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Heterogeneity of demand for forestry insurance: Explanations based on a comparison between France and China

Yafei Wang[1], Marielle Brunette[2], Fanny Claise[3]

Abstract

Forest insurance is a relevant tool to consider in a context of increasing natural hazard due to climate change. However, forest insurance is highly heterogeneous from one country to another, with some countries having large insured forest areas and others not. In this article, we attempt to identify the reasons for this heterogeneity. To do so, we compare the forest insurance schemes of two countries, France and China. France is characterized by a low level of insured forest area, while China is the opposite. We identify differences and similarities between the two schemes that can explain the heterogeneity in terms of insured area. In particular, we highlight the different role of the government in these schemes. Finally, we present some innovative insurance products likely to encourage insurance adoption.

Keywords: Insurance, Forestry

Highlights:

- We compared forest insurance schemes in two countries: one government-run, the other entirely market-based.
- The way forest insurance is implemented in one country can be a source of inspiration for the other.
- The two countries experiment with several innovative products that may be promising.

JEL Codes: G22 (Insurance; Insurance Companies; Actuarial Studies), **Q54** (Climate; Natural Disasters; Global Warming), **Q23** (Forestry), **Q58** (Environmental Economics: Government Policy), **O57** (Comparative Studies of Countries)

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1. Introduction

Natural hazards are the main threat for forests worldwide. According to the State of the World's Forests 2024 (SOFO, 2024) report, there's evidence that climate change is making forests more vulnerable to stressors such as wildfires and pests. Wildfire intensity and frequency are increasing, including in areas not previously affected, with fires in 2023 releasing an estimated 6,687 megatons of carbon dioxide globally. In 2021, such fires reached a new high, mainly driven by extended drought causing an increase in fire severity and fuel consumption, and accounted for nearly one-quarter of total wildfire emissions. Climate change also makes forests more vulnerable to invasive species, with insects, pests and pathogens threatening tree growth and survival. Pinewood nematodes have already caused significant damage to native pine forests in some countries in Asia, and areas of North America are projected to experience devastating damage due to insects and disease by 2027.

In Europe, the most devastating natural event is a windstorm. Damage due to various disturbances over the last 20 years accounted for a timber volume of 44 million m^3, i.e. 16% of the mean annual harvest (Patacca et al., 2023). Windstorms accounted for 46% of the total damage, fire for 24% and bark beetles for 17%. Climate change is suspected to have a serious impact on storm occurrence both in terms of frequency and intensity, so that the return period is projected to reduce significantly and the associated damage is predicted to increase (Della-Marta and Pinto, 2009; Gardiner et al., 2011; Brèteau-Amores et al., 2023). In addition, Schelhaas et al. (2010) show that forest damages from wind are expected to increase in the future mainly as a consequence of an increase in the total growing stock and in vulnerability.

In this context of increasing risks due to climate change, forest insurance against natural hazards has become a crucial risk management tool. Indeed, forests hold significant economic value, not only as resources for timber and land but as critical providers of ecosystem services that include carbon sequestration, climate change mitigation, and biodiversity conservation. However, these natural assets are increasingly vulnerable to multiple and cascading climate-related risks, threatening both economic stability for private forest owners and the continued provision of vital ecosystem services (Brunette and Hanewinkel, 2023). Forest insurance, therefore, plays a key role as a risk-sharing mechanism and a means of financing adaptation to climate change (OECD, 2015; Global Agenda Council on Climate Change, 2014; Brunette and Couture, 2023).[4] In addition, forest insurance may be seen as a tool for enhancing investment in planted forest and is a means of stabilizing forest owners' income (Zhang and Stenegr, 2014). By taking out an insurance policy, forest owners can transfer the risk of natural hazards to an insurer in exchange for a premium. Yet forest insurance coverage varies considerably from country to country, highlighting the diversity of approaches to natural hazard management worldwide. Zhang and Stenger (2014) reported that some countries have large part of forest area covered by insurance, as for example Finland with 40%, Denmark 50%, China 50%, New-Zealand 55% and Sweden with 95% whereas in other countries the proportion is much lower like in Japan, France or United States, where it is less than 10%. The authors highlight differences in forestry practices between these countries, with planted forests being easier to insure in Scandinavia than

[4] Forest insurance generally takes two forms: third-party liability coverage, which protects forest owners from damages their trees may cause to third parties, and damage insurance, which covers losses to the forest itself as a result of events such as fires or storms. In this article, we use the term “forest insurance” to refer to the insurance of forest damage against natural hazards.

natural forests because their well-defined location, species composition and age reduce transaction costs for the insurer.

