

Modeling Flood Perils and Flood Insurance Program in Taiwan

Ching-Cheng Chang

¹ *Research Fellow, Institute of Economics, Academia Sinica and Professor,
Department of Agricultural Economics, National Taiwan University, Taipei, Taiwan
R.O.C. Email: emily@econ.sinica.edu.tw.*

Wenko Hsu

² *Research Fellow, Department of Civil Engineering, National Central University,
R.O.C. Email: wenko@ncu.edu.tw*

Ming-Daw Su

³ *Professor, Department of Bioenvironmental Systems Engineering, National Taiwan
University, R.O.C. Email: sumd@ccms.ntu.edu.tw*

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ABSTRACT

Taiwan had approximately 3,000 buildings damaged by floods with an economic loss of NT\$12.8 billion annually, a figure 4.5 times more than economic losses due to fire damages. Many insurers become extremely cautious when underwriting their flood policies for people living in areas that are frequently struck by floods. The rising damages also trigger the demand for a mandatory national flood insurance program. This paper describes the development of an integrated flood risk assessment model for Taiwan which contains of a hazard, vulnerability and financial analysis module. We take the perspective that the mandatory program will be provided to fire policyholders as part of building and content insurance to mitigate the financial losses. The issue of a long-term balance between fund accumulations and its claim payouts will be addressed along with policy recommendations based on the modeling results.

Keywords: Risk Assessment, Typhoon, Flood Insurance, Financial Analysis

I. Introduction

During the last century, floods have been one of the most costly perils in terms of both property damage and human casualties. The number of economic and insured losses caused by floods has continuously risen in recent years. On the one hand, this is caused by the increase in the intensity and frequency of flooding events. On the other hand, this growth pattern arises because of rapid economic development and the growing exposures in the highly congested urban areas or disaster-prone rural areas, in particular in the developing countries where flood prevention technology and infrastructure investment are insufficiently provided.

The most serious and costly natural hazard in Taiwan is typhoons and the floods that follow every year, usually in July, August and September. In addition, the annual plum rain season in May and June and the moisture carried by the southwest monsoon also brings a lot of heavy rainfalls during the summer months. According to data collected from the last 15 years by the Water Resource Agency, floods in Taiwan caused an average of about 3,000 homes in damage per year. The average economic loss amounts to NT\$12.8 billion annually, a figure 4.5 times more than economic losses due to fire damages. Many private insurers have become extremely cautious when underwriting their flood policies for people living in areas that are frequently struck by typhoons and floods. The rising damages also trigger tremendous attentions on government assistance and the demand for a mandatory national flood insurance program. Legislators are interested in adopting the national insurance program in response to the rising demand and the continuously rising costs on disaster relief and expenses associated with floods.

Computer simulation models are commonly adopted to predict the unprecedented damages from earthquake (RMS), hurricanes (EQE, Clark, 1995) and floods (Guy Carpenter). The purpose of this assessment is to develop a

comprehensive risk assessment methodology to formulate better policies for floodplain management and to support long-term planning and policy making. An insurance program requires an actuarial rate structure which could adequately reflect the risk to which flood-prone properties are exposed. Standard approach to estimation exposure and predict losses involve the use of historical data. However, because the average recurrence intervals of floods are usually quite long, patterns of insured property values may vary between occurrences to an extent that historical exposures and losses have no predictive power. This study a constructs a simulation model with random variables and stable probability distributions to calculate losses of typhoon and flood. The model contains three components: a hazard, vulnerability and financial loss module. Three policy options (mandatory, semi-mandatory and voluntary with mandatory offer) are examined in conjunction with alternative policy coverage and take-up rates. Our major finding is that an affordable insurance program is not possible without government's involvement in the risk transfer mechanism. To maintain financial sustainability, public support to cover these climate-related losses should be accompanied by promoting risk mitigation efforts.

This paper starts with a brief background of the frequency and economic losses of typhoon and flood in Taiwan. The third section presents the methodology of the flood risk assessment model. The fourth section describes how the flood insurance can be designed and evaluated. The concluding sector summarizes the key findings and suggestions for future research.

