

Economies of Integrated Risk Management? An Empirical Analysis of the Swiss Public Insurance Approach to Natural Hazard Prevention

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Abstract In this paper we discuss the impact of prevention programmes Swiss property insurers undertake to reduce damage claims. While the cantonal public law insurer KGV tends to spend notable amounts of money on prevention programmes to avoid or decrease damage due to natural hazard, the private insurers in the so-called GUSTAVO cantons rather do not. We investigate the interaction of prevention spending, claims and premiums in the KGV system. Furthermore, for the KGV system, we check the causality direction of influence of prevention on the claims and find that increases in damage cause increased prevention. This may seem counterintuitive at first glance, but can be explained by political pressure on public insurers caused by increasing damages of natural hazards.

Keywords Risk management · Insurance · Buildings · Natural hazards

Introduction

In the insurance industry, risks are being rated based on arbitrarily complex quantitative models. However, sometimes, the insurer does not only take the risk for which he provides

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insurance as given, but may try to influence the probability of claims or their magnitude. For instance, health insurance companies provide health and fitness programmes for their policy holders, or car insurance companies offer special rates for policy holders that keep their car at a locked indoor parking space at night.

Comparing the outcome of these programmes to a scenario at which the programmes are not provided, is usually hard to do. *Ceteris paribus* conditions are usually violated when comparing two regions, two periods of time or two political systems. In the Swiss property insurance sector, however, there are two different systems active at the same time and over a long time (30 years of record), only being discriminated by the Swiss cantons. This provides the rare opportunity of a natural experiment: While one Swiss system provides prevention programmes to avoid or decrease property damages due to natural hazard damage, the other does not. This may have its influence on the premiums and the claims ratio, which is investigated in this paper. Damage prevention programmes in our wide sense can be as diverse as, e.g., installment of flood masonry walls, hail-resistant material use for buildings, teaching material for architects to help designing buildings more storm-proof or training of fire-brigades and specialized forces against oil spills and wild fires. While the latter is sometimes called ‘intervention’ in terms of emergency preparedness and response and the others are preventative in terms of avoiding damages *ex ante*, both contribute to reducing disaster risk and consequent claims to the insurers. Oftentimes, the programmes cannot be attributed to hazard types, e.g. fires or floods, as in the case of emergency trainings.

The Swiss cantons at which prevention is carried out may benefit or suffer harm from the urge to invest into prevention. Here, we analyze the relationship between the claims ratio and the prevention rate by performing a random effects panel analysis based on a rich data set. Also, we analyze the Granger causality, i.e. we identify cause and effect of the rather complex and time varying prevention-vs-claims system.

In general, the contribution of this paper is twofold, i.e. we analyze these two research topics: 1.) Does investment in prevention and intervention decrease the claims ratio of insurers? If so, how does the insurers’ prevention spending affect their natural hazard damage spending (claims rate) and the premium per insured object (sum insured)? 2.) What is the causal relationship between the claims ratio and the prevention rate: Do greater prevention efforts lower natural hazard damage or does greater natural hazard damage mean more preventative measures are required on the part of the KGV? In addition, we evaluate how private and public insurers in Switzerland’s dual system compare in terms of premiums. For this topic, we perform a simple comparative institutional analysis.

The remainder of this paper is organized as follows: “[Overview and State of the Literature](#)” provides a more profound overview of the property insurance situation in Switzerland and discusses the literature basis. In “[Data, Terminology and Methodology](#)”, we present our data set, sharply define our terminology and develop the necessary methodology. “[Empirical Findings](#)” presents the results. Finally, “[Conclusion](#)” draws a short conclusion.

Overview and State of the Literature

Switzerland has a unique system of property insurance against natural hazards. In seven cantons,¹ property is insured privately and market-based, regulated by the Swiss Federal

¹ Geneva, Uri, Schwyz, Ticino, Appenzell Innerrhoden, Valais and Obwalden, known jointly as the GUSTAVO cantons.