Faced with this situation, increasing natural events in a context of climate change and heterogeneity in terms of insurance coverage among countries, it seems legitimate to question the determinants of the insurance coverage. A first step in this direction is to identify the descriptive elements that explain why forest insurance is widely adopted in some countries, while not in others. These descriptive elements may stem from the country's forestry context, the way forest insurance was implemented and developed, the contracts offered, etc. This is precisely the aim of this article.

In the literature, forest insurance is analyzed for a long time with the first article published by Kaul (1928) on fire insurance in the US (Brunette and Couture, 2023). Forest insurance has recently received attention through a literature review. Brunette and Couture (2023) provide an overview of the literature on this topic. They conclude that an article on forest insurance has a high probability to identify some determinants of insurance demand and that it deals with fire risk in the US or storm risk in Europe. An interesting point is that the methodologies used to identify determinants of insurance demand are various from theoretical model (actuarial model, insurance economics model, forest economics and cost-benefit analysis and risk models and spatialization) to empirical analysis (experimental economics, surveys, descriptive analyses/reports/reviews). Importantly, some articles present insurance schemes like Angström (1982) with Sweden, Hillayova et al. (2021) with Slovakia or Yatagai (1933) with Japan. However, to our knowledge, there is no comparison on insurance schemes between countries aiming to underline drivers of insurance coverage.

In this article, we deal with the determinants of the insurance coverage but with an original approach that we can classify in "descriptive analyses" following the categorization of Brunette and Couture (2023). Specifically, the study proposes a comparative analysis of two distinct forest insurance schemes: those of France and China. For each country, we describe the context in terms of forest management, natural hazards and insurance schemes. It allows us to highlight the difference between the two countries but also the similarities.

We focus on these two countries for several reasons. First, most of the recent literature in forest insurance come from France (Brunette et al., 2013; Brunette et al., 2020; Loisel et al., 2020) and China (Dai et al., 2015; Qin et al., 2016; Ma et al., 2019; Feng and Dai, 2019) suggesting that the stakes are high in both countries on this issue. Second, 2024 marks the 60th anniversary of the establishment of diplomatic ties between China and France. In the framework of this anniversary, the two countries proposed strengthening cooperation in the field of nature and forest and in this context, we would like to think that each country could be an inspiration to the other in terms of forestry risk management.[5] Finally, we want two contrasted countries in terms of insurance adoption, which is the case since in France with approximately 9% of the forest area that is insured (Adrast, 2022) whereas

[5] In 2015, China and France worked together to promote the Paris Agreement at the United Nations Climate Change Conference in Paris (The Guardian, 2015; UNFCCC, 2018). Both of the two have shown a positive willingness to jointly respond to global challenges. Since 2018 the two countries proposed strengthening cooperation in the field of nature protection three times during their meetings with the two heads of state (China's National Forestry and Grassland Administration, 2024; Ministry of Foreign Affairs of the People's Republic of China, 2024). China and France issued Beijing Call for Biodiversity Conservation and Climate Change in November 2019 to cooperate in protecting biodiversity and addressing climate change (Maison Elysée, 2019).

in China it is more than 70%, but exposed to natural hazards of the same nature (wildfire, storms and pathogens) and with a high forest surface.

The remainder of our paper is structured as follows. We first describe the forestry context in each country (Section 2) followed by the insurance schemes (Section 3). In Section 4, we provide a comparison of the countries highlighting the differences and similarities. Finally, we discuss the implications of our findings for the insurance market and provide public policy recommendations aimed at enhancing the effectiveness and resilience of forest insurance frameworks in both countries, as well as addressing the limitations of our work and avenues for future research.

