

Catastrophe Risk in Japan

by **Anton Brink** and **Paulina Teste**



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Japan in general is a country facing the risk of earthquakes and windstorms. Because of the density of people and industry around the three biggest cities, Japan is extremely vulnerable for the occurrence of natural hazards, both in the economic as well as the human life aspect.

Most of Japan's 125.6 million inhabitants live on only one-third of the country's total area because of the mountain ranges. This results



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in a population density, which is among the highest in the world, estimated in 1995 at 340 persons per square kilometre. It is believed that around 80% of the population live on Honshu in the three metropolitan areas of Tokyo, Osaka and Nagoya.

1. Natural hazards in Japan

1.1 Earthquakes

During the history of Japan several major earthquakes have occurred. Perhaps the best known and most devastating quake, together with the recent one in Kobe, is the Great Kanto Earthquake, which occurred in Tokyo in 1923. This 7.9 Richter quake virtually destroyed what was then the world's largest city. Very little was left standing, apart from the Imperial Palace. Even though modern infrastructure and modern buildings in a better way can handle a major earthquake the experience of the Kobe earthquake in 1995

shows that a natural hazard with this dignity has a tremendous impact on the economy. We will later use the Kobe earthquake as an example to illustrate the impacts of an earthquake in Japan.

Looking at the Kanto region, where Tokyo is located, the risk for a new earthquake seems to be severe. Due to the movement of tectonic plates on which Tokyo stands, quakes of comparable intensity have occurred with remarkable regularity every 70 or so years since

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1663, the longest gap being 79 years. Since it has now been 76 years since the last big earthquake, many scientists believe that a big earthquake might occur in the Tokyo region in a close future. A recent study by Stanford University of California concluded that a repetition of the Great Kanto Earthquake would kill between 30,000 and 60,000 people, injure further 80,000 to 100,000 and cause economic losses in excess of US \$3,300 billion.

Gas mains and electricity lines are much more apparent today than they were in 1923 and fire following an earthquake could cause more damage than the actual shock itself, though this did not happen during the Kobe earthquake. There is still a heavy risk for conflagration in Japan, even in central Tokyo. There exists automatic cut-out protection for water and gas supplies, but in the event of fracture, water pressure would almost certainly be very reduced. There is also an early warning system, which consists of electronic detection equipment, stationed on the ocean floor in Sagami Bay. This is automatically set to turn all traffic signals to red, blow CO₂ into petrol storage tanks, cut off gas mains and initiate several other emergency operations. Experience from the serious earthquake in Okushiri in 1993 shows however, that the automatic cut-off system may not work as well as anticipated.

It is not only the earthquakes that appear on the islands of Japan that are of great concern. Also the ones that occur in the ocean can cause severe floods, so-called "Tsunamis". In 1998 an alarming seismic activity along one of Japan's most dangerous fault lines was detected. The epicentres of earthquakes that had occurred along that fault line were discovered in the 1970s and historical data reveal that a big quake occurs there every 140 years. The last major earthquake was in 1854 and seismologists are predicting a quake with a magnitude of 8.1, nearly 25 times as powerful as the Kobe earthquake. The government of

Shizuoka prefecture, closest to the epicentre, estimates that 500 000 buildings in the prefecture will collapse, burn down or be washed away by Tsunamis.

The question is whether or not such an earthquake will effect Tokyo. Most experts believe that Tokyo's buildings should withstand an 8,1-magnitude quake. However, some earthquake engineers fear that the ground underlying parts of Tokyo would be temporarily liquefied by the quake, with devastating consequences for the buildings above.

1.2 The Kobe earthquake

Probably the best way to describe the impact of an earthquake is to describe the results in terms of loss of lives and property after an occurrence. The Kobe Earthquake dramatically illustrates the damage that can be expected to a modern industrialised society from an earthquake.