Insurance Supervisory Law. In the remaining 19 of the 26 Swiss cantons, property is insured by the Kantonale Gebäuderversicherungen (KGV) which are independent non-profit monopoly institutions under cantonal public law. The Swiss property insurance system therefore can be characterized as a dual system of regional public monopolies (the KGVs) and private insurance (Kirchgässner 1996; Ungern-Sternberg 2001). Both systems are competing in political debates,² but are legally secured from economic competition in their territories of services by rules of demarcation. Insurance is compulsory for all Swiss homeowners, and all insurers are obligated to contract and insure, both in the public as well as in the private system. A unique feature of the KGVs is that they are not only responsible for property insurance in their cantons but, at the same time, they also operate in the fields of damage prevention and regional fire and emergency services, the latter of which is termed ‘intervention’ here. In this respect, they are integrated risk management institutions which carry out public authority tasks.

In general, great importance is placed on natural hazard risk reduction in Switzerland.³ According to the Swiss intercantonal reinsurance enterprise, IRV, the KGV alone spends around 300 million CHF per year on prevention, i.e. support for risk reduction by means of constructional measures, hazard and risk assessment and intervention planning, an equivalent of 276 million EUR.⁴ IRV statistics are used in our analysis.

The literature basis concerning our research questions is unequally developed. As far back as the 1990s, a public discussion was underway in Switzerland about the advantages of the cantonal monopoly in the property insurance sector (Kirchgässner 1996, 2007; Ungern-Sternberg 2002). In analyzing the cost and benefits of the KGV, this discussion focuses particularly on eliminating agents’ commissions in the monopoly which results in a cost saving and these savings are passed on to policyholders in the form of lower premiums. The privately insured, however, pay more than 15% in commission. The analyses of administrative costs paint a similar picture: KGV administrative costs are only around one fifth of the costs of private insurers. According to the 1990s debate, another reason for the cost disadvantage is that private insurers have to pay more on reserves holdings compared to the century-old KGV institutions (Haller 1997), and they are more generous when it comes to compensation in order not to lose their customers to the competition (Kirchgässner 2007). We contribute to this literature by studying the full spectrum of public insurers (low to high premiums), controlling for various contractual details (e.g. excess) and the spending for prevention of the KGV.

Concerning research topic 1.), the usage of insurance to increase risk mitigation has been proposed in several academic writings, e.g. by Kleindorfer and Kunreuther (1999)

²In frequently held cantonal direct polls citizen groups and politicians often argue with the outcomes in cantons in their vicinity, e.g. lower premiums and higher services quality, to make the case for a reform of their cantonal insurance system.

³Every year, private households and public institutions spend an average of 3 billion CHF (2.76 billion EUR) on reducing the vulnerability of buildings with respect to natural hazard damage with the help of constructional, biological and spatial planning measures, and assistance for emergency planning and preparation for natural disasters, as well as on research and planning. A good quarter of this (741 million CHF or 682 million EUR) is spent on private and public insurance in Switzerland. By contributing to the prevention of damage caused by natural disasters, this is instrumental in creating social responsibility for natural hazard management within the insurance sector.

⁴Please note that the KGV prevention data also include spending on fire safety and fire services and consumables (i.e. intervention spending).

and Kunreuther and Pauly (2006) as well as, more recently, Crichton (2008) and Paudel (2012). Good cases of risk mitigation through insurance are also recorded in the recent Global Assessment Report (GAR) of the United Nations Office for Disaster Risk Reduction (UNISDR) (cf. (UNISDR 2013))⁵ or the EU-funded project ENHANCE (cf., e.g., (Kellermann et al. 2015)).⁶ A systemic long-term study of the effects of prevention spending of insurers on risk reduction has been lacking so far, however. With this article we contribute to that specifically by our panel analysis of effects on insurance claims of insurers' investment in risk reduction in the KGV system of Switzerland.

Research topic 2.) is a corollary following research topic 1.), where we find evidence that increasing insurance claims can be 'causal' to improved risk mitigation, when insurance corporations act socially responsible as in Switzerland. No scientific literature has dealt with this relationship to the best of our knowledge.

Data, Terminology and Methodology

The public insurers (KGV) are, very much in dissociation from their private counterparts in Switzerland, assuming public authority tasks such as participation in land use planning, e.g. hazard zoning and informing legislation on building codes. In our view, this provides the KGV system with an economic advantage in terms of integrated risk management (IRR). At the same time, this 'philosophy' of IRR implies that spending on disaster risk reduction is as wide and diverse as, e.g., subsidy programmes for house-owners for the installment of flood walls (practiced in 11 of 19 KGV) to the development of so-called 'intervention maps' for the training and continuous improvement of fire-brigades and specialized forces in response to emergency situations and to their risk information and preparedness programmes for local citizens. The KGV insurers, in reporting the spending on the various 'preventions' of disaster risk, do not distinguish between natural hazard and fire risks, and—in the spirit of the IRR approach—not between public and private risks of their insureds. With a mandatory insurance coverage of nearly 100%, their aim is to contribute to prevention (*ex ante*), insurance and intervention (*ex post*) in an integrated approach. Their 'public responsibility' is enshrined in their legal status as public law enterprises but, more importantly, repeatedly contested by the performance of private insurers in the GUSTAVO cantons and in direct cantonal polls.

