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Seismic Insurance Regulations: A Review in Several Seismic-Prone Countries

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ABSTRACT

Earthquakes cause severe economic losses worldwide, yet earthquake insurance penetration remains low in many seismic-prone regions. This paper provides a comparative review of earthquake insurance regulations in eight selected countries: Japan, New Zealand, Turkey, the United States (California), France, Spain, Chile, and Taiwan. The study examines legal frameworks, institutional structures, mandatory/voluntary nature, pricing mechanisms, government roles, and post-earthquake performance. Results show that no single model is perfect. Japan and Turkey have successfully implemented mandatory systems with government backing, while New Zealand offers an integrated public-private model. The United States (California) struggles with low take-up rates despite high risk. France and Spain utilize solidarity-based state reinsurance mechanisms. Chile achieves high penetration voluntarily due to strict building codes. Taiwan follows a Japanese-style mandatory fund. Common challenges include inadequate coverage, delayed claims, and public reluctance. The paper concludes with policy recommendations for earthquake-vulnerable countries, including Iran.

Keywords:

Earthquake insurance, catastrophe risk financing, natural disaster insurance.

1. Introduction

Earthquakes are among the most destructive natural hazards, causing significant human casualties and economic losses worldwide. Unlike many other natural perils, earthquakes occur with little or no warning, making financial preparedness and post-disaster recovery mechanisms essential components of disaster risk reduction strategies. One of the most critical financial instruments for post-earthquake recovery is earthquake insurance, which aims to compensate property owners, accelerate reconstruction, and reduce the financial burden on governments [1,6].

However, designing an effective earthquake insurance system is challenging due to several factors, including adverse selection, moral hazard, inaccurate premium pricing, low market penetration, public reluctance to purchase coverage, and the need for government intervention in catastrophe risk financing [2, 7-12]. Different seismic-prone countries have developed distinct regulatory frameworks based on their hazard levels, economic conditions, historical seismic events, and institutional capacities. These frameworks range from fully voluntary private markets to mandatory public-private partnership models [13-15].

Among the most well-established systems, Japan operates a multi-layered mandatory scheme where earthquake coverage is bundled with fire insurance, supported by the Japan Earthquake Reinsurance Company (JER) and a government guarantee [16-20]. New Zealand offers an integrated model through the Natural Hazards Commission (NHC), combining public and private sector roles, though significant challenges emerged following the Canterbury earthquakes [21]. Turkey established the Turkish Catastrophe Insurance Pool (TCIP) after the 1999 Marmara earthquake, creating a compulsory earthquake insurance program with technical and financial support from the World Bank [1].

In the United States, particularly California, the California Earthquake Authority (CEA) provides voluntary coverage through participating insurers but struggles with low take-up rates despite high seismic risk [22]. France and Spain have adopted solidarity-based models where natural disaster coverage is partially mandatory and backed by state reinsurance mechanisms (CCR in France, CCS in Spain) [2]. Chile, despite having a voluntary system, achieves relatively high penetration rates due to strict building codes and high public awareness [23]. Taiwan offers another example with its Taiwan Residential Earthquake Insurance Fund (TREIF), which operates under a framework similar to Japan's [24].

Despite the diversity of these regulatory models, no single system is flawless. Common challenges include inadequate coverage limits, delayed claims settlement, financial sustainability concerns, and public unwillingness to purchase policies [7,22]. Therefore, a systematic review of earthquake insurance regulations in several seismic-prone countries can help identify best practices, policy gaps, and transferable lessons for other earthquake-vulnerable regions, including Iran.

This paper provides a comparative review of earthquake insurance regulations in eight selected seismic-prone countries: Japan, New Zealand, Turkey, the United States (California), France, Spain, Chile, and Taiwan. The study examines each country's legal framework, institutional structure, mandatory or voluntary nature, pricing mechanisms, government role, financial backing, and post-earthquake performance. The objective is to offer a comprehensive overview that can inform policy development in other earthquake-prone countries.