In the early hours on 17 January 1995 an earthquake struck Kobe. With a magnitude of 7.1 it was not considered to be "a really large event". However, when looking at the horizontal acceleration of the ground rather than the Richter scale, which measures the overall energy of an earthquake, the quake was the strongest ever recorded in Japan. The intensity of the horizontal shaking at Kobe surprised many seismologists. This phenomenon of unexpected intensity was a new problem for Japanese engineers. Most highways in Japan are built to resist a ground acceleration of 3,5 metres per second. This is less than half of that which shook Kobe.

1.2.1 Economic Impact of the Kobe Earthquake **Repair costs**

In the aftermath of the Kobe Earthquake it was clear that the extent of regional economic disruption exceeded the experience of any modern urban area in a natural disaster. The

repair costs were reported to be around US\$ 100 billion. Some of the costs of repair and reconstruction were financed through a variety of governmental programs. The national government set up an emergency budget of US\$ 10 billion to deal with the impact of the earthquake, especially to repair roads, water systems, harbour facilities and schools. They also subsidised up to 90% of the cost of repairing public facilities. Earthquake victims were eligible for relief grants, low cost loans, and tax breaks. To cover the costs of reconstruction, the government issued US\$ 8 billion in construction bonds and US\$ 7 billion in deficit covering bonds in anticipation of tax revenue drop. Taking into account earthquake-related drops in corporate and personal income taxes, the Ministry of Finance believes to have lost around US\$ 7 billion in tax revenues for the 1995 fiscal year.

Business Interruption and Recovery

The region shaken by the earthquake accounts for almost one-fifth of the Japanese Economy. Therefore, in addition to the cost of repairing physical damage, the regional economy was severely affected by the temporary business interruptions and the loss of import/export capabilities. Two examples that illustrate the economic consequences are Hanshin Electrical Railway and Osaka Gas. The former one estimated that in addition to US\$ 895 million in damage to its rail facilities, it lost US\$ 51 million in revenues. The latter, which is also the second largest gas utility in Japan, estimated that in addition to US\$ 170 million in pipe repair, it lost US\$ 68 million in revenues.

Virtually all economic activity in Kobe halted due to the earthquake. Two of the three largest employers in Kobe closed their plants for several days. The third one was able to resume production at only one of its two area plants at 40% of normal production level.

Those three companies belonged to Kobe's principal industries such as steel production and shipbuilding. The manufacturing business had also extensive losses in both large and small business.

Producers that had little or no damage to their own facilities had their business indirectly disrupted since they had difficulties in obtaining supplies and other input to production or in selling products. For example, one week after the earthquake, water for industrial consumption was still unavailable to 190 companies. Auto manufacturers reported production cutbacks and temporary shutdown of operations in plants as far away as Tokyo. This was due to the fact that parts could not be obtained from or transported through the affected area. Transportation disruption also raised the transportation costs for producers moving goods in the region since the closure of the port of Kobe forced many businesses to divert cargo shipment to other facilities around Japan or East Asia.

Indirect effects were also being felt in other areas such as the real estate market. In Osaka, household and business seeking temporary relocation initially drove up the prices of apartment and commercial office space by about 10%. Another interesting fact was that consumer spending dropped by as far as 30% in Osaka after the disaster. The indirect effects are thus believed to have caused far more economical losses than the physical damage.

1.2.2 Impact on the Insurance Industry from the Kobe earthquake

The total insurance payments arising from the Kobe earthquake were estimated in June 1995 to be US\$ 6 billion, which is extremely low when considering that the actual property loss was US\$ 100 billion. When comparing with previous events in the U.S, it appears to be a major disparity between property loss and the portion borne by the insurance industry in

Japan. This difference existed because the government and the Japanese insurance industry recognised the difficulties in insuring earthquake risks in Japan. In other words, they believed that earthquakes in Japan might be “uninsurable”, in the sense that Japan has the potential for large earthquakes almost anywhere on the islands, and comprises a relatively small number of cities. Thus, Japan in whole was considered to represent a unique sort of adverse selection, for which the government and the insurance industry were unable to identify an adequate insurance solution.