KGV spending on prevention and intervention has increased in absolute terms over time (see Fig. 1). In relative terms, i.e. in relation to the insurance cover, spending has stagnated at around 0.14% since the turn of the millennium (non-weighted average across 19 cantons).

The claims ratio, defined as the ratio of annual claims settled (gross) to premiums paid [per 1,000 CHF sum insured], has shown a downward trend since the 1980s, but a look at Fig. 2 shows that this downward trend is driven mainly by the strong decline in fire damage, while natural hazard damage tends to increase.

⁵The GAR 2013 recommendations for insurance-related instruments of disaster risk reduction are partly grounded and further explained by Suarez and Linnerooth-Bayer (2011).

⁶For an overview of additional ENHANCE case studies, see http://enhanceproject.eu/case_studies. A survey of novel insurance instruments for risk reduction is provided by Surminski et al. (2015).

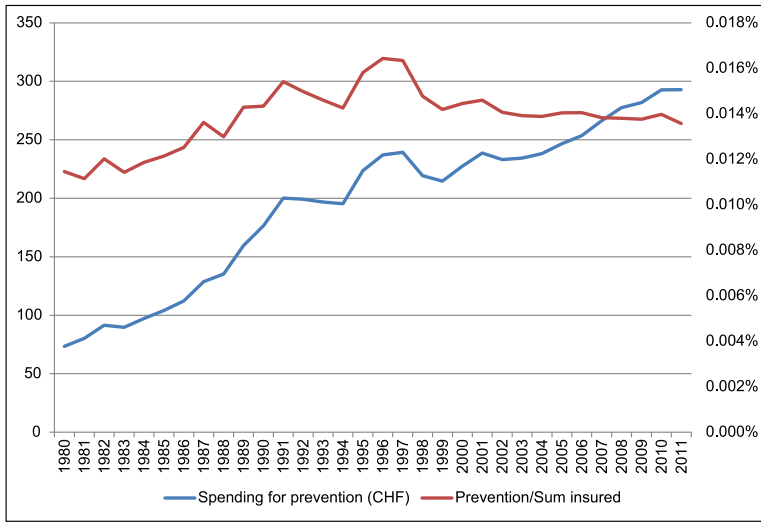


Fig. 1 Prevention spending by the 19 KGV insurers

At the same time, the insurance premiums paid since the 1980s for natural hazard damage have decreased in every canton (albeit at different rates). Figure 3 shows premium trends for the 19 KGV insurers on average (CH) as well as for the individual cantons of Zürich (ZH), Nidwalden (NW), Basel City (BS), Grisons (GR) and Aargau (AG).

The dual nature of the Swiss insurance systems allows us to compare the benefits and costs in the public vis-à-vis the private insurance system under controlled conditions. We

