The Mandatory Earthquake Insurance Scheme in Turkey

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Abstract

The devastating 1999 Marmara and Düzce earthquakes lead to a significant increase in the earthquake studies in Turkey in geological, engineering and financial aspects. The launch of the Turkish Catastrophe Insurance Pool (TCIP) in September 2000 brought the mandatory earthquake insurance scheme in Turkey. Since then, many claims have been made after the earthquakes. In this study, the earthquake history of Turkey, the development of the insurance sector in Turkey and the features of the Turkish Catastrophe Insurance Pool are briefly discussed. A method to analyse earthquake insurance claims data of the TCIP is also suggested.

Key words: Earthquake, catastrophe, insurance, claims.

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1 Introduction

The aim of this paper is to discuss the historical development of earthquake events in Turkey, the features of the Turkish Catastrophe Insurance Pool (TCIP) and to introduce a statistical method to analyse earthquake insurance claims data. Section 2 gives some information about the past earthquake events in Turkey. Section 3 briefly explains natural hazard insurance, basics of the Turkish insurance sector and features of the Turkish Catastrophe Insurance Pool. Finally, Section 4 gives an estimation method for the capacity of the TCIP.

2 Introduction to Turkish Earthquakes

Turkey is one of the most earthquake-prone countries in the world. The United Nations Development Programme (UNDP) announces Turkey as the third country after Iran and Yemen according to the number of deaths as a result of earthquakes. The UNDP also ranks Turkey 35^{th} among fifty five countries for the flood losses. Rock falls, landslides and avalanches are the other types of disasters that happen in Turkey, where floods and landslides are mainly experienced in the Black Sea Region and the coastal areas. Table 1 gives the figures of different types of natural disasters in Turkey since 1990.

Event	Date	Killed	Injured	Homeless	Affected	Loss in $ m
Earthquake (Erzincan)	13/03/1992	653	3,850	95,000	250,000	750
Avalanches (S.Anatolia)	1992 (14 events)	328	53	11,600	30,000	25
Avalanches (S.& E. Anatolia)	1993 (31 events)	135	95	1,100	300	10
Mud flood (Senirkent-Isparta)	13/07/1995	74	46	2,000	10,000	65
Earthquake (Dinar)	01/10/1995	94	240	40,000	120,000	100
Flood (Izmir)	04/11/1995	63	117	6,500	300,000	1,000
Earthquake (Çorum-Amasya)	14/08/1996	0	6	9,000	17,000	30
Flood (W. Black Sea)	21/05/1998	10	47	40,000	1,200,000	1,000
Earthquake (Ceyhan)	27/06/1998	145	1,600	88,000	1,500,000	500
Earthquake (Marmara)	17/08/1999	17,480	43,953	675,000	15,000,000	16,000
Earthquake (Düzce)	12/11/1999	763	4,948	35,000	600,000	750
Earthquake (Sultandaği)	03/02/2002	42	327	30,000	222,000	95
Earthquake (Bingöl)	01/05/2003	177	520	45,000	245,000	135
Total		19,964	55,802	1,078,200	19,494,300	20,460

Table 1: Natural Disasters in Turkey since 1990. *Source:* [JICA, 2004], GDDA

The main main fault line to cause the most devastating earthquakes in Turkey is the 'North Anatolian fault line (NAF)'. The 1939 Erzincan earthquake is the start of the chain of earthquakes along the NAF. The fault was ruptured 600 kilometers to the west between 1939-1944. Afterwards, this movement slowed down and another rupture of 100 kilometers was recorded between 1957-1967. The 1999 Marmara and Düzce earthquakes filled the 100-150 kilometers gap of the previous ruptures [Bibbee et al., 2000].

Table 3 categorises the total number of earthquakes and magnitude between 1900-2004.

Magnitude	1900-1932	1933-1966	1967-2004
8.0-9.9	0	0	0
7.0-7.9	3	13	5
6.0-6.9	6	14	18
5.0-5.9	6	28	27
Total	15	55	50
Total number of estimated deaths	4,926	48,410	28,522

Table 2: The significant earthquakes in Turkey between 1900-2004. *Source:* The General Directorate of Disaster Affairs (GDDA)

3 Natural Hazard Insurance

The number of the catastrophic events has dramatically increased in the past decades due to some factors like the rise in world's population, the unbalance of nature, the Greenhouse effect, the widening hole in the ozone layer, the loss of rain forests. As a result, disaster loss figures can reach to huge amounts both in life and economical terms. One way to reduce disaster financial losses is to have a well-developed and effective insurance system. Some devastating disasters pushed the countries to develop disaster emergency plans mainly with the help of insurance sector.