1.3 Windstorms

Each year under normal circumstances between 25 and 30 typhoons occur in the Pacific Ocean, but an average of only 3 or 4 strike Japan. Most typhoons form in the Southeast and sweep around and cross Japan from a south-south-westerly direction during the months of July, August and particularly September. As they approach Japan, typhoons tend to lose their strength because the waters around the country are cooler than in the tropics.

However, typhoons can be powerful enough to decimate large areas. There have been a number of large, destructive typhoons in Japanese history. Among the biggest was the typhoon that struck Ise Bay in September 1959, claiming 5,000 lives and destroying or damaging 800,000 homes in the southern part of the country which is most affected by these storms.

Tokyo is rarely hit by typhoons and the bay area is well protected by sea defences. The most vulnerable industrial locations are at Osaka and Kobe.

1.4 The deregulation

After the Great Hanshin-Awaji earthquake in Kobe in 1995, Japanese insurance companies have been forced to provide significantly more

earthquake coverage to homeowners and commercial interests. This has put pressure on the supply and of capacity. Foreign governments, led by the United States and international trade organisations, have also for a long time expressed concern about market access restrictions, national treatment inconsistencies, and the highly regulated nature of the market. After experiencing great reductions in their asset values, Japanese insurers also started to demand changes in the market. The Ministry of Finance proposed a revision of the insurance law and the new Insurance Business Law became effective on April 1, 1996.

The regulatory environment in the Japanese non-life insurance market has changed with the new Insurance Business Law. In addition to the new law the Japanese government proposed a plan for a major financial system reform. This “Big Bang” reform is scheduled to be completed by 2001. As an integrated part of the reform a Financial System Reform Bill was approved on June 5, 1998.

The new law allows competition on price and product. Before the deregulation process began, tariff rates for catastrophe insurance were calculated by the Insurance Rating Organisation of Japan and was enforced by the Ministry of Finance. In line with the passing of the Financial System reform, the Law concerning Non-Life Insurance Rating Organisations was revised, effective from the first of July 1998. As a result of this revision the rating organisations now have been transformed into data collecting agencies that publish nonbinding recommendations. Except from Domestic earthquake insurance other lines of business have become free rating, even though the companies still have to justify their premium calculations to the Ministry of Finance.

Together with the Big Bang reform proposals, the new Insurance Business law permits, with limitations, Japanese insurers to operate

in both the life and non-life sector. Eventually, insurers can offer broad financial services through holding company arrangements. The new law also permits new marketing and underwriting methods. All insurers can now offer earthquake insurance and the companies can buy as much as they want. Banks and security houses, however, are prevented from selling insurance until the end of 2001.

Mutual entry between insurance and other financial institutions through subsidiaries is to be permitted but is postponed until 2001. As with the old law, the new law also permits mutualization.

After the deregulation each non-life insurance company has endeavoured to strengthen services. These include the establishment of counselling bureaux open even on public holidays. New distribution channels such as direct sales and mail-order sales through insurance agents have been introduced to the market. New payment methods for insurance premiums, such as by credit card and prepaid cards, automatic account drawing and payment convenience stores have also recently been made available in the Japanese non-life insurance market.

1.5 Insurance companies

The top four insurers in Japan are

- the Tokio Marine & Fire Insurance,
- the Yasuda Fire & Marine Insurance,
- the Mitsui Marine & Fire Insurance and
- the Sumitomo Marine & Fire Insurance.

Under the tariff system, where all insurers offered the same products and prices, market share was largely determined by the number of agents each company employed and by shareholding relationships.

In 1997 the foreign companies wrote only 2.2% of the national Property account. This result is based partly on the fact that foreign companies have no shareholder relationships in Japan, and partly on the Japanese prefer-

ence for dealing with national companies, particularly in a tariff environment which has prevented price competition or product differentiation.