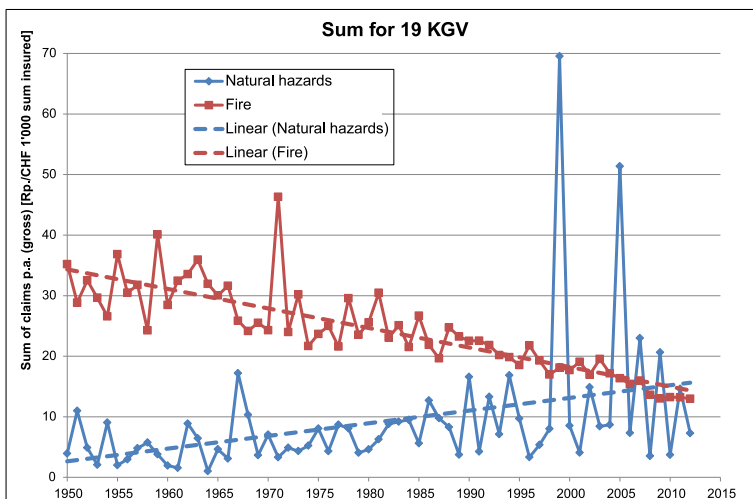


Fig. 2 Claims ratios for fire and natural hazard damage

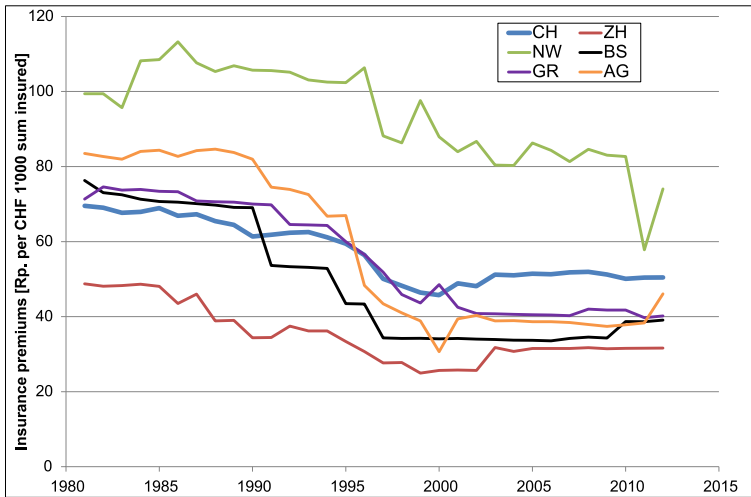


Fig. 3 Premium trends

restrict the comparison to an analysis of costs and premiums,⁷ and investment in private and public preventative measures.

The comparison of gross premiums (including operational costs, see Table 1) for natural hazard and fire insurance (basic contract) shows that the private insurers of GUSTAVO offer premiums which are approximately two to three times more expensive⁸ despite lower coverage and higher excess in the private system.⁹

In order to answer research topics 1.) and the subsequent research topic 2.) on the causal relationship, a comprehensive econometric analysis of panel data was carried out. The individual data received from IRV were amalgamated into one file and then transformed into a panel structure, i.e. the available variables were converted into time series data per canton. The 19 cantons (plus all these cantons combined (CH)) therefore represent the individuals $i = 1, \dots, n$ with $n = 20$ in the panel. The analysis was limited to the period $t = 1981, \dots, 2012$ (thus, the number of observations in time is $T = 32$) owing to the lack of certain variables for the period prior to 1981. In total, the number of observations for the balanced panel is $N = nT = 640$.

Using a multivariate approach, our research topics 1.) and 2.) were examined, taking into account variables for administrative costs and reserves: Separate analyses were conducted for different types of natural hazard (storms, floods, hailstorms, avalanches, snow pressure

⁷Data are for the combined natural hazard and fire premium (NH + F) for a single family house (SFH). For the private GUSTAVO cantons, this value comprises the statutory natural hazard premium of 0.46 per mille and a mid-range fire premium of 0.39 per mille from consistent market analyses.

⁸KGV (low) and KGV (high) compare the set of costs and premiums of the KGV with lowest and highest cost and premium in our sample.

⁹Another comparison of standardized insurance cases (including industrial cases) for the canton of Grisons came to the same conclusion: For a private property valued at 500,000 CHF, an inhabitant of Grisons pays an annual premium of 150 CHF while with eight comparable private insurers, the premium would cost an average of 373.50 CHF. For industrial buildings and hotels (valued at 4,800,000 CHF each), the policyholder would pay an insurance premium of between 2,376 and 2,592 CHF whereas with private insurers they would pay around twice that amount: from 5,065 to 5,341 CHF (see Advantis Versicherungsberatung 2009).

Table 1 Comparison of KGV (high/low) and GUSTAVO

	KGV (low)	KGV (high)	GUSTAVO
Gross premium (F + NH)	0.25‰	0.46‰	0.85‰
Premiums for SFH	EUR 75	EUR 138	EUR 255
Prevention levy	0.07‰	0.16‰	None (financed through taxes)
Premiums (overall)	EUR 96	EUR 186	–
Prevention	Integrated	Integrated	Not integrated
Coverage	Unlimited	Unlimited	Limited
Excess	EUR 414	EUR 164 – 8,200 (selectable)	EUR 2,070 – 41,400 (regulated)

and other) and fire safety (fire). The details are given in another report (Schwarze et al. 2015). Here, we refer solely to the broader category of ‘natural hazard damage’ which is the sum of the aforementioned types of natural hazard excluding fire.¹⁰