2. Description of the forestry context in China and France

2.1. Forestry context in China

In recent decades, China has become the country with the fastest and largest growth in forest resources globally. According to the State of the World's Forests of FAO in 2024, China led the world with the maximum forest area gain of 1,937,000 hectares annually between 2010 and 2020. China's forest area ranks fifth in the world, which reached 231 million hectares by 2022 (National Greening Commission Committee Office, 2023). The forest coverage rate has continued to increase from 12% in 1981 to 25% by the end of 2023[6] (National Greening Committee Office, 2025). The area of artificial forests has reached 86 million hectares, ranking first in the world for many years, accounting for over one-third of the total forest area. China has a vast territory with diverse geographical and climatic conditions that created a wide variety of habitats for different vegetation types. There are more than 2,000 species of arbor trees in total. Meanwhile, the differences in geomorphology and climatology have resulted in an uneven distribution of forests over the country. China's coniferous forests (49.8% of the total forest area) are slightly more than broad-leaved forests (47.2%). Among broadleaf species, oak (*Quercus*) is the most common species in China (16,56 million hectares, account for 9.2%), followed by birch (*Betula*), poplar (*Populus*), Eucalypt (*Eucalyptus*) and other evergreen and deciduous trees. For coniferous forests, primary species including larch (*Larch gmelinii*) and spruce (*Picea asperata*) are widely distributed in the mountains of Northeast, North, Northwest and Southwest China. Yunnan pine (*Pinus yunnanensis*), mainly located in the hilly areas of southwest China, and Chinese arborvitae (*Platycladus orientalis*) widespread throughout the country. Chinese fir (*Cunninghamia lanceolata*) and Chinese red pine (*Pinus massoniana*), situated in south-central and southeast China, are the main tree species used in plantation forests.

China began to implement forest classification management in the 1990s. Based on the needs of ecological protection, the state designated forests that are important in forest ecological location or fragile in ecological condition and whose main purpose is to exert ecological benefits as non-commercial forests. This means that in non-commercial forests, there is no harvesting and no timber production value. The others are commercial forests which can be used for timber production. Currently, 57% of China's forest area is non-commercial forests and 43% is commercial forests.
Another key point is the ownership of Chinese forest. Quite different from Europe, the land ownership and the forest ownership are separated in China. Since all land belongs to the state and the collective, the forest ownership by individuals is equal to use-right. Which means that China doesn't have real

[6] https://www.gov.cn/lianbo/bumen/202503/content_7013112.htm

private forests. But the government began to encourage the transfer of forest contracting rights and management rights since 2008 by strengthening collective forest tenure reform. Enterprises and forest farmers have obtained more contracted management rights to make the forest economy vibrant. By 2023, nearly 300,000 new forest management entities, such as family forest enterprises, large professional households and forest cooperatives have been established nationwide after the implementation of the reform (National Forestry and Grassland Administration of China, 2023).

China is severely affected by natural hazards. Forest fires and especially biological hazards are the major threats to the forests. Based on the affected forest area and the number of casualties, forest fires are classified into four categories in China: general Forest Fire (affected area < 1 hectare), Large Forest Fire (1–100 hectares), Major Forest Fire (100–1,000 hectares), Extremely Severe Forest Fire (> 1,000 hectares). After more than 30 years of working to prevent and control forest fires, China's forest fire frequency and area burned both decreased as indicated in Figure 1. But in 2006, a total of 8,170 forest fires occurred, including 5 extremely severe forest fires (China Statistical Yearbook, 2007). Three of these extremely severe forest fires occurred in May and were all caused by lightning. Due to dry conditions at the fire sites and strong winds, the flames spread rapidly, resulting in severe damage to forest areas.