Before the deregulation there were 22 non life insurance companies in Japan. When it became possible to be involved in more than one of the three sectors, 11 life insurance companies decided to enter the catastrophe risk insurance market. This also meant that companies within the same keiretsu group became competitors. Foreign firms also entered the market.

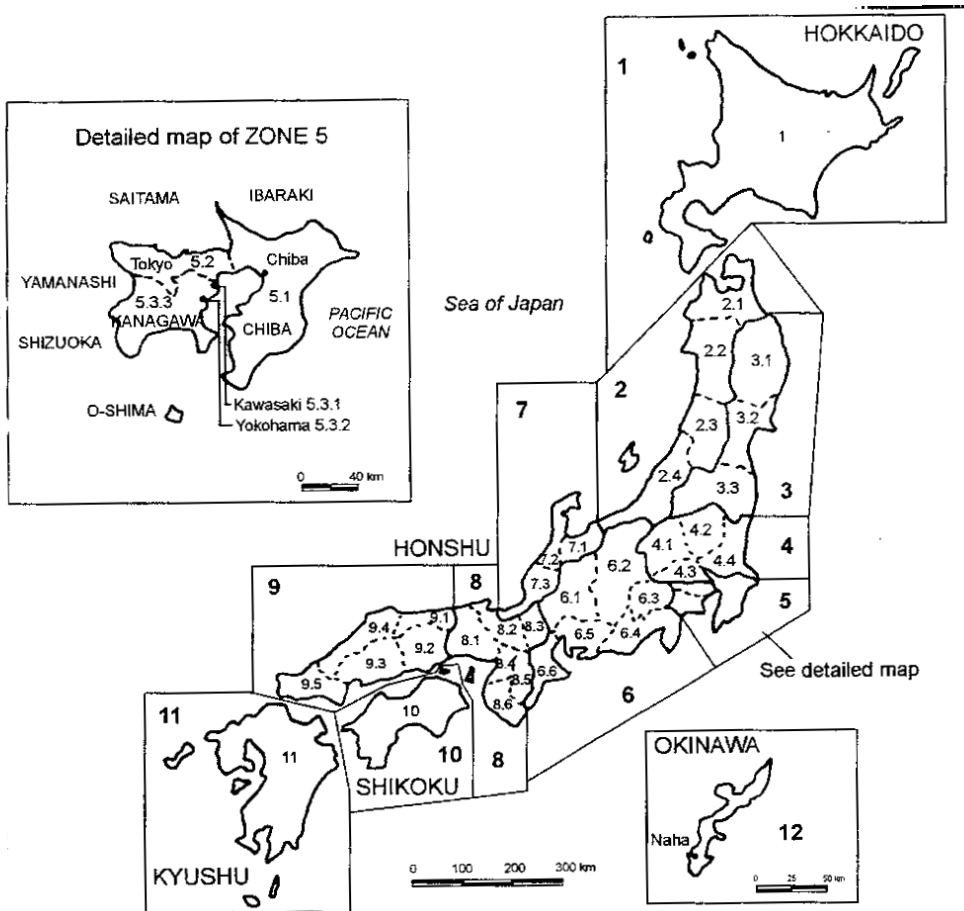
The increased competition from these players, as well as from newcomers like investment banks, has persuaded insurers to lift limits on indemnity and lower the price of earthquake cover. The result has been a small increase in the sale of earthquake insurance in Japan.

The intensely competitive environment has also lead to consolidation in the market in Japan as well as globally. On October 19, 1999 The Koa Fire and Marine Insurance Co, The Nippon Fire and Marine Insurance Co and Mitsui Marine and Fire Insurance Co declared that they had agreed to work towards the formation of a new insurance group integrating all three companies.