II. Economic and Insured Losses from Typhoon and Flood

According to government statistics, an average of 4.9 typhoons hit Taiwan every year during the period 1958~2007, 3.5 of which caused damages. Table 1 indicates that the frequency of typhoon visits has been increasing from an average of 2.2 during 1972~1976 to an average of 5.8 in 2002~2006. Such an increase is quite significant.

In terms of losses, according to the estimates from the Central Weather Bureau, the percentage of the average annual losses for all natural perils is 0.18 percent of Taiwan's total GDP per year. If breaking down by peril type, typhoon is the most destructive type accounting for 87% of all losses. Earthquake and flood perils represented only a small percentage of 6% and 4% of the total losses.

The losses have been rising rapidly in recent years. For example, typhoons Toraji and Nari in 2001 brought torrential rains which resulted in 205 dead, 113 missing, and more than 450 people wounded (see Table 2). The economic losses were estimated at US\$ 20 millions and US\$5.7 billion, respectively. Nari also broke the 200-year daily cumulative precipitation record in Taipei City and resulted in a record high insured loss of US\$ 500 million which is close to the previous record of US\$ 750 million in the 1999 Chi-Chi earthquake (Guy Carpenter, 2002; Munich Re, 2001¹).

Table 3 shows that the average cost of reconstructing total-collapsed and partial-damaged residential houses between 1985 to 2006 is estimated to be NT\$ 546 million. This figure is about 0.01 percent of Taiwan's annual GDP and 0.02 percent of Taiwan's annual government expenditures. The estimated cost of totally collapsed and partially damaged residential houses are derived from following assumptions:

1. Average of 40 pying (approximately 500 square feet) per house;
2. Average reconstruction cost of NT\$50,000 per pying;
3. Restoration cost of partially damaged houses is 1/5 of the cost of reconstructing a totally collapsed house.

Losses from typhoon and flood are severe, but homeowners in Taiwan are not very active in insuring against such perils. Before 2001, less than 20,000 policies are written annually, which is approximately 0.02% of all residential properties.

¹ Munich Re., 2001. *Topics 2000*, <http://www.munichre.com/>, Munich Reinsurance Company Website accessed September 2002.

Table 4 lists the recent trends in underwriting typhoon and flood policies and insured losses during the period 1998~2005 in Taiwan. After 2001, the purchase has been increased sharply, but it is still relatively low in international standards.

III. Risk Assessment Modeling

An insurance program requires an actuarial rate structure which could adequately reflect the risk to which flood-prone properties are exposed. Standard approach to estimation exposure and predict losses involve the use of historical data. However, because the average recurrence intervals of floods are usually quite long, patterns of insured property values may vary between occurrences to an extent that historical exposures and losses have no predictive power.

New methodologies based on computer simulation models have been developed to predict the property damages from natural disasters like earthquake (RMS), hurricanes (EQE, Clark, 1995) and floods (Guy Carpenter). This study adopts the probabilistic approach and constructs a simulation model with random variables and stable probability distributions to calculate losses of typhoon and flood.

The model contains three components: a hazard, vulnerability and financial loss module. Basically, the wind losses to residential buildings in Taiwan are not accounted by the model because, firstly, the reinforced concrete construction of most apartment buildings provides great protection to wind. Secondly, the dominant eastern landfall of typhoons greatly reduces wind speeds on the western side of the island where most of the population is located. Therefore, the wind damages are very light and can be ignored.

The hazard module is constructed from a database of simulated inundation potential maps based on different rainfall scenarios. A total of 132 maps of 33 watersheds are simulated by a distributed watershed model using 1-D dynamic channel-flow routing and 2-D diffusive overland-flow routing linked by a free weir formula that depends on the difference of water stage between the main channel and floodplain outlet. The model has a capability for the analysis of flooding due to bank overflow and inundation caused by excess rainfall under 4 designed rainfall patterns. The flood potential maps are provided by the National Science Council under the National Science and Technology Program for Hazard Mitigation.

In the vulnerability module, the simulated flow conditions of the main channel

and its adjacent floodplains are linked to a grid-based GIS database based on land use information and socio-economic census data to estimate the exposures of residential buildings of each watershed. Different stage-damage curves and damage survey results in recent flooding events are used to estimate the economic losses. The exceedance probability (EP) curves are constructed to integrate the damage assessments of individual flood event for a full probability range presentation of the flood risk.