The IRV dataset on natural hazard damage was adjusted for inflation and standardized using the sum insured.¹¹

$$Y_1 = \frac{\text{natural hazard damage}}{\text{sum insured}}. \tag{1}$$

An additional adjustment for the number of claims produces a proxy for the damage intensity per claim. If in a given period with considerable damage there are very few actual damage claims, these claims have an intense level of damage per individual claim (affected building), resulting in:

$$Y_2 = \frac{Y_1}{\text{number of claims}}. \tag{2}$$

The prevention rate X was measured as a proportion of the KGV’s spending on natural hazard safety (including intervention) per insured object (sum insured):

$$X = \frac{\text{prevention spending}}{\text{sum insured}}. \tag{3}$$

Table 2 presents the descriptive statistics for Y_1 , Y_2 and X . It can be seen that each of the three time series is askew (skewed to the right).

To measure the effect of (or the increase in) extreme weather phenomena separately, their deviations from a linear time trend were used as an explanatory variable for Y_1 and Y_2 . Long-term property protection measures such as structural installations or repeated training programmes for emergency and rescue workers (accumulated expertise) are unique in that they develop over time. For this reason, and in the absence of amortization figures, cumulative spending on preventative measures was also examined. Cumulative data for any one given variable Z_t were generated simply by adding the figures up:

$$\text{Cum } Z_t = \sum_{s=1}^{t-1} Z_s. \tag{4}$$

¹⁰All of the aforementioned steps were, however, applied to every type of claim and analyzed individually.

¹¹Adjusting the claims (measured in monetary terms) for the sum insured is an (implied) inflation adjustment, since the sum insured itself is an inflation proxy.

Table 2 Descriptive statistics

	Y_1	Y_2	X
Min	0.5062	0.0007	0.0133
Max	48.4885	0.0868	0.3545
Median	2.6871	0.0042	0.0968
Mean	3.6146	0.0059	0.1096
SD	4.0114	0.0077	0.0590
N	640	640	640

To remove distortions, the data are smoothed using moving average filters (MA) for both a five-year and a ten-year window in order to determine the relationship between X and Y_1 and Y_2 . This paper looks at the ten-year windows only:

$$Y_{1,MA10} \quad (5)$$

and

$$Y_{2,MA10}. \quad (6)$$

Finally, since it is not possible to clarify in advance whether claims (Y_1) or claims intensity (Y_2) has a temporal causal relationship with prevention or, vice versa, whether preventative measures demonstrate temporal causality with past damage occurrences—e.g. because the more damage claims, the more political and economic pressure on insurers to take preventative measures—tests for Granger causality as provided by Granger (1969) were conducted.

Empirical Findings

The first structural result of the panel analysis is the observation of, according to typical pooled-vs-within-F-testing, significant heterogeneity within the KGV that is not reflected in the variables of the IRV dataset (unobserved heterogeneity). When the claims ratio is plotted against the prevention rate, as in Fig. 4, the cantons exhibit substantial differences in the correlation between prevention rates and claims ratios. It may be significantly positive (i.e. claims rates increase as prevention rates increase), significantly negative, or prevention may have no effect (i.e. there is an almost constant claims ratio).

Despite the fact that heterogeneity cannot be observed using IRV data, it is possible to obtain relevant results for the research topics 1.) and 2.) using random effects estimates.¹²

Surprisingly, Y_1 and the cumulated X show a significant positive correlation in our study, i.e. we observe that decreasing natural hazard damage correlates with lower prevention spending, and not with higher prevention spending as the theory of damage control might lead one to expect. At the same time, however, results from the Granger tests show that Y

¹²A test was conducted to determine whether a fixed effects (FE) estimator or a random effects (RE) estimator was better suited to addressing the heterogeneity issue. Fixed effects are present when individual effects remain constant over time. Random effects do not need to be constant over time but do require strict exogeneity. The Hausman test was applied and showed that, in this case, an RE estimator was the better choice.