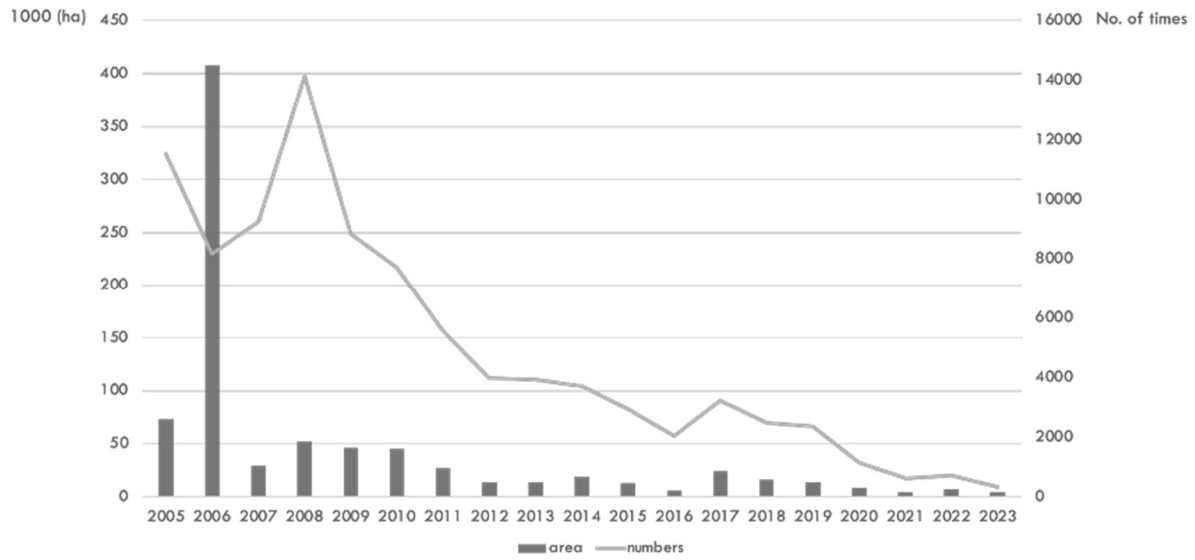

Figure 1: Area of burnt forest and times of forest fires in China between 2005 and 2023

Source: China Statistical Yearbook 2006-2024

However, the economic losses caused by forest biological hazards are 1,000 times greater than those caused by forest fires in China. Massive plantation of pine monoculture is probably one explanation of the increase in damage caused by biological hazards. The main biological agents causing damage to China's forests include pathogens, insects, rodents (rabbits) and harmful plants as shown in Figure 2. The areas affected by these problems are significant. Also, the proportion of moderate and severe forest catastrophes has increased. The State Forestry and Grassland Administration has issued forecasts for many years since the 21st century, indicating that forest biological disasters will remain on the heavy grade in the coming year. Since 2007, the annual occurrence of forest biological hazards in China has been over 11.7 million ha, accounting for 50.69% of the total area of forestry hazards, which is dozens of times the area of forest fires, and has resulted in losses of more than 110 billion yuan per year on average (National Forestry and Grassland Administration of China, 2022). In addition,

the pinewood nematode (*Bursaphelenchus xylophilus*) and the Fall Webworm (*Hyphantria cunea*) cause the most severe forest biological hazards in the country. Pinewood nematode was first introduced to China in 1982. In 2023 the disease caused by pinewood nematode affected an area of 1.22 million hectares and resulted in the death of 7.6 million pine trees (China Biological Disaster Prevention and Control Bulletin, 2024).