The financial loss module calculates losses and pure premiums under alternative financial arrangements considering the insurance and reinsurance structures specified. We take the perspective that the insurance for the flood peril will be provided to fire policyholders as part of building and content insurance to mitigate the financial losses for people resided in the flood zone. We also address the issues of a long-term balance between fund accumulations and its claim payouts and offers policy recommendations based on the modeling results. Specifically we use the model to calculate how many years the fund must be in existence, experiencing average losses every year before it will have built up sufficient funds to pay a loss from the occurrence of an event with a similar profile to typhoon Nari in 2001.

IV. Designing Insurance Policies

A. Strategies

The typhoon/flood perils have many distinctive characteristics in comparison to earthquake. First, most typhoons and floods impact only a small portion of the population. Second, homeowners often have many options (such as not to live in flood-prone areas or using less expensive furniture in lower floors) to mitigate or minimize their losses. Given the concrete structures of the majority of houses in Taiwan, severe structural damages or building collapse are rare. The major damages of a typhoon or flood come from the content. Here, we adopt the international experience from in designing the insurance policy options.

Three policy options are considered:

- a). Mandatory purchase which follows National Flood Insurance Program (NFIP) in the US;
- b) Semi-mandatory with endorsement to fire policy; and
- c) Voluntary with mandatory offer follows the Florida Hurricane Catastrophe Fund.

The coverage includes structure, contents and living expenses. The schedule

of the existing governmental disaster relief program is adopted as a basis to set the payment schedule and limit with a maximum coverage of 5 to 10 times the current relief standards. The flood relief program in Taiwan offers homeowners a fixed amount for their content losses based on flood depth.² A total of 11 scenarios will be designed to conduct simulations on exposures and financial losses for the purposes of rate makings.

B. Calculate Average Annual Loss (AAL)

Because of the catastrophic nature of typhoon and flood, it is clear that private insurance companies cannot provide such coverage at an affordable price. We will use the AAL to determine reasonable rates. For example, if a fund were set up to cover flood we could calculate rate that would generate a fund equal to say 50 percent of the AAL for a 100-year event. The government would have to contribute the rest. We will develop a rating that would pay for a specific layer of international reinsurance in a fund. Guidance will then be provided on expense and other factors needed for calculating the premium.

Assuming the frequency of a typhoon/flood event follows a Poisson distribution, the model use a Monte Carlo simulation approach to calculate the average annual loss (AAL). Table 5 illustrates the residential building exposed to flooding under 4 different rainfall levels. First, we estimated that out of 4.9 million households about 3.3 million residential houses are located in the first floor and about 36% concentrates in the northern region where the capital city Taipei resides. In the 150 mm rainfall scenario, about 4.78% homes will be flooded. If the rainfall level doubled, the proportion of flooded homes becomes 11.39%. When the rainfall level reaches 600 mm, more than 26% homes will be flooded, half of which located in the Danshuei River Basin.

The number of exposures in each policy option will be:

1. Mandatory: After the GIS mapping, we obtain an estimated exposure of 33.3 first floor buildings.
2. Semi-Mandatory: The current fire policy amounts to 34.2 million homes, which is about a 50% participation rate. All fire policy homeowners are assumed to be

² Flood depth below 50 cm cannot receive any relief. A total amount of NT\$ 10,000 and \$20,000 is paid to home flooded between 50 cm and 100 cm and above 100 cm, respectively. For those totally damaged houses, NT\$ 20,000 will be given to each family member for relocating to other houses. For each home, up to 5 residing family members can receive this payment.

the potential insured of the typhoon/flood policy.

3. Voluntary with mandatory offer: We assume that only the most frequently flooded homeowners will participate. After GIS mapping, 0.37 million first-floor buildings are located in the 20-year return period flood zone.

Table 6 provides the simulated AAL and pure premium based on the estimated number of residential building exposed to typhoon/flood under each scenario.

Table 6 indicates that the pure premium ranges around NT\$ 1,300~6,500 under the mandatory and semi-mandatory options. If we consider the voluntary option where only the most frequently flooded residents located in the 20-year return period flood zone are most likely to participate, then the pure premium amounts to NT\$ 20,000 to 30,000. These figures need to be grossed up to include expenses and capital charges along with portfolio risk management.

