same time. Thus, individual damages are to a great extent or even completely correlated. The pooling of affected and non-affected households that is typical of many other risks only works partially here, or it is eliminated at all. The correlation of individual damages results in an accumulated damage that cannot be diversified. Based on general considerations, *Marshall* (1974) developed two applicable insurance principles: (1) the transfer, or reserves principle and (2) the mutuality principle.

In the transfer or reserve principle, claims payments are financed by redistributing premium earnings among the insured. Accumulated damages are

protected in this system by reserves that are built up over the course of time. Large events may use up reserves and require a single insurer to tap into its equity capital which forms the limit of what can be paid by the company. To avoid tapping into equity capital the insurer will buy reinsurance or transfer risks to the capital market by selling catastrophe bonds and catastrophe options (*Doherty,* 2000).

In a system based on the mutuality principle, reserves only play a subordinate role. Instead, the insured are entitled to the surplus remaining in the insurance pool in years without damages and must make an additional payment in years when a disaster occurs. Thus in the mutual system damages are financed through a combination of advance premium payments and subsequent profit or loss sharing. This construction enables protection against correlated risks within a collective insurance scheme. By taking out reinsurance or tapping the capital market directly, part of the non-diversifiable risk in a policy based on the mutuality principle can be ceded.

Insurance systems based on the transfer or reserve principle need a high portion of reinsurance as long as their reserves' level is low. For correlated risks the reinsurance premium includes a risk premium, which can be very high (*Froot,* 2001). *Doherty / Dionne* (1993) show in a standard expected utility model that only extremely risk-averse households would choose full reinsurance under a transfer system. Less risk averse households would prefer to carry part of the accumulated risk themselves and therefore would prefer a mutual insurance.

There is also a macroeconomic argument against insurance systems based on the reserve principle because they have undesirable macroeconomic side effects: Financing the accumulated damage by dissolving large reserves can put heavy pressure on the price of securities and result in losses of capital. At the same time, this causes interest rates to rise so that private clean-up and renovation work becomes more expensive – not only due to price increases caused by the high demand for clean-up and construction services but also because of the higher costs of financing this work (*Doherty,* 1997). In a mutual insurance system the amount of reserves to be dissolved is small, so the pressure on security prices is limited. Moreover, because of the withdrawal of purchasing power from insured households (supplemental payments) other building activities that were planned before the natural phenomenon occurred may not be done, or the demand for reconstruction work might be postponed. Both effects would mitigate the inflation for clean-up and construction services that takes place after a disaster, although for a small open economy like Austria the interest rate effect is likely to be negligible.

At the moment, Austrian households have only limited possibilities to take out insurance based on the mutuality principle. Practically, an insurance policy could be underwritten by a mutual insurer specializing in natural disaster risks.

Such a mutual may offer a profit and loss sharing contract. At present, there is no such insurer in Austria. Another solution would be to take out an insurance policy with a regular stock company. However, such an insurance policy would either have to replicate the appropriate profit and loss sharing principle based on mutuality, or the household has to purchase shares in this insurance company contemporaneously in order to participate in the dividend payments. In this case, it would be ideal if it were a specialty insurer (*Doherty / Dionne,* 1993). An alternative solution presented by the Austrian Insurance Association suggests creation of a mutual insurer underwriting the risk but leaving distribution and loss management to primary insurers.

5. A Proposal for an Alternative Risk Transfer System for Natural Hazards in Austria

Based on the deficiencies identified in the Austrian risk management and the requirements for an efficient system we are in a position to suggest some improvements. At present, the government plays a central role in the risk transfer system. From an economic point of view, the system's costs have to be weighed against benefits with respect to three dimensions: (1) to encourage prevention, (2) to trigger mitigating activities while the event is going on, and (3) to provide quick and complete compensation subject to conditions agreed-upon in advance.

The efforts made by the Austrian government to meet the first two objectives seem to be adequate. However, its role in the risk transfer is not satisfactory because occasionally large individual damages are not covered (neither by indemnities nor by relief payments) and because private precautionary activities are discouraged. In a first step, indemnities paid by insurance companies should not offset relief payments although overall compensations must not exceed the loss.

In a second step, undesirable side effects of public relief payments should be addressed: they crowd out self and market insurance by private households and they are tax funded and therefore the link between the riskiness of a property and the associated financial burden is blurred. The financial burden should reflect exposure to hazards and this condition for an efficient risk transfer system is not met in Austria. The experience from the U.S. Flood Insurance Program after its introduction in 1968 may serve as an example for the substitution between ad hoc disaster relief and subsidized flood insurance. Only after changing the incentive structure in 1973 the number of policies in force was increased substantially (FEMA and FIMA, 2002). Flood insurance is not mandatory in the U.S. and many properties in flood prone zones are still not insured even though premium subsidies are granted for houses that were built prior to the delineation of flood zones (*Kunreuther / Pauly,* 2006).