Earthquake Insurance

Some countries have direct earthquake insurance schemes, whereas some offers the earthquake coverage in addition to the fire insurance policies. The magnitude of an earthquake, the depth of the epicentre, duration of the earthquake, the distance of the settlement area to the focus of the earthquake and some ground structure help scientists to calculate the loss ratio (the ratio of incurred claims to the earned premiums). Beside all of these factors, the earthquake zone maps, the location, the height and the age of the buildings, the historical earthquake records help insurance companies to determine the premium.

3.1 The Insurance System in Turkey

During the Ottoman Empire, the insurance business was mainly run by the international agencies. Türkiye İş Bankasi was established in 1924. Then in 1925, the start of the Anadolu Sigorta A.Ş (Anadolu Insurance), which is the insurance group of Türkiye İş Bankasi, followed. Today, there are about sixty seven insurance and reinsurance companies in total in Turkey, most of which are privately owned. These companies have to be a member of the 'Insurance and Reinsurance Companies' Association'. The General Directorate of Insurance the Prime Ministry Undersecretariat of the Treasury regulates the insurance system of the country.

3.2 The Turkish Catastrophe Insurance Pool (TCIP)

Fire insurance policies used to cover the earthquake risk in Turkey before the 1999 Marmara earthquake. The Turkish Catastrophe Insurance Pool started operation on 27/September/2000, which has basis of the California Earthquake Authority and New Zealand Earthquake and War Damage Commission. The aim of the TCIP is to transfer the national risk to world-wide risk sharing pools under the management of the international reinsurance companies. The TCIP is directed by a board of members, who represent government, academia and insurance companies. The administrative power is the General Directorate of Insurance the Prime Ministry Undersecretariat of the Treasury. The current Pool Manager is Garanti Insurance since August 2005.

Earthquakes, fires due to an earthquake, explosions and landslides following an earthquake are in the coverage of the Turkish Catastrophe Insurance Pool. The contract period of the TCIP is one-year. The aim of the TCIP is to provide minimum amount standard insurance for residents living in different risk zones. The TCIP plans to have an earthquake coverage of USD 30.000 per housing unit with a deductible amount of 2 %. The mandatory earthquake insurance only covers the losses of the residential buildings within the municipality borders. It does not offer any coverage for the rural areas or for the building contents. This urban coverage is one of the obstacles of the TCIP since the ideal prototype insurance should be able to reach all parts of the community, that is including the poor and the vulnerable areas.

TCIP will play a crucial role in the control of the use of the necessary building codes during the construction, since it is required by the reinsurers [Erdik, 2000, Bibbee et al., 2000]. The use and the control of the current Building Code 1998 is one of the main problems in terms of disaster management in Turkey.

There are 32 authorised insurance companies to sell TCIP policies by March 2005 figures [Gurenko et al., 2006]. The following chart in the next page shows the marketing process of the mandatory earthquake insurance scheme [Gurenko et al., 2006]:

TCIP

↓

Insurance companies

↓

Agents

↓

Homeowners

TCIP uses fifteen tariffs, which are calculated according to five earthquake risk zones and three types of buildings. The insured value of a property is decided every year by $\Big($(cost per square meter $\times$ gross area of the house/flat) $\times$ tariff price$\Big)$. This value changes every year according to the increase in the construction cost of a property. The maximum coverage of the TCIP is 100,000 YTL for each house/flat. Table 3 gives the yearly premium rates of the Turkish Catastrophe Insurance Pool.

Building type	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	Zone 5 (%)
Steel, reinforced concrete	2.20	1.55	0.83	0.55	0.44
Masonry	3.85	2.75	1.43	0.60	0.50
Other	5.50	3.53	1.76	0.78	0.98

Table 3: The yearly premium rates of the TCIP by earthquake risk zone and building type [TCIP, 2006].

Table 4 gives an example of a yearly mandatory earthquake insurance premium amount to be paid by the insured for $100m^2$ reinforced concrete flat, which has an insured value of 38,000 YTL. The values in Table 4 are calculated by using the rates for reinforced concrete building type in Table 3 (e.g. for risk zone 1, Bingöl-centre, the premium to be paid in one year is: $38,000(2.20\%) = 83.60$).

Place	Risk Zone	Yearly premium (YTL)
Ankara-centre	4	20.90
Artvin-centre	3	31.54
Bingöl-centre	1	83.60
Erzurum-centre	2	58.90
Karaman-centre	5	16.72

Table 4: The yearly premium rates of the compulsory earthquake insurance for a $100m^2$ reinforced concrete flat in Turkey in five risk zones obtained from [TCIP, 2006].

Table 5 gives the number of the earthquake claims reported to the TCIP and the payments made for these claims in terms of years by the figures of 26/October/2006.

Year	The number of earthquakes	The number of claims	The total payment in YTL
2000	1	6	23,022
2001	17	338	127,497
2002	21	1558	2,284,835
2003	20	2504	5,203,990
2004	31	586	768,692
2005	39	3448	7,970,223
2006	13	368	1,089,633
Total	142	8808	17,467,892

Table 5: The claim and payment information of the TCIP [TCIP, 2006].