1.6 Insurance coverage

Within the Japanese industry only 15-16% have got earthquake insurance. This varies among the different regions facing different risks within Japan. One of the reasons why so little was covered by insurance during the Kobe accident was the fact that the risk of an earthquake was expected to be very low in this area. After the Kobe earthquake there has been a small increase in the sales of earthquake insurance in Japan. This trend is however diminishing now. One reason that not more catastrophe insurance is sold is the high cost and the perception among the customers

Earthquake map over Japan



that catastrophes will not occur. Difficulties in obtaining earthquake cover have also been a problem in the past. Nowhere in the world has insurance been harder to find than in Japan's earthquake Zone 5, a quadrangle of land that encompasses Tokyo, Yokohama and the industrial centre of Chiba. (See earthquake map.) Zone 5 borders an area where four tectonic plates converge, probably no place is more vulnerable to an earthquake.

There is also a very limited penetration of Domestic Earthquake insurance. According to the Marine and Fire Insurance Association,

only 15% of households were insured in March 1999.

1.6.1 Household Earthquake Coverage

Household Earthquake Coverage is governed by the 1966 Law concerning Earthquake Insurance which introduced a government supported earthquake protection scheme. Cover is available on a voluntary basis, but only in conjunction with a basic household policy. A separate earthquake policy is issued by the policyholder's household insurer covering

earthquake shock and fire. For practical purposes all policies except warehouse include windstorm and storm water damage.

Under the latest revision of the scheme (April 1, 1996) the maximum insurance limits are JPY 50 million (US\$ 384,600) on Buildings and JPY 10 million (US\$ 76,900) on contents. Within these monetary limits, the policy pays the following percentages of the actual sum insured (see Table 1).

1.6.2 Commercial Earthquake Coverage

Commercial Earthquake Insurance is provided by means of an extended coverage endorsement to the standard fire policy. The basic earthquake peril is shock and fire following an earthquake. Additional premiums are required for (1) explosion resulting from earthquake and (2) flood and tidal wave resulting from earthquake.

Before the deregulation of the financial markets in Japan, the Japanese companies could only buy coverage up to 15% of total physical losses in the event of an earthquake in earthquake zone 5. In zones 1, 4, 6, 8, 9 and 12 the limit was 30%. (See earthquake map, foregoing page). No restriction applied to zones 2, 3, 7, 10 or 11.

Earthquake cover was limited not only as a percentage of the fire sum insured but also by what is known as the “reduced indemnity” method. Under this method the amount re-

coverable in respect of partial loss is calculated as follows;

$$\begin{aligned} \text{Amount recoverable} &= \\ &= \text{Earthquake sum insured} * \frac{\text{Earthquake Damage}}{\text{Fire sum insured}} \end{aligned}$$

The earthquake rationing system has never been entirely respected. Right from the beginning the Ministry of Finance is said to have allowed selected strategic industries around Tokyo Bay to buy 15% first loss cover rather than the more restricted “reduced indemnity” cover. When news about this leaked out, it became difficult for the Ministry not to permit similar treatment for other industries. The increase in exposure was opposed by international reinsurers.

1.7 Earthquake Fire Expenses Insurance (EFEI)

All household policies and most commercial fire policies except warehouse risks are automatically extended to include Earthquake Fire Expenses Insurance without additional premium. The EFEI extension pays an additional 5% of the sum insured in the event that 50% or more of the property is destroyed by fire following earthquake or volcanic eruption. The maximum EFEI indemnity is limited to JPY 3 million (US\$ 23,000) in respect of Domestic risks and JPY 20 million (US\$ 153,800) in respect of Industrial risks.

Table 1. Maximum Insurance Limits

Extent of Damage	Percentage Payable
<i>Buildings</i>	
Damage exceeds 50% of sum insured or 70% of floor area	100%
Damage between 20% and 50% of sum insured or between 20% and 70% of floor area	50%
Damage between 3% and 20% of sum insured	5%
<i>Contents</i>	
Damage exceeds 80% of sum insured	100%
Damage between 30% and 80% of sum insured	50%
Damage between 10% and 30% of sum insured	5%

1.8 Rating and Deductibles

Domestic Earthquake insurance

Domestic earthquake rates are set by the Property and Casualty Insurance Rating Organisation of Japan (PCIORJ). The same rates are charged for both buildings and contents. Rating depends on construction and exposure zone.