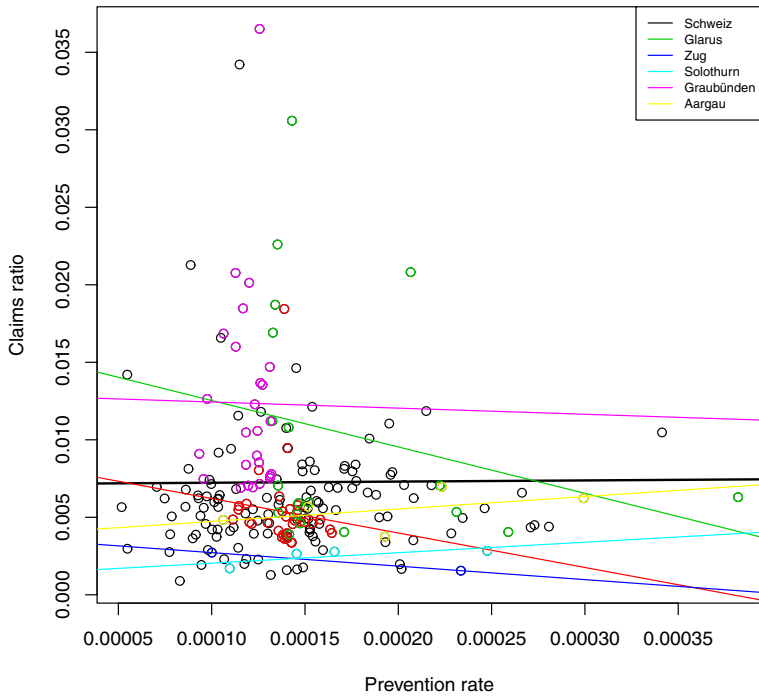


Fig. 4 Substantial differences among cantons

has a causal effect on X (p -value = 0.4085 for Y_1 and 0.5110 for Y_2 for this direction of Granger causality), not vice versa. This means that the increase in natural hazard damage precedes the increase in prevention efforts. Obviously, increasing natural hazard damage increases the political pressure on the KGV to enhance their preventative efforts.

Subsequent analyses show that the rising number of claims in the natural hazards sector do not lead to rising premium rates, i.e. the price pressure resulting from the political competition between public monopoly insurance and private insurance in Switzerland's dual system makes it difficult to pass on the costs associated with rising natural hazard damage, at least as long as reserves from other sectors (fire) have not been exhausted.

There is also a significantly negative correlation between Y_2 and X . Specifically, the claims ratio per affected case (insured object) decreases as prevention spending rises. This is particularly clear from a cumulative viewpoint (cumulated X), i.e. in the case of long-term prevention measures with a smoothed impact measurement in the ten-year moving average ($Y_{2,MA10}$). Table 3 presents the results for $Y_{1,MA10}$ and $Y_{2,MA10}$.

Yet why is a significantly negative correlation between the claims ratio per affected building and the investments of the KGV in property protection ($Y_{2,MA10}$) not equally evident for the general claims ratio for natural hazard damages (Y_1)? To answer this question, we must recall the general risk formula used in natural hazard research, which defines risk as the product of hazard, value and vulnerability, see Fig. 5.

While the use of preventative measures in property protection is a necessary condition for decreasing risk, it is not sufficient: If an increase in natural hazards (as a consequence

Table 3 Results for RE estimations on $Y_{1,MA10}$ and $Y_{2,MA10}$

	$Y_{1,MA10}$	$Y_{2,MA10}$
Constant	0.0001*** 0.0000***	0.0000*** 0.0000***
cumulated X	0.0213*** 0.0008***	-0.0001*** 0.0000***
Squared trend distance	1,793.2970*** 41.6999***	1.0313*** 0.0085***
σ_a	0.0000***	0.0000***
σ_v	0.0000***	0.0000***
ρ	0.3819***	0.1314***
R^2 (overall)	0.6094***	0.6725***

Standard errors are below the parameter estimates. ‘***’, ‘**’ and ‘*’ mean statistical significance on 1, 5 and 10% levels. a_i refers to the idiosyncratic effects, while v_{it} denotes the remaining error component. ρ denotes the fraction of the variance that is due to a_i

of climate change, for example) causes the risk exposure of property to grow faster than the risk mitigation resulting from the KGV’s investment in property protection, it is certainly possible that the risk of natural hazard damage will rise over time.

With respect to preventative measures in long-term property protection, however, this analysis helps to clarify that the reduction in exposure has its origins in the natural hazards sector and not in the effectiveness of fire safety measures. Figure 6 shows that in the period 1981 to 2012, the vulnerability of buildings with respect to fire (as measured by the claims ratio per affected building) rose again after a long, relatively steady decline, while vulnerability with respect to natural hazards decreased slightly.