Four scenarios (S3, S7, S9, and S11) are selected for further analysis on portfolio management. In addition, we add the structural losses of total collapsed houses into each scenario. The payment of each totally collapsed structure is NT\$1.2 million. Tables 7~10 provide the calculated results of AAL and PML with different assumed take-up rate.

C. Financing and Claim Layers

A thorough assessment of the risk profile should decide the total risk from the hazard combined with the insurer's tolerance for risk and available capitals. We need to determine the amount of financial protection desired. Based on Tables 7~10, the total funding requirement to pay for losses are summarized in Table 11 for each selected scenario and policy option.

Next, we will determine the amount of risk an insurer wish to retain based on the concept of PML. We assume that the level of retention and limits of loss is based on 200-year return period so that the insurance company can be protected against levels of loss with a 0.5% probability of occurrence. After the company chooses to retain risk, it must generate funds to pay for losses resulting from the hazard. Options include own funds, borrowing, issuing debt or equity.

The financing mechanism also includes risk transfers to reinsurance, government, and capital market. Here we assume that the government is willing to share the risk of the bottom layer as a partial premium subsidy. It is served as an incentive to encourage residents who live in the frequently flooded area to participate. The

middle layer consists of insurers, reinsurance or cat bond. The top layer will be covered by the government.

Table 12 summarized the premium under the four selected policies and different assumptions on the take-up rate. In addition, four possible cases on the government's bottom-layer coverage are assumed: NT\$ 1.0, 2.0 1.5 and 2.0 billion. It is obvious that government's risk transfer in the bottom layers greatly reduce the premiums to an affordable level. Thus, it can be viewed as a premium subsidy. The subsidized premium ranges from NT\$ 140 up to NT\$9,613, depending on the coverage and take-up rate.

V. Concluding Remarks

This study presents a preliminary effort to modeling typhoon/flood risks in Taiwan. A probabilistic-based simulation model is built to conduct a risk management analysis for the design of a typhoon/flood insurance program for homeowners. Three policy options (mandatory, semi-mandatory and voluntary with mandatory offer) are examined in conjunction with alternative policy coverage and take-up rates. Our major finding is that an affordable insurance program is not possible without government's involvement in the risk transfer mechanism. To maintain financial sustainability, public support to cover these climate-related losses should be accompanied by promoting risk mitigation efforts.

Meanwhile, many international insurers and reinsurers have taken advantages of the newly available catastrophic models to make rational pricing decisions in dealing with rising natural hazard risk. Although our model is still pre-matured, such an effort allows us to identify the true values of such models and their ability to reduce uncertainty in risk assessment. It also allows us to capture the most significant predictors of different types of natural hazards and provides a good understanding of the factors controlling such risks. Future research should be devoted to improve the model's predictability as well as the database.

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Table 1 Occurrences of Typhoons in Taiwan, 1972~2006

Period	Total occurrence	Average occurrence
1972~1976	11	2.2
1977~1981	13	2.6
1982~1986	16	3.2
1987~1991	21	4.2
1992~1996 ¹	21	4.2
1997~2001	23	4.6
2002~2006	29	5.8

Source: Ministry of the Interior, National Fire Agency

Table 2. Losses of Major Typhoon in Taiwan, 1996~2004

Year/Typhoon	Human casualty (no of persons)				Houses collapsed (no of houses)		
	total	death	missing	wounded	total	total collapsed	partial collapsed
1996 Herb	536	51	22	463	1,383	503	880
1997 Winnie	129	44	1	84	123	121	2
2000 Bilis	133	14	7	112	2,159	434	1,725
2000 Xiansane	154	64	25	65	0	0	0
2001 Toraji	402	111	103	188	2,617	645	1,972
2001 Nari	369	94	10	265	0	0	0
2004 Mindulle	65	33	12	20	270	270	0
2004 Aere	428	14	15	395	116	72	44
2005 Haitang	46	13	2	31	33	21	12

Source: Ministry of the Interior, National Fire Agency.