Commercial Earthquake insurance

There is no official tariff for commercial earthquake risks though all insurers are reported to charge the same rates because their reinsurance protections are derived from the same limited number of sources. Rates depend on five classes of construction (A to E) and seven exposure zones (Table 2). (See earthquake map.)

Windstorms

For the windstorm/water damage extension an additional 0.5‰ to 1‰ would be the average but the tariff rates vary from a low of 0.2‰ up to a maximum of 4.1‰, depending on construction and location. Both domestic and commercial windstorm extensions are subject to a franchise of US\$ 1,540.

Flood

Where cover is purchased separately from an extended coverage package, rates of between 0.2‰ and 4.3‰ are charged, subject to discounts, depending on the number of floors etc. The average actual rate would be around 0.45‰. Under household and storekeepers comprehensive policies flood claims are subject to a franchise of 30% of the sum insured unless the floodwaters actually cover the ground floor.

2. Catastrophe Reinsurance

Japan has two domestic reinsurance companies, the Toa Fire and Marine Reinsurance Company and the Japan Earthquake Reinsur-

Table 2.

Commercial earthquake insurance rates

Class of A building %	B %	C %	D %	E %	
<i>Zone</i>					
1	1.10	1.40	1.80	3.29	4.50
2	1.30	1.70	2.10	3.90	5.60
3	1.60	2.20	2.70	4.80	6.80
4	2.10	2.90	3.60	6.80	10.00
5	2.30	3.00	3.80	6.60	8.90
6	2.80	3.70	4.70	8.50	12.20
7	3.90	5.20	6.40	12.40	18.60

ance Company. Approximately 70 % of Toa's shares are held by the domestic insurance companies and the balance by the major Japanese banks. In fiscal year 1995 (to March 1996) Toa had a net written premium income of JPY 110.47 billion (US\$1.17 billion) and shareholders equity of JPY 27.94 billion. About 85 % of Toa's income is derived from the domestic market and 15% from abroad. Japan Earthquake Reinsurance Company (JER) is owned partly by the domestic insurance industry and partly by the Government. JER's only function is to underwrite the state-sponsored Earthquake protection scheme for residential risks. Apart from its shareholding in JER, the Japanese state does not participate in local reinsurance arrangements. In addition to the domestic reinsurance companies most of the worlds leading professional reinsurers have either branches or representative offices in Tokyo.

2.1 Domestic Earthquake Reinsurance

Domestic Earthquake risks are reinsured exclusively with JER and shared with the Japanese Government. Under the current arrangement, all Domestic Earthquake business is reinsured 100% with JER which return a certain portion of the portfolio back to the direct market and to Toa Re by way of Excess of Loss reinsurance. The remainder of the

portfolio is guaranteed by an Excess of Loss contract concluded between the Government and JER under the Law concerning Earthquake insurance.

Since the likelihood of catastrophic losses following an earthquake is high, the aggregate amount of indemnity payable by all insurers to all policyholders per any one occurrence is limited. This aggregate limit of indemnity for earthquake insurance is reviewed periodically in the Diet in order to be able to cope with such huge quakes as the Great Hanshin-Awaji Earthquake.

From April 1, 1999 the limit of indemnity was raised from 3,700 billion Yen to 4,100 billion yen. The changes in the aggregate limits are shown in Table 3. (The Marine and Fire Insurance Association of Japan, Inc.)