On the basis of this experience, we propose a withdrawal of the government from the risk transfer system, which leaves open two alternative options: (1) The potential claimants carry the costs of the damages themselves by accepting self-insurance or self-protection in the sense of *Ehrlich / Becker* (1972), or alternatively (2) a system with compulsory insurance with private insurers taking over the risk transfer at risk adequate premiums. Option (1) suffers from a lack of credibility because the government has no instrument to commit itself credibly not to pay out disaster relief after an incident, cf. *Coate* (1995). A purely market based solution will involve low levels of self-insurance and self-protection by private households because of the possibility of charitable transfers from altruistic rich households in the bad state. In this case, there is no reason to expect the level of transfers to be optimal for victims. Additionally, there is a free rider problem in fixing the level of charity payments by rich households, and there is no way to implement cost-effective protection in the presence of self-insurance opportunities. Moreover, self-insurance does not enable the household to benefit from the law of large numbers offered by an insurance pool and opportunities to spread risks are foregone. A system of compulsory insurance with risk adequate premiums, on the other hand, provides the government with a commitment device (*Kunreuther / Pauly,* 2006), generates the biggest possible insurance pool, and induces complementary self-protective action, although self-insurance will be substituted by compulsory market insurance. Insurance systems based on risk adequate premiums have the advantage that complementary ex ante damage prevention and damage-mitigating activities are triggered through risk adequate premiums. The practical instruments for this are differentiated premium levels, discounts, deductibles, and on-site inspections.

Risk-adequate premiums increase the risk awareness of private households because properties that are in more danger or less protected also face higher insurance premium. This information already influences the choice of the location where properties may be built and should also lead to a situation where the benefits of all ex ante protective measures (anchoring oil tanks, for example) are balanced against their costs. Risk-adequate premiums reward efficient protective measures, depending on how much it costs the insurer to monitor them, either with discounts (ex ante) or with deductibles (ex post). In so doing, they contribute to the efficient reduction of the risk of natural hazards (*Shavell,* 1979; *Winter,* 2000). Alternative instruments are experienced based bonus malus systems, partial insurance exclusion or coinsurance clauses. Insurance policies with a coinsurance clause only cover a portion of the damage, starting at a damage amount that is agreed upon in advance. None of these instruments requires monitoring the policyholder, and they automatically sanction behaviour that does not minimise damage by increasing premiums or restricting benefits.

Enforcing private households to sign insurance policies does not solve the high costs of reinsurance in a reserve based insurance system. On the contrary,

primary insurers are likely to pass through high reinsurance premiums into the price. For this reason we suggest establishment of a natural hazard insurer based on the mutuality principle, maybe combined with some degree of reinsurance. Underwriting non-diversifiable risk can be reduced with reinsurance, for which a risk premium has to be paid. This organisational form is superior to other forms because it can carry both diversified and non-diversified risk to a large degree. The mutuality principle makes upper limits for coverage superfluous. Limits to the total indemnity violate an essential element of an efficient risk transfer system because complete coverage is not offered under foreseeable conditions. If the government acts as the insurer of last resort it will effectively subsidise the risk premium and thus violate the principle of risk-adequate premiums.

5.1 Transition to the New Risk Transfer System

Several factors impede an unmodified implementation of our proposal in Austria. First of all, there are legal hurdles against a system of compulsory insurance. Partial coverage against flood insurance, as already offered by some firms, is an indication that the market does not fail completely and EU-law limits the implementation of compulsory systems if market institutions already exist. To establish a system similar to that in Spain or Switzerland bears considerable legal risks. A system of compulsory insurance which had to be abandoned after being challenged at courts would do no good. A way out of legal challenges could be achieved by systems similar to those in the UK, in Italy or Belgium where insurance of natural disasters is bundled with fire insurance. Buying coverage against natural hazards would then not be compulsory in a legal sense but quasi-compulsory for most owners of properties.

Besides legal objections, political resistance may be vigorous. The change would result in a shift of the burden from public tax-financed transfers to those households exposed to moderate or high risk properties. Several elements of an insurance based solution could help reduce this: Insurance premiums should only reflect risks, i.e. there should be no redistribution between risk classes. By pooling different uncorrelated natural perils the number of households with insurance would rise and premiums could be offered less expensively. Compulsory insurance would probably be more acceptable for many of the people if the tax burden were reduced at the same time compensating for abandoned funding of public catastrophe relief. Nevertheless, the group of persons that is likely to be affected most by compulsory insurance (the owners of approximately 200,000 high-risk objects) is relatively small compared to the group of persons that would benefit from such a solution (several million tax payers). In many cases smaller interest groups are more effective in manipulating the policy making process in their interest (*Olson,* 1982). Therefore it is possible that the public savings of approximately 80 Mio. Euros per annum

will not suffice to compensate the majority of low-risk households for their costs of supporting an insurance based solution.

On the supply side, insurers will have a vital interest to transfer part of the risk to the state as the insurer of last resort. *Schwarze / Wagner* (2007) mention this as one of the decisive reasons for the failure of establishing a compulsory insurance based system in Germany. The mutuality based system would be able to cope with a lower degree of reinsurance as compared to a reserve based system and thus faces less need for a state layer covering large scale disasters. Nevertheless, subsequent profit or loss sharing within the insurance pool might be challenged in the case of a large scale disaster and an additional state layer for extreme events may be considered, e.g. as a returnable public credit to the mutual (*Jaffee / Russell,* 2006). Such a construction should attenuate resistance by the government against a role as an insurer of last resort.