2. Methodology

This study employs a qualitative comparative review methodology based on documentary analysis of existing laws, regulations, academic literature, and institutional reports. Eight countries were selected based on the following criteria:
1. High seismic hazard according to the Global Seismic Hazard Map (GSHAP)
2. Presence of an established earthquake insurance system
3. Availability of sufficient documentation in English
4. Diversity in regulatory approaches (mandatory vs. voluntary, public vs. private, etc.)

The selected countries and their primary information sources are:
Data were extracted and categorized into seven analytical dimensions: (1) legal basis, (2) institutional structure, (3) mandatory/voluntary, (4) coverage scope, (5) premium pricing, (6) government role, and (7) claims performance.

3. Results and Comparative Analysis

In this section, the earthquake insurance regulatory frameworks of eight selected seismic-prone countries Japan, New Zealand, Turkey, the United States (California), France, Spain, Chile, and Taiwan are systematically compared based on the seven analytical dimensions defined in the methodology. The comparison draws primarily from the academic and institutional sources listed in the references. Specifically, the Turkish model is analyzed based on the work of Başbuğ-Erkan and Yilmaz [1], while the relationship between seismic hazard and premium pricing is informed by Tafi et al. [2]. The voluntary system in California is reviewed using the comprehensive report by Webb [7], and the Japanese model is examined through Okumi [16] as well as the comparative analysis by Havelock [22]. The French and Spanish solidarity-based mechanisms are discussed with reference to Yanhui [4] and Tafi et al. [2], while the Chilean experience is interpreted through the multi-dimensional comparative study by Li et al. [23]. Finally, the Taiwanese mandatory fund is assessed based on the detailed legislative study documented in [24]. Where discrepancies or gaps in the literature exist, the present review integrates cross-references among the sources to provide a balanced and evidence-based comparison. Table 1 summarizes the key characteristics of each system, followed by a country-by-country qualitative analysis.

Table 1. Summary of Earthquake Insurance Systems.

Dimension	Japan	New Zealand	Turkey	USA (CA)	France	Spain	Chile	Taiwan
Legal basis	Earthquake Insurance Law (1966)	Natural Hazards Commission Act (1993, 2023)	Compulsory Earthquake Insurance Decree (2000)	California Earthquake Authority Act (1996)	Cat-Nat Law (1982)	Private Insurance Law	Building Code + Insurance Reg.	TREIF Act
Institution	JER + Govt	NHC	TCIP	CEA	CCR	CCS	Private insurers	TREIF
Mandatory?	Yes (bundled)	Semi-mandatory	Yes (residential)	Voluntary	Semi-mandatory	Semi-mandatory	Voluntary	Yes
Govt role	Reinsurer (backstop)	Primary insurer	Pool manager + int'l support	Facilitator	State reinsurer	State reinsurer	Regulator only	Fund manager
Premium basis	Zonal + construction type	Flat + value-based	Zonal + structural type	Risk-based	Single national rate	Single national rate	Market-based	Flat + value-based
Take-up rate	~70%	~95% (before 2010)	~35% (urban)	~13%	100% (bundled)	~95%	~30%	~35%
Post-quake performance	Good (2011)	Poor (2010-2011)	Moderate (2023)	Poor (1994)	Good	Good	Good	Moderate

Key Findings by Country's are as follows.

3.1. Japan: Multi-Layered Mandatory Model

The Japanese earthquake insurance system operates under a mandatory multi-layered structure in which earthquake coverage is bundled with standard fire insurance policies. This model has resulted in a relatively high penetration rate of approximately 70%, largely due to the legal requirement and public awareness. A key strength of the Japanese system is the government backstop, which acts as a reinsurer of last resort through the Japan Earthquake Reinsurance Company (JER), thereby ensuring solvency even after major seismic events. However, the system faces significant weaknesses, including considerably high premiums in high-risk zones and limited coverage for commercial properties, which often remain underinsured. The primary lesson from Japan is that bundling earthquake insurance with a commonly purchased product like fire insurance, combined with a mandatory requirement and government backing, is an effective strategy for achieving broad coverage [16], [22].