Table 3. Development of Aggregate Limit of Indemnity

<i>Effective from</i>	<i>Aggregate limit of indemnity per one occurrence</i>
June 1966	300 billion Yen
May 1972	400 billion Yen
April 1975	800 billion Yen
April 1978	1,200 billion Yen
April 1982	1,500 billion Yen
June 1994	1,800 billion Yen
Oct. 1995	3,100 billion Yen
April 1997	3,700 billion Yen
April 1999	4,100 billion Yen

The maximum liability of the private insurance market in respect of any one event is JPY 502.55 billion (US\$ 3.87 billion). This is allocated as follows:

Table 4. Liability Share

<i>Amount</i>	<i>Private insurers</i>	<i>Government</i>
< JPY 114 billion (US\$ 876 million)	100 %	-
JPY 114 - 579 billion (US \$ 876 million - 4.45 billion)	50%	50%
JPY 579 - 3,700 billion (US \$ 4.45 - 28.46 billion)	5%	95%

2.2 Commercial Earthquake Reinsurance

Most Earthquake reinsurance is arranged under proportional Treaties. Until recently companies ceded part of their exposures by means of earthquake quota shares and part by means of fire and earthquake surplus treaties. The latter were intended to make the earthquake cessions more acceptable to reinsurers by connecting it with conventional fire business. During the recent soft market conditions Japanese cedents have largely phased out their surplus treaties.

As proportional capacity has increased, a number of the largest Japanese insurers have phased out their earthquake excess of loss programmes, which are now confined to the smaller end of the market.

Japanese companies are said to be extremely cautious reinsurance buyers and will not purchase additional capacity from carriers who might withdraw from the catastrophe business when market conditions change. Security supply is said to be one reason why Tokio Marine and Fire arranged US\$ 90 million of Catastrophe Bonds in November 1997.

2.3 EFEI Reinsurance

Earthquake Fire Expenses Insurance was pooled through Toa Re until 1 April 1996. After the pooling arrangement was cancelled under pressure from the Fair Trade Commission, some companies arranged excess of loss protection abroad while others retained the business for net account.

Reinsurance for windstorms and floods

Windstorm risks are ceded to the companies' proportional fire treaties. Insurers main exposure is from the household and motor portfolios and all companies therefore buy large lines of excess of loss protection. Excess of loss policies normally cover windstorms and

flood. Some companies have separate programmes for their property and motor portfolios while others combine them.

2.4 Limitation in reinsurance coverage

The problem with the reinsurance market today is that it only covers the repair costs and the damage resulted by a disaster. When it comes to business interruption it is not included in the insurance cover. Therefore there is a need for other kinds of insurance. There will most likely be a development of more products within the capital market that enables the insurance of risks concerning business interruptions. The deal with Tokyo Disney Land is one example of how the capital market can insure this kind of risks.

3. Securitizing catastrophe risk

In recent years the insurance market has turned to the capital market in order to develop new products. The catastrophe bond market with the major players globally, i.e. Goldman Sachs, AON, Merrill Lynch and Citigroup, grew from the collapse of the reinsurance market in 1992 in the wake of Hurricane Andrew in the US. However, since the insured catastrophe losses in the past few years have not been as high as in previous years it has left reinsurers with a lot of cash and resulted in cheap traditional reinsurance. Many of the insurance companies have invested their cash surplus in stocks and the positive development in the stock market in recent years has also increased the solvency margins for the insurers. This has had negative effects on the development of the cat bond market and other similar capital market products.

The prices today for capital market solutions are high relative to the actuarial ones. The customers will have to pay four times and sometimes up to nine times the expected value on a market solution.

In this section we will describe three important deals within the Japanese market.

3.1 Tokyo Marines-Swiss Re

The first catastrophe bond deal in Japan took place in 1997. Tokyo Marine & Fire, that underwrites US\$ 1,5 billion of commercial earthquake risk in Japan, reinsured US\$ 90 million of earthquake event risk with Swiss Re for a period of 10 years. The deal worked in the way that Swiss Re set up Parametric Re, a Cayman Island special purpose reinsurer that would provide the reinsurance agreement for the earthquake cover. Goldman Sachs as underwriter, placed notes that would cover multiple events and would create US\$ 90 million in risk transfer for Swiss Re.