This in sum results in the following propositions:

- Increases in extreme events (deviations from the trend) drive natural hazard damage upward.
- Increases in natural hazard damage politically necessitate more preventative spending.
- Increases in prevention spending on the part of insurers do not offset the rising costs of natural hazard damage.
- The rising costs of natural hazard damage are not passed on to the customer (pass through of costs is restricted through regulation and the political competition between private/public systems), and so do not lead to rising premiums. This is achieved by means of cross-subsidisation of surpluses of fire insurance.
- Long-term property protection measures reduce the vulnerability of existing buildings.

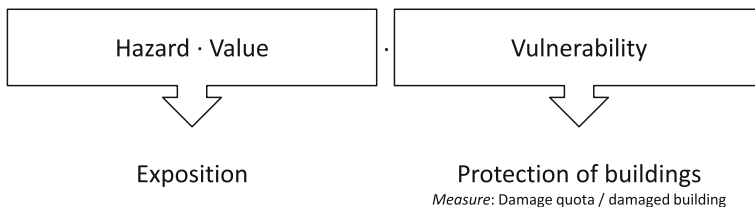


Fig. 5 Hazard, value and vulnerability as the determinants of risk

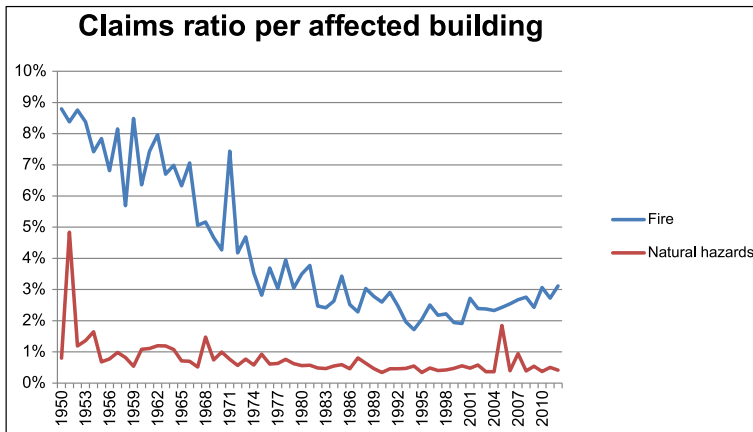


Fig. 6 Vulnerability trends with respect to fire and natural hazard damage

Conclusion

Switzerland's cantonal property insurance (KGV) is a globally unique system of integrated prevention, intervention and insurance, which allows comprehensive natural hazard insurance at consistently low average premiums. This positive economic performance can be traced back to an integration of the additional components of risk management—prevention and intervention—within the KGV system. Despite great heterogeneity of empirical outcomes and trends, the KGV spending on preventative measures shows an overall positive long-term impact on claims payments and decreased vulnerability of buildings.

The KGV insurance system is faced with a major long-term challenge: Increases in extreme events result in an increase in natural hazard damage and justify the call for more preventative measures. Owing to the extreme nature of natural hazards, however, increases in prevention spending on the part of insurers do not offset the trend towards rising costs. Since it has thus far not been possible to pass the rising costs of natural hazard damage on to the customer through regulatory limitation and political competition between private/public insurance systems in Switzerland, the public insurers have had to be absorbed by savings made in other areas. The decline in claims for fire damage has helped here. But there are statutory and political limits to cross-subsidisation even in the KGV monopoly cantons. Moreover, in view of the long-term challenges faced, it will not be possible to stabilize and maintain the current level of premiums through the continued decline in claims for fire damage. To stabilize overall costs, the KGV system needs to pursue new avenues by increasing prevention by stronger involvement and better coordination of property insurers' spending and efforts of municipalities and cantonal authorities.

In our view, the KGV's systemic economic advantages and its accompanying positive impact on welfare¹³ stems from the integrated risk management approach of the KGVs, i.e. the combination of insurance with investment in prevention and intervention. Therefore,

¹³We can infer on increased economic welfare from lower insurance production costs because, in a regulated monopoly, cost reductions translate into cheaper premiums and, in turn, result in an increase in consumer surplus (increase in prosperity from the customer perspective).

a further going question would be whether it is in fact possible to observe economies of scope from integrated risk management of public monopoly insurance, controlling for administrative costs and reserves. We will deal with that in future research.

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