3.2. New Zealand: Integrated Public-Private Model

New Zealand's earthquake insurance framework is an integrated public-private model managed by the Natural Hazards Commission (NHC). Before the Canterbury earthquakes of 2010–2011, the system achieved an exceptionally high penetration rate of approximately 95%, demonstrating the success of its semi-mandatory approach. However, the Canterbury sequence revealed critical weaknesses, including slow claims settlement processes and chronic underfunding of the NHC relative to actual loss magnitudes. These shortcomings led to widespread dissatisfaction and legal disputes among policyholders. The key lesson from New Zealand is that even well-designed and historically successful insurance systems require regular stress testing, periodic funding reviews, and adaptive legislative updates to remain solvent and responsive after major disaster events [22].

3.3. Turkey: Compulsory Pool with World Bank Support

Following the devastating Marmara earthquake of 1999, Turkey established the Turkish Catastrophe Insurance Pool (TCIP), a compulsory earthquake insurance program developed with technical and financial support from the World Bank. A major strength of this model is its rapid post-disaster implementation and the integration of international expertise and reinsurance capacity. Nevertheless, the Turkish system suffers from low urban penetration—approximately 35%—despite its mandatory nature, largely due to public distrust, inadequate coverage limits, and weak enforcement mechanisms. The central lesson from Turkey is that mandatory legislation alone does not automatically translate into high penetration rates. Public awareness, trust in the insurance system, credible enforcement, and affordable yet adequate coverage limits are equally critical for success [1].

3.4. USA (California): Voluntary CEA Model

The California Earthquake Authority (CEA) represents a purely voluntary earthquake insurance model in one of the most seismically active regions of the United States. Its primary strengths are consumer choice and the absence of direct fiscal liability for the state government, as the CEA is funded entirely by participating insurers and policyholder premiums. However, the voluntary nature has resulted in a very low penetration rate of approximately 13%, even in high-risk zones. This situation has led to severe adverse selection, where only those who perceive themselves at highest risk purchase coverage, driving up premiums and further discouraging broader participation. The key lesson from California is that purely voluntary systems in high-risk areas are ineffective without strong financial incentives, purchase mandates, or integration with mortgage lending requirements [2, 7].

3.5. France: Solidarity-Based Cat-Nat System

France operates a solidarity-based natural disaster (Cat-Nat) insurance system in which earthquake coverage is automatically bundled with standard property insurance policies. This approach achieves universal coverage—100% of insured properties—and applies a single national premium rate without geographic discrimination between low-risk and high-risk zones. The main strength of the French model is its political acceptability and simplicity for consumers, who do not need to make separate decisions about earthquake coverage. However, the system's principal weakness is cross-subsidization, whereby policyholders in low-risk areas effectively subsidize those in high-risk areas, which may be considered actuarially unfair. The lesson from France is that solidarity models are politically viable and effective for achieving universal coverage, even if they deviate from pure risk-based pricing [2,13].

3.6. Spain: CCS Consortium Model

Spain's earthquake insurance system is managed by the Consorcio de Compensación de Seguros (CCS), a state-owned consortium that has operated continuously since 1954. The CCS provides coverage for extraordinary risks, including earthquakes, as a supplement to standard property insurance policies. A major strength of this model is its long-term stability, institutional continuity, and ability to cover multiple perils under a single administrative framework. Furthermore, the consortium has demonstrated efficient claims handling capabilities after past seismic events.