The penetration rate in Turkey as of 01/February/2005 is 16.51 %, where most of the policies are sold in the Marmara region [Gurenko et al., 2006]. The culture of insurance is still far from many parts of the country. Many householders do not renew their contracts when it is terminated, if they did not experience an earthquake during the contract year.

The TCIP reassured USD 540m of its risk to A-level and above rated international reassurers in 2001, that of USD 840m in 2002 and USD 740m in 2003. In 2006, the reinsured amount of the pool is EUR 920m ($\sim$ USD 1.1b). By 2006 Figures, the payment capacity of the TCIP is approximately EUR 1.1b ($\sim$ USD 1.33b).

4 Statistical Approach

The calculation of the expected total claim amount (aggregate mean), $E(S(t))$, in the portfolio of risks (the TCIP) due to the catastrophic events is a high interest of the actuaries in the recent years. The claim number process (aka claim frequency) $N(t)$ and the claim amount (aka claim severity) X are the key elements in the computation of the total claim amount $S(t)$ of the portfolio. The relation between the response variables and the aggregate mean can be summarised with the following chart:

The number of claims ($N(t)$) & The claim amount (X)
↓
The total claim amount ($S(t)$)
↓
Net (Pure) premium ($E(S(t))$)

The total claim amount (the aggregate claims) is defined as $S(t) = \sum_{i=1}^{N(t)} X_i$, which is also called the 'collective risk model' in the actuarial context since the process is the sum of the claim amount from each policy in a certain time period [Karlin and Taylor, 1994, Daykin et al., 1994, Rolski et al., 1999]. In this study, $N(t)$ denotes the time-dependent inhomogeneous Poisson process. The necessary assumptions for the aggregate claims model are the independency of the $N(t)$ and X and the independent identically distributed X's. This makes $S(t)$ a Compound Poisson Process. The aggregate mean $E(S(t))$ and the aggregate variance $Var(S(t))$ are

$$E(S(t)) = E(N(t))E(X) = \Lambda(t)\mu_X, \tag{1}$$

and

$$Var(S(t)) = E(N(t))Var(X) + Var(N(t))E(X) = \Lambda(t)(\mu_X^2 + \sigma_X^2), \tag{2}$$

where μ and σ^2 are the mean and the variance of the chosen claim amount X distribution, $\Lambda(t)$ is the mean intensity function of an inhomogeneous Poisson claim number process $N(t)$. It should be noted that the external effects like the inflation, interest rate, unemployment rate, other economical factors (seasonal trends etc.) and the management expenses (office equipment, cost of personnel) are excluded for the calculations of the required premium amounts [Booth et al., 1999].

After giving some basic statistical background information, we can briefly explain how the disaster insurance claims data can be used statistically. Here, the aim is to represent the jump behaviour of the TCIP earthquake insurance claims and make some reserve estimation. The TCIP data used in this study is collected between 2000-2003.

Figure 1 and Figure 2 show the relation between the claim number and time in terms of weeks/months based data for earthquake risk zones 1-2 classification. The jumps in the data, which are caused due to the big earthquake claims, can be observed in both plots. One way to represent the jump feature of these claims is to use the special function of the exponential kernel form.

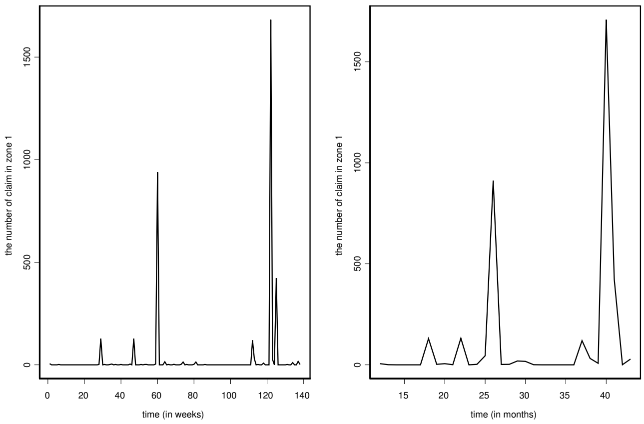

Figure 1: The number of claims versus time in earthquake risk zone 1. Left: weeks data, right: months data