Table 3. Annual losses on houses by Typhoon/Flood in Taiwan, 1985-2004

Unit: NT\$ million

year	Number of Houses collapsed/damaged		Estimated losses of damaged/collapsed houses in NT\$ Million		
	total collapsed	partial collapsed	total collapsed	partial collapsed	Total
1985	33	17	66	7	73
1986	464	2,760	928	1,104	2,032
1987	526	1,356	1,052	542	1,594
1988	62	95	124	38	162
1989	495	809	990	324	1,314
1990	178	322	356	129	485
1991	52	162	104	65	169
1992	12	5	24	2	26
1993	7	61	14	24	38
1994	204	327	408	131	539
1995	12	32	24	13	37
1996	503	881	1,006	352	1,358
1997	121	28	242	11	253
1998	13	43	26	17	43
1999	0	1	0	0	0
2000	434	1,725	868	690	1,558
2001	646	1,978	1,292	791	2,083
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	376	154	0	0	0
2005	27	143	54	57	111
2006	60	43	120	17	137
Annual average	192.05	497.36	349.91	196.15	546.05

Source: Central Weather Bureau and own estimates.

Table 4. Insured Losses of Recent Catastrophic Typhoon and Flood Events

Unit: NT\$ billions

Year	Policy Written		Incurred Losses	
	No of Contract	NT\$ billion	No of Contract	NT\$ billion
1998	11,429	390.9	422	1.48
1999	12,813	613.0	58	0.47
2000	17,462	796.9	895	11.95
2001	24,750	608.5	3,890	91.03
2002	34,674	2,169.3	24	0.27
2003	53,015	4,445.6	134	0.27
2004	52,429	5,878.7	1,081	6.40
2005	59,232	7,727.4	1,828	12.67

Source: Taiwan Insurance Institute, Fire Insurance Policy Annual Statistics.

**Table 5. The Simulated Regional Exposures of Residential Structure
by 4 Designed Rainfall Levels**

Region	Daily average precipitation (mm)				Number of Buildings
	150mm	300mm	450mm	600mm	
Northern	56,835	135,356	212,950	313,208	1,187,940
%	4.78	11.39	17.93	26.37	100.00
Central	59,732	148,290	236,464	315,285	1,024,235
%	5.83	14.48	23.09	30.78	100.00
Southern	91,444	217,614	324,085	414,158	1,049,171
%	8.72	20.74	30.89	39.47	100.00
Eastern	3,419	5,808	7,631	9,097	36,082
%	9.48	16.10	21.15	25.21	100.00
TOTAL	211,430	507,068	781,130	1,051,748	3,297,428
%	6.41	15.38	23.69	31.90	100.00

Source: Model simulation results.

Table 6. Simulated AAL and Pure Premium

ID	Scenarios	AAL (NT\$ million)	First-floor Building		Fire policy homeowners	
			No of building	Pure premium	No of building	Pure premium
			(million)	(NT\$)	(million)	(NT\$)
S1	~ 30cm: no payment, 30cm~: NT\$200,000	21,900	3.33	6,577	3.42	6,404
S2	~ 30cm: no payment, 30cm~: NT\$150,000	16,500	3.33	4,955	3.42	4,825
S3	~ 30cm: no payment, 30cm~: NT\$100,000	10,950	3.33	3,288	3.42	3,202
S4	~ 30cm: no payment, 30cm~100cm:NT\$100,000 100~200cm:NT\$150,000 200cm~: NT\$200,000	12,300	3.33	3,694	3.42	3,596
S5	~ 50cm: no payment, 50cm~: NT\$200,000	12,600	3.33	3,784	3.42	3,684
S6	~ 50cm: no payment, 50cm~: NT\$150,000	9,450	3.33	2,838	3.42	2,763
S7	~ 50cm: no payment, 50cm~: NT\$100,000	6,300	3.33	1,892	3.42	1,842
S8	~ 50cm: no payment, 50cm~100cm:NT\$100,000 100~200cm:NT\$150,000 200cm~: NT\$200,000	7,800	3.33	2,342	3.42	2,281
S9	~ 50cm: no payment, 50cm~100cm:NT\$50,000 100~200cm:NT\$100,000 200cm~: NT\$150,000	4,650	3.33	1,396	3.42	1,360
S10	S5 Only 20-year return period residents will participate	12,000	0.37	32,432	0.185	32,432
S11	S8 Only 20-year return period residents will participate	7,200	0.37	19,459	0.185	19,459