Nevertheless, a persistent weakness is low public awareness regarding the specific details and limits of CCS coverage, as many policyholders are unaware that earthquake protection is already included in their standard policies. The lesson from Spain is that a dedicated, long-standing consortium can efficiently manage extraordinary risk compensation, but continuous public communication is necessary to maintain awareness and trust [2, 13].

3.7. Chile: Voluntary but High Penetration

Chile presents a unique case among the eight reviewed countries, as it maintains a purely voluntary earthquake insurance system yet achieves a penetration rate of approximately 30%, which is the highest voluntary uptake rate globally. The primary strength of the Chilean model is that it demonstrates the feasibility of voluntary coverage without legal mandates. This success is largely attributable to two factors: first, strict and consistently enforced building codes that have reduced actual seismic risk; and second, a strong insurance culture and high public awareness of earthquake hazards. However, a clear weakness is that the system's performance relies heavily on continued regulatory rigor and public education, which may not be replicable in all contexts. The key lesson from Chile is that rigorous construction quality regulation can indirectly but powerfully support voluntary insurance uptake by reducing actual risk and building public confidence [22].

3.8. Taiwan: TREIF Mandatory Fund

Taiwan operates the Taiwan Residential Earthquake Insurance Fund (TREIF), a mandatory system modeled on the Japanese approach. The fund provides basic earthquake coverage bundled with standard fire insurance policies. A significant strength of the Taiwanese system is its very low annual premium, approximately USD 10–15 per policy, which makes earthquake insurance affordable for nearly all homeowners and has contributed to reasonable uptake rates. However, a critical weakness is the low coverage limit, currently approximately USD 35,000 per claim, which is inadequate to cover total losses in the event of a major earthquake, especially in high-value urban properties. The lesson from Taiwan is that low premiums successfully increase affordability and uptake, but coverage limits must be set at realistic levels that provide meaningful financial protection after a total loss event; otherwise, the system may deliver only symbolic rather than substantive compensation [23].

4. Discussion

The comparative analysis of earthquake insurance regulations across eight seismic-prone countries reveals several patterns regarding what works effectively and what leads to systemic failure. First, mandatory or bundled systems, as observed in Japan, France, and Taiwan, consistently achieve higher penetration rates compared to voluntary schemes. The requirement to purchase earthquake coverage either as a standalone mandate or attached to a commonly held product like fire insurance removes the problem of consumer procrastination and adverse selection. Second, government backing in various forms—whether as a reinsurer of last resort as in Japan, a pool manager as in Turkey, or a state reinsurer as in France and Spain—ensures solvency after major seismic events. Private insurers alone cannot bear the full financial burden of low-probability, high-severity catastrophes without some form of public sector support or guarantee. Third, single national premiums, implemented in France and Spain, simplify pricing structures and avoid geographic discrimination. While this approach is not actuarially fair because low-risk areas subsidize high-risk areas, it has the political advantage of universal acceptability and ease of administration. Fourth, strong and consistently enforced building codes, as demonstrated by Chile, reduce actual seismic risk and thereby encourage private insurance uptake even in a voluntary market. When buildings are constructed to withstand expected ground motions, insurers gain confidence, premiums become more affordable, and homeowners perceive insurance as a valuable rather than wasteful expense [1, 2, 7, 24].

Conversely, certain approaches have consistently failed or underperformed across different contexts. Pure voluntary systems, exemplified by the California Earthquake Authority (CEA) in the United States, suffer from very low uptake and severe adverse selection. When only high-risk individuals purchase coverage, the risk pool becomes skewed, premiums rise, and even more low-to-moderate risk individuals drop out, creating a death spiral. The CEA's penetration rate of approximately 13% despite California's well-known seismic hazard illustrates this failure clearly. Another recurrent failure mechanism is underfunded insurance pools, as observed in New Zealand prior to the Canterbury earthquakes of 2010–2011. The Natural Hazards Commission (NHC) had accumulated reserves that proved grossly inadequate for the actual losses incurred, leading to delayed claims settlement, legal disputes, and a crisis of public confidence. This experience demonstrates that even well-designed systems require regular stress testing, periodic funding reviews, and legislative updates to remain solvent. Finally, low public awareness undermines even mandatory systems, as seen in Turkey and Taiwan. In Turkey, despite the compulsory TCIP framework, urban penetration remains only around 35% due to public distrust, poor enforcement, and inadequate understanding of policy benefits. In Taiwan, the TREIF system achieves only moderate uptake because many homeowners remain unaware that earthquake coverage is already bundled with their fire insurance or misunderstand the low coverage limits [1, 7, 16, 21, 24].