The US\$ 100 m in offerings took two forms. The first one, the higher risk notes, is a US\$ 90 m deal in which the entire principal is at risk. It pays investors a floating rate of 430 basis points over LIBOR. Moodys Investors Service and Duff & Phelps Credit Rating Co rated it as a BB/Ba2 bond. The reason for the necessity of ratings is that in order for insurance companies to carry cat bonds in their reserves at face value ratings from credit agencies must exist.

The second one, the safer rate defeasance notes, which is a principal protected certificate gave Swiss Re an additional US\$ 10 m. This one gives investors 206 basis points over LIBOR and was rated as BBB-/Baa3 bonds. For both transactions the rates are locked up for ten years.

The trigger point for bondholders' losses are based on the magnitude of an earthquake within two zones or grids in the Tokyo region. As you can see in Table 5, if the quake occurs in the inner grid with a magnitude more than 7.6 all principal will be lost.

The initial offerings were over-subscribed four times. All in all 32 institutional investors signed on the deal and of those were 16% Hedge funds, 24% life insurers, 50% mutuals

Table 5. Trigger point for bondholder's losses

<i>Magnitude</i>	<i>Inner grid (%)</i>	<i>Outer grid (%)</i>
7.1	25	0
7.2	40	0
7.3	55	25
7.4	70	44
7.5	85	63
7.6	100	81
7.7	100	100
7.8	100	100
7.9	100	100

and banks and the remainder were bought by reinsurance and other nonlife insurers.

3.2 Yasuda Fire & Marine - AON - Munich Re

In June 1998 the Yasuda Fire & Marine Insurance Co placed a US\$ 80 m deal to protect them from typhoons. In the same manner as the previous one, a special facility Pacific Re was created to issue the floating rates notes. However, the deal has some other particular features.

The uniqueness was that the trigger point would have an annual adjustment reflecting Yasuda's catastrophic exposure each year. In other words, the deal has an option feature that allows Yasuda to convert the notes cover a lower layer if a major catastrophe occurs that would cause reinsurance prices to raise in the traditional reinsurance market. The notes are for a US\$ 1.4 billion typhoon event, a less than one percent probability occurrence. Investors get 370 basis points in exceed return above LIBOR. However, if Yasuda experience losses of more than US\$ 650 m and those losses are not covered by the notes, the company would have the option to drop the trigger point to US\$ 480 million and pay investors 950 basis points over LIBOR. This protects Yasuda if reinsurance prices for lower layers increase dramatically after an event.

The transaction develops an additional source of secure capital reinsurance capacity and stabilise the reinsurance costs for Yasuda during a period of seven years. This is of importance because of price volatility and credit risk associated portions of traditional reinsurance markets following a catastrophic event.

3.3 Oriental Land

Oriental land, the owner of Tokyo Disney Land, recently invested US\$ 3.3 billion in a second theme park. Because of this investment the company will face a heavy depreciation burden for several years to come. Therefore Oriental Land wished to secure cashflows during the coming period.

Even though the theme parks are said to withstand a major earthquake, Oriental Land estimates ten months recovery of visitors if an earthquake occurs nearby. This is due to the belief that the number of visitors will decrease if expressways or other traffic routes are damaged. Since it is impossible to insure against a decline in cashflows, Oriental Land decided to issue cat bonds with the advice from Goldman Sachs.

The bond issue by Oriental Land on May 13, 1999 amounted to US\$ 200 and is deposit with a special investment company in Cayman Islands. The structure of the deal is somewhat similar to the Tokio Marine-Swiss Re deal. The deal consists of two types of bonds, a principal-risk type and a credit risk switch type. The principal-risk type implies that investors face the risk that the principal may have diminished when the bond is redeemed five years from the date of issue. In the credit risk switch type Oriental Land has an option to borrow money if a quake occurs. The trigger is an earthquake within a 75 km radius of Maihama in Chiba Prefecture where the theme parks are located. The bonds in this deal were sold entirely over seas.