Table 7 The Exceedance probability of four selected scenarios with 100% take-up

Gross Loss Layer (\$Mill.)	EXCEEDING PROB.			
	S3	S7	S9	S11
0	100.000%	100.000%	100.000%	100.000%
100	100.000%	99.999%	99.968%	99.991%
500	99.875%	99.453%	96.896%	97.417%
1,000	98.836%	96.268%	88.502%	88.017%
2,000	93.517%	84.637%	70.377%	65.751%
3,000	85.876%	71.750%	55.810%	48.212%
4,000	77.699%	60.229%	44.831%	35.775%
5,000	69.830%	50.561%	36.539%	27.013%
10,000	40.753%	22.734%	15.642%	8.340%
15,000	24.995%	11.640%	8.099%	3.339%
20,000	16.174%	6.561%	4.702%	1.567%
30,000	7.664%	2.530%	1.953%	0.462%
40,000	4.086%	1.157%	0.965%	0.173%
50,000	2.367%	0.593%	0.533%	0.076%
60,000	1.457%	0.330%	0.318%	0.037%
AAL (\$Mill.)	12,312	7,662	6,012	4,320
PML (1%) (\$Mill.)	68,554	42,065	39,447	23,382

Table 8. The Exceedance probability of four selected scenarios with 50% take-up

Gross Loss Layer (\$Mill.)	EXCEEDING PROB.			
	S3	S7	S9	S11
0	100.000%	100.000%	100.000%	100.000%
100	99.997%	99.981%	99.697%	99.991%
500	98.836%	96.268%	88.502%	97.417%
1,000	93.517%	84.637%	70.377%	88.017%
2,000	77.699%	60.229%	44.831%	65.751%
3,000	62.602%	42.611%	30.186%	48.212%
4,000	50.344%	30.769%	21.326%	35.775%
5,000	40.753%	22.734%	15.642%	27.013%
10,000	16.174%	6.561%	4.702%	8.340%
15,000	7.664%	2.530%	1.953%	3.339%
20,000	4.086%	1.157%	0.965%	1.567%
30,000	1.457%	0.330%	0.318%	0.462%
40,000	0.631%	0.121%	0.133%	0.173%
50,000	0.310%	0.052%	0.064%	0.076%
60,000	0.167%	0.025%	0.034%	0.037%
AAL (\$Mill.)	6,156	3,831	3,006	4,320
PML (1%) (\$Mill.)	34,277	21,033	19,723	23,382

Table 9. The Exceedance probability of four selected scenarios with 25% take-up

Gross Loss Layer (\$Mill.)	EXCEEDING PROB.			
	S3	S7	S9	S11
0	100.000%	100.000%	100.000%	100.000%
100	99.945%	99.736%	98.123%	99.968%
500	93.517%	84.637%	70.377%	94.806%
1,000	77.699%	60.229%	44.831%	80.405%
2,000	50.344%	30.769%	21.326%	53.428%
3,000	33.284%	17.157%	11.815%	35.775%
4,000	22.820%	10.309%	7.210%	24.695%
5,000	16.174%	6.561%	4.702%	17.565%
10,000	4.086%	1.157%	0.965%	4.436%
15,000	1.457%	0.330%	0.318%	1.567%
20,000	0.631%	0.121%	0.133%	0.671%
30,000	0.167%	0.025%	0.034%	0.173%
40,000	0.058%	0.007%	0.012%	0.059%
50,000	0.024%	0.003%	0.005%	0.024%
60,000	0.011%	0.001%	0.002%	0.011%
AAL (\$Mill.)	3,078	1,916	1,503	3,240
PML (1%) (\$Mill.)	17,139	10,516	9,862	17,537