Homeowners in high risk zones have a high interest to lobby for premium subsidies. Some people might find it 'fair' that those in zones without any risk contribute to a collective burden sharing system because of equity concerns. It is therefore not unlikely that in one way or another, premiums will be subsidised (either by the tax payers or by low-risk agents). A negative consequence of granting premium subsidies is reduced incentives to avoid damages. Subsidies for premiums, however, seem to be the most suitable instrument for mitigating the burden of the compulsory insurance on disadvantaged groups while avoiding the inefficiencies of charity payments by private households (*Coate,* 1995). Social equity concerns are likely to emerge as poor households tend to settle in hazard prone zones because of lower land prices. If premium subsidies have to be granted due to equity concerns, regional administrative bodies (primarily the local communities) should finance them because they were and are responsible for designating zones for developments. However, if there is a premium subsidy it should only be temporarily granted and limited to existing properties. New developments would carry the price signal of high insurance premiums with them and thus ensure risk adequate behaviour.

5.2 An Appraisal of the Political Feasibility of the Proposed Risk Transfer System

The bundling of natural hazards with fire insurances has been suggested by several authors as a means to improve the risk transfers system in Austria and Germany. This would be a quasi-obligatory insurance while we propose mandatory insurance of all non-commercial properties in hazard zones. From an administrative perspective it is advantageous to add coverage to an existing contract which may increase acceptance by private households. But if fire insurance is not comprehensive we again end up with uncovered damages and consequently incentives for the public to provide disaster relief. These incentives grow with the value of properties in natural hazard zones lacking fire

insurance. Therefore, an evaluation of this exposure is necessary prior to the decision over the implementation of a mandatory or a quasi-obligatory system. Political resistance against a mandatory insurance seems to be lower if commercial properties are not included because the heterogeneity of commercial risks could make the calculation of premiums less transparent.

Authors like *Schwarze / Wagner* (2007) and *Prettenthaler / Vetters* (2005) propose an alternative organisation of the risk transfer system: primary insurers underwrite contracts with clients, provide claims management services, and pool the risk of natural hazards in a first layer. In both proposals, the state is the insurer of last resort which allows saving the risk premium for reinsurance. Since the mutuality principle also minimizes the need for costly reinsurance private households should be indifferent with respect to both approaches. Reinsurance by the state transfers wealth from tax payers to households in risk zones and dampens efforts to prevent damages. Furthermore, it creates unforeseen pressure on public budgets.

Prettenthaler / Vetters (2005) plead for a "risk differentiated premium" but oppose a risk adequate premium because of the high costs in high risk zones. This system implies subsidies flowing from low risk towards high risk households. The acceptance of such a system is likely to be low and a preference for redistribution is better implemented by temporary targeted subsidies for low income households.

6. Discussion and Conclusions

The European Floods Directive will create an EU framework for flood risk management (*CEC,* 2006). It builds on and is closely coordinated and synchronised with the 2000 Water Framework Directive, the cornerstone of EU water protection policy. The Floods Directive adopted by Council and Parliament will require that Member States take a long-term planning approach to reducing flood risks in three stages (*CEC,* 2007): Member States will by 2011 undertake a preliminary flood risk assessment of their river basins and associated coastal zones. Where real risks of flood damage exist, they must by 2013 develop flood hazard maps and flood risk maps. By 2015 flood risk management plans must be drawn up for these zones. These plans are to include measures to reduce the probability of flooding and its potential consequences. They will address all phases of the flood risk management cycle but focus particularly on prevention, protection and preparedness, e.g. providing instructions to the public on what to do in the event of flooding.

Results presented in this paper show that Austria spends large sums for preventive measures in regions with relatively low risks. This finding supports the view that measures are not taken in a cost-effective manner. The European Floods Directive does not seem to be an instrument with a broad enough ap-

proach that forces governments of Member States to take cost-effective measures as the Water Framework Directive does. Depending on the way Member States implement the Floods Directive, national regulations may turn out to put too much weight on an engineering way of decision making confined to technical effectiveness.

In this paper we stress the economics behind the three phases before, during, and after a disaster to show that a compulsory insurance based risk transfer system with risk adequate premiums fosters efficient allocation of resources over all phases of natural hazards. This favourable outcome is a consequence of complementarity between market insurance and self-protection which can be shown to hold if the premium level for an insurance contract depends on the effectiveness of self-protective measures undertaken by households. Although self-protection can be expected to be implemented efficiently within our scheme, there is no mechanism to guarantee that public goods in the pre-disaster phase will be provided efficiently. Given the Austrian record of preventive spending in low-risk areas, the next challenge after the establishment of an insurance based system of risk transfer in Austria would be to coordinate the preventive public activities, like building dams or retention basins, with signals on value at risk from the risk transfer system. The estimated value of assets under risk in hazard zones, as assessed by the insurance industry, is an essential input for efficiently spending public money. An established coordination mechanism between well informed insurers and the government would make it possible to use public funds for protective constructions in a way that is based on cost-benefit criteria.

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