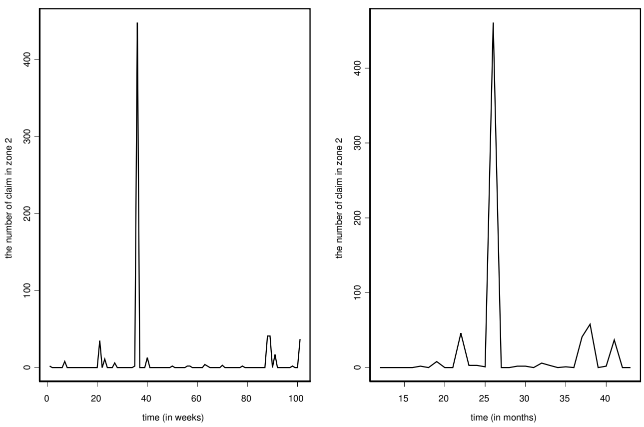

Figure 2: The number of claims versus time in earthquake risk zone 2: Left: weeks data, right: months data

Since we use the idea of an inhomogeneous Poisson process, the mean intensity function of the claim number process is $\Lambda(t)$ and the rate for the claim amount is $\mu(t)$ (considering time dependency). After using the binning approach, that is where we bin the claim number and the corresponding total claim amount in the given time interval, the exponential kernel function has the following suggested form of Λ_i

$$\hat{\Lambda}_i = e^{\hat{\alpha}_0 + \sum_{j=1}^{k} \hat{\alpha}_j e^{-\hat{\beta}(t_i - s_j)|_+}}, \tag{3}$$

and of μ_i

$$\hat{\mu_i} = \hat{\alpha}_0 + \sum_{j=1}^{k} \hat{\alpha}_j e^{-\hat{\beta}(t_i - s_j)|_+}, \tag{4}$$

where $i = 1, \ldots, n$ for $N(t) = n$ observations, $j = 1, \ldots, k$ knots to sit the kernel function, α's are the linear parameters to be estimated to realise the significant earthquake effects and β is the non-linear parameter to represent the exponential claim decay.

As a part of our research claims data, the exponential kernel function fits well to represent the behaviour of the TCIP data in risk zone 1. The empirical selection of the significant earthquakes in the modelling process of the data shows the jump pattern in the next page in Figure 3.

Some figures can be suggested for the capacity of the pool by using the idea of generalised linear models (glm). The estimates of the parameters α's and β are obtained from these glm models. First replacing these estimates in (3) and (4) and then using the results in (1) suggest a reserve estimation of the TCIP. The use of the exponential kernel function estimates approximately 1,275,417 YTL payment out of the TCIP for a prospective Istanbul earthquake itself; where in 2006 TCIP paid 1,089,633 YTL for 368 claims of 13 earthquakes all around Turkey [TCIP, 2006].

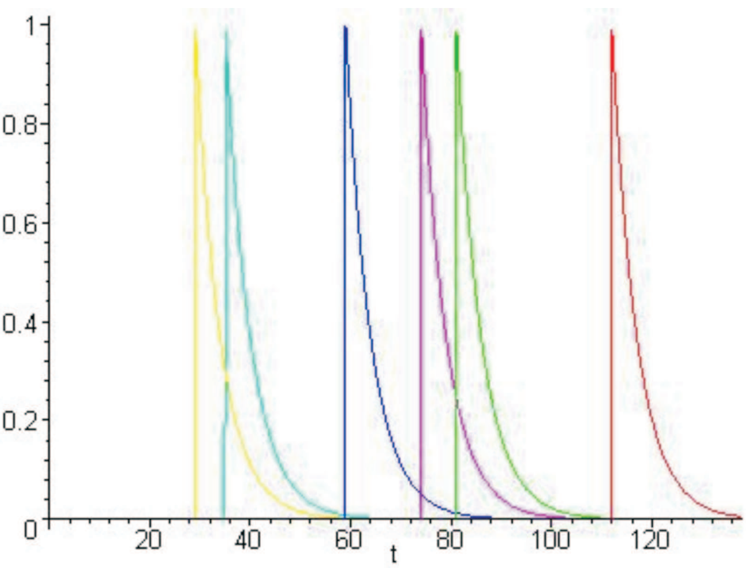

Figure 3: The use of the exponential kernel function in risk zone 1 at weeks 29, 35, 59, 74, 81 and 112

The discussions on the effects of the possible future earthquakes in Turkey mostly conclude that the current reserves of the pool will not be enough to cover the losses of a shock earthquake. In disaster risk management, it is important to take precautions in the pre-disaster period to lessen the effects of a disaster event. For the case of the TCIP, some suggestions are to re-arrange the premium ratings by considering the other factors (e.g residential building number, population) as well as the building type and the zone effect (careful underwriting), invest more in reinsurance and make the earthquake insurance mandatory indeed. Turkey needs a sustainable National Disaster Risk Management Program, in which all the bodies cooperate efficiently. Finance is an important leg of such system and statistics is one of the tools to estimate the necessary reserve amount. As a part of future work, more detailed statistical analysis will be conducted for the TCIP reserve estimation by zone classification and by using covariates like population and building number. History should not repeat itself.

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