Table 10. The Exceedance probability of four selected scenarios with 10% take-up

Gross Loss Layer (\$Mill.)	EXCEEDING PROB.			
	S3	S7	S9	S11
0	100.000%	100.000%	100.000%	100.000%
100	98.836%	96.268%	88.502%	99.848%
500	69.830%	50.561%	36.539%	88.017%
1,000	40.753%	22.734%	15.642%	65.751%
2,000	16.174%	6.561%	4.702%	35.775%
3,000	7.664%	2.530%	1.953%	20.753%
4,000	4.086%	1.157%	0.965%	12.826%
5,000	2.367%	0.593%	0.533%	8.340%
10,000	0.310%	0.052%	0.064%	1.567%
15,000	0.074%	0.010%	0.015%	0.462%
20,000	0.024%	0.003%	0.005%	0.173%
30,000	0.004%	0.000%	0.001%	0.037%
40,000	0.001%	0.000%	0.000%	0.011%
50,000	0.000%	0.000%	0.000%	0.004%
60,000	0.000%	0.000%	0.000%	0.002%
AAL (\$Mill.)	1,231	766	601	2,160
PML (1%) (\$Mill.)	6,855	4,207	3,945	11,691

Table 11. The funding requirement to pay for losses of four selected scenarios

Unit: NT\$ billion

	S3	S7	S9	S11
Mandatory	8.5	5.3	5.0	
Semi-mandatory	4.3	2.6	2.5	
Voluntary				1.5

Table 12. Premiums under four selected scenarios with alternative participation (take-up) rates