The implications of these findings for other earthquake-vulnerable countries, particularly Iran, are substantial. Iran is located in one of the most seismically active regions of the world and has experienced several catastrophic earthquakes in recent decades, including the 1990 Manjil–Rudbar earthquake, the 2003 Bam earthquake, and the 2012 East Azerbaijan earthquakes. Despite this high hazard level, Iran currently lacks a comprehensive and mandatory earthquake insurance framework. Based on the international evidence reviewed in this paper, Iran could consider adopting a mandatory bundled model similar to Japan or France, wherein earthquake coverage is attached to standard fire insurance policies for residential properties. Such an approach would immediately achieve broad penetration without requiring separate consumer decisions [25-30]. Additionally, Iran could establish a state-backed catastrophe insurance pool, modeled on the Turkish Catastrophe Insurance Pool (TCIP), with initial technical and financial support from international partners such as the World Bank or regional development banks. This pool would aggregate premiums, manage reserves, and arrange reinsurance to ensure solvency after major events [31-38]. Furthermore, Iran could implement tiered premiums based on construction quality and structural type to incentivize safer building practices. Homeowners with seismically retrofitted or code-compliant buildings would pay lower premiums than those with vulnerable unreinforced masonry structures, creating a direct financial incentive for risk reduction. Public awareness campaigns, delivered through mass media, schools, and municipal offices, would be essential to build trust and explain policy benefits [39-45]. Finally, international reinsurance partnerships would allow Iran to spread its catastrophe risk globally, reducing the fiscal burden on the government and ensuring rapid claims payment after a disaster. Without such a comprehensive framework, Iranian households will remain financially exposed to seismic risk, and post-earthquake reconstruction will continue to rely on inadequate state budgets and international charity [1, 2], 7,22].

5. Conclusion

This paper reviewed earthquake insurance regulations in eight seismic-prone countries. The following conclusions are drawn:

1. No single model is universally optimal; each system reflects its country's hazard level, economic capacity, and institutional history.
2. Mandatory or bundled systems consistently achieve higher penetration than voluntary ones.
3. Government involvement (as reinsurer, pool manager, or guarantor) is essential for catastrophe risk.
4. Premium differentiation based on seismic hazard and construction type is common but may reduce uptake in high-risk zones.
5. Public awareness and trust are as important as legal mandates.
6. Regular stress testing and funding reviews (e.g., New Zealand's lesson) are necessary.
7. For countries like Iran, a mandatory bundled system with a state-backed catastrophe pool and tiered premiums based on building quality appears most suitable.

Future research should examine the interaction between building codes and insurance premiums, as well as the role of micro insurance for low-income households in seismic zones.

Term	Definition
Adverse selection	Tendency of high-risk individuals to purchase insurance more than low-risk individuals
Catastrophe pool	A collective risk-sharing mechanism for low-probability, high-severity events
CEA	California Earthquake Authority
CCR	Caisse Centrale de Réassurance (French state reinsurer)
CCS	Consorcio de Compensación de Seguros (Spanish insurance compensation consortium)
JER	Japan Earthquake Reinsurance Company
NHC	Natural Hazards Commission (New Zealand)
TCIP	Turkish Catastrophe Insurance Pool
TREIF	Taiwan Residential Earthquake Insurance Fund

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