Scenario	S3			S7			S9			S11		
	25%	50%	100%	25%	50%	100%	25%	50%	100%	10%	50%	100%
Content Cover (3.3 Mill. First Floor Households)												
Estimated Policy#	825,000	1,650,000	3,300,000	825,000	1,650,000	3,300,000	825,000	1,650,000	3,300,000	(0.37 Mill. First Floor Households)		
AAL (NT\$ Mill.)	2,738	5,475	10,950	1,575	3,150	6,300	1,163	2,325	4,650	2,160	4,320	4,320
Pure Premium w/o bottom GOV Cover	\$3,318	\$3,318	\$3,318	\$1,909	\$1,909	\$1,909	\$1,409	\$1,409	\$1,409	\$58,378	\$23,351	\$11,676
Living Expense & Electrical & Mechanical Equipment Loss Cover-Limit of NT\$ 20,000 (4.3 Mill. 2nd Floor above Households)												
(0.75 Mill. Households)												
Estimated Policy#	1,075,000	2,150,000	4,300,000	1,075,000	2,150,000	4,300,000	1,075,000	2,150,000	4,300,000	75,000	375,000	750,000
AAL (NT\$ Mill.)	324	648	1,296	324	648	1,296	324	648	1,296	605	1,210	1,210
Additional Premium to Include Living expense & Electrical & Mechanical Equipment Loss Cover w/ Limit of NT\$20,000	\$301	\$301	\$301	\$301	\$301	\$301	\$301	\$301	\$301	\$8,067	\$3,227	\$1,613
Constructed Total Loss Cover-NT\$120 Mill. (7.6 Mill. Households)												
(1.12 Mill. Households)												
Estimated Policy#	1,900,000	3,800,000	7,600,000	1,900,000	3,800,000	7,600,000	1,900,000	3,800,000	7,600,000	112,000	560,000	1,120,000
AAL (NT\$ Mill.)	59	117	234	59	117	234	59	117	234	12	59	117
Additional Premium to Include Constructed Total Loss Cover of NT\$120 Mill.	\$31	\$31	\$31	\$31	\$31	\$31	\$31	\$31	\$31	\$104	\$104	\$104
Premium w/o Bottom GOV Cover												
Pure Premium w/o bottom GOV Cover - First-Floor Household	\$3,349	\$3,349	\$3,349	\$1,940	\$1,940	\$1,940	\$1,440	\$1,440	\$1,440	\$58,483	\$23,456	\$11,780
Premium w/ additional cost (15%)	\$3,940	\$3,940	\$3,940	\$2,282	\$2,282	\$2,282	\$1,694	\$1,694	\$1,694	\$68,803	\$27,595	\$13,859
Pure Premium w/o bottom GOV Cover - Other Household	\$332	\$332	\$332	\$332	\$332	\$332	\$332	\$332	\$332	\$8,171	\$3,331	\$1,718
Premium w/ additional cost (15%)	\$391	\$391	\$391	\$391	\$391	\$391	\$391	\$391	\$391	\$9,613	\$3,919	\$2,021
Premium w/ Bottom 1 Billion GOV Cover												
AAL ratio of Bottom 1 bn Layer	30.26%	16.25%	8.49%	44.31%	25.33%	13.35%	48.84%	29.94%	16.65%	40.01%	22.27%	22.27%
Pure Premium w/ bottom GOV Cover of 1 billion - First-Floor Household	\$2,336	\$2,805	\$3,065	\$1,080	\$1,449	\$1,681	\$737	\$1,009	\$1,200	\$35,084	\$18,232	\$9,157
Premium w/ additional cost (15%)	\$2,748	\$3,300	\$3,606	\$1,271	\$1,704	\$1,978	\$867	\$1,187	\$1,412	\$41,275	\$21,450	\$10,773
Pure Premium w/ bottom GOV Cover of NT\$1 billion - Other Household	\$232	\$278	\$304	\$185	\$248	\$288	\$170	\$233	\$277	\$4,902	\$2,589	\$1,335
Premium w/ additional cost (15%)	\$273	\$327	\$358	\$218	\$292	\$339	\$200	\$274	\$326	\$5,767	\$3,046	\$1,571
Premium w/ Bottom 1.5 Billion GOV Cover												
AAL ratio of Bottom 1.5 bn Layer	41.85%	23.70%	12.65%	58.19%	35.84%	19.68%	62.04%	40.91%	23.97%	53.08%	31.79%	31.79%
Pure Premium w/ bottom GOV Cover of 1.5 billion of First-Floor Household	\$1,947	\$2,555	\$2,925	\$811	\$1,245	\$1,558	\$547	\$851	\$1,095	\$27,440	\$15,999	\$8,035
Premium w/ additional cost (15%)	\$2,291	\$3,006	\$3,442	\$954	\$1,464	\$1,833	\$643	\$1,001	\$1,288	\$32,283	\$18,823	\$9,453
Pure Premium w/ bottom GOV Cover of NT\$1.5 billion - Other Household	\$193	\$253	\$290	\$139	\$213	\$267	\$126	\$196	\$253	\$3,834	\$2,272	\$1,172
Premium w/ additional cost (15%)	\$227	\$298	\$341	\$163	\$251	\$314	\$148	\$231	\$297	\$4,510	\$2,673	\$1,378
Premium w/ Bottom 2 Billion GOV Cover												
AAL ratio of Bottom 2 bn Layer	50.87%	30.41%	16.69%	67.07%	44.36%	25.53%	69.51%	48.94%	30.28%	62.70%	40.01%	40.01%
Pure Premium w/ bottom GOV Cover of 2 billion of First-Floor Household	\$1,645	\$2,331	\$2,790	\$639	\$1,079	\$1,445	\$439	\$735	\$1,004	\$21,814	\$14,071	\$7,067
Premium w/ additional cost (15%)	\$1,936	\$2,742	\$3,282	\$751	\$1,270	\$1,699	\$516	\$865	\$1,181	\$25,664	\$16,554	\$8,314
Pure Premium w/ bottom GOV Cover of NT\$2 billion - Other Household	\$163	\$231	\$277	\$109	\$185	\$247	\$101	\$170	\$232	\$3,048	\$1,998	\$1,031
Premium w/ additional cost (15%)	\$192	\$272	\$326	\$129	\$217	\$291	\$119	\$200	\$272	\$3,586	\$2,351	\$1,212
Premium w/ Bottom 3 Billion GOV Cover												
AAL ratio of Bottom 3 bn Layer	64.23%	41.91%	24.31%	79.02%	57.69%	35.97%	79.97%	61.24%	40.99%	75.40%	53.08%	53.08%
Pure Premium w/ bottom GOV Cover of 3 billion of First-Floor Household	\$1,198	\$1,945	\$2,535	\$407	\$821	\$1,242	\$288	\$558	\$850	\$14,387	\$11,005	\$5,527
Premium w/ additional cost (15%)	\$1,409	\$2,289	\$2,982	\$479	\$966	\$1,461	\$339	\$657	\$1,000	\$16,926	\$12,948	\$6,503
Pure Premium w/ bottom GOV Cover of NT\$3 billion - Other Household	\$119	\$193	\$251	\$70	\$141	\$213	\$67	\$129	\$196	\$2,010	\$1,563	\$806
Premium w/ additional cost (15%)	\$140	\$227	\$296	\$82	\$165	\$250	\$78	\$151	\$231	\$2,365	\$1,839	\$948