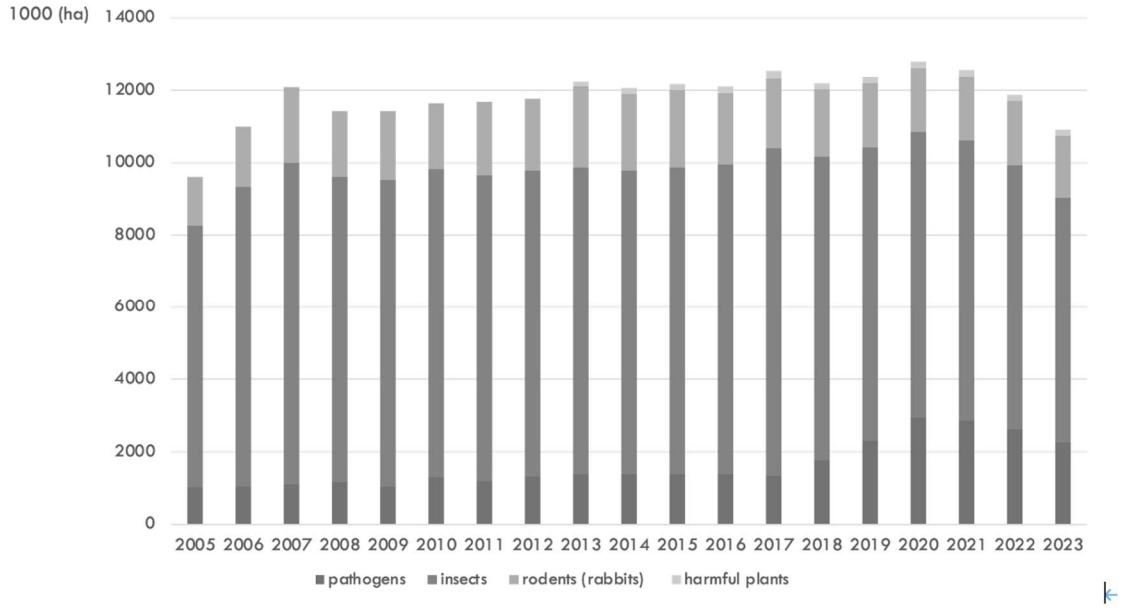

Figure 2: The damaged forest area by biological disasters in China between 2005 and 2023
Source: China Statistical Yearbook 2006-2024 (No statistics on harmful plants from 2005 to 2012)

2.2. Forestry context in France

France has one of the most significant forest resources in Europe, ranking as the continent's largest broadleaved forest and holding the third-largest timber stock in Europe, following Germany and Sweden. In terms of overall forest area, France is the fourth largest forested country in Europe, after Sweden, Finland, and Spain (CNPF, 2021). These rankings underscore the importance of French forests both as a valuable economic resource and as a major contributor to Europe's ecological landscape.

French forests cover approximately 17 million hectares, accounting for nearly 31% of the metropolitan territory, of which at least 2.1 million hectares planted and 80% with conifers (IGN, 2017). French forests are diverse, shaped by various climates, landscapes, and soil types, resulting in a wide variety of tree species and forest ecosystems. French forests are predominantly broadleaf (around 67%), while coniferous species make up about 21% of the total forest area. Among broadleaf species, oak is the most common (representing around 40% of broadleaf forests), followed by beech, chestnut, and other deciduous trees. For coniferous forests, primary species include maritime pine in the southwest (notably in the Landes region) and fir and spruce in mountainous areas (such as the Vosges and Alps). Mixed oak and beech forests are primarily located in central and northern France, coniferous species dominate the mountainous regions, while the Landes forest, the largest man-made forest in Europe, is predominantly covered with maritime pines (IGN, 2024).

An important characteristic of French forest is that it is mainly privately owned. Indeed, in France, approximately 75% of the forest area is owned by private forest owners, with 3.8 million owners,

including 200,000 who own more than 10 ha (representing 68% of the total area). In France, forest ownership is rarely an individual's main activity. According to Agreste (2014), in France, the main socio-professional categories of private forest owners are: retired, farmer, employee, liberal profession, intermediate profession, senior manager, etc. This means that many forest owners do not make a living from their forestry income and are therefore less inclined to guarantee this "secondary" income through insurance. Public forests, owned by the State (10%) or local authorities (16%), are managed by the Office National des Forêt (MASA, 2020). This means that the natural hazards management is mainly at the scale of the private forest property.

Metropolitan France accounts for 14% of the very serious natural events recorded in Europe between 1900 and early 2022 (Chiffres clés des risques naturels, 2023). The natural hazards affecting French forests are similar to those affecting European forests: windstorm, fire and biological hazards.

Storms pose a significant threat to French forests. The occurrence of storms generates huge losses. For example, Lothar and Martin in 1999 are responsible for 140 Mm3 of damage in France amounting to 4.57 billion euros (Caurla et al., 2015). More recently, in 2009, Klaus was associated with a total of 42 Mm3 of damage in south-western France for a loss estimated between 1.34-1.77 billion euros (Lecocq et al., 2009).

Fire was also very damaging for French forests. On average, 26 400 ha of forest burnt each year in France (period 1976-2022). The areas burnt and the number of fires starting vary greatly from year to year as indicated in Figure 3. The years 1989, 1991 and 2003 stand out, with more than 70,000 hectares burnt. More recently, the year 2022 was particularly affected, with 62,000 ha of forest and 10,000 ha of other vegetation burnt. The South-West zone was particularly hard hit, with more than 36,000 ha burnt in 2,653 fires. Among these, the Landiras (Gironde) fires, which occurred in July and August, burnt almost 20,000 ha. The fire in La Teste-de-Buch (Gironde) destroyed almost 6,000 ha and required the evacuation of 22,000 people, 6,000 of whom were in the 5 campsites, 90% of which were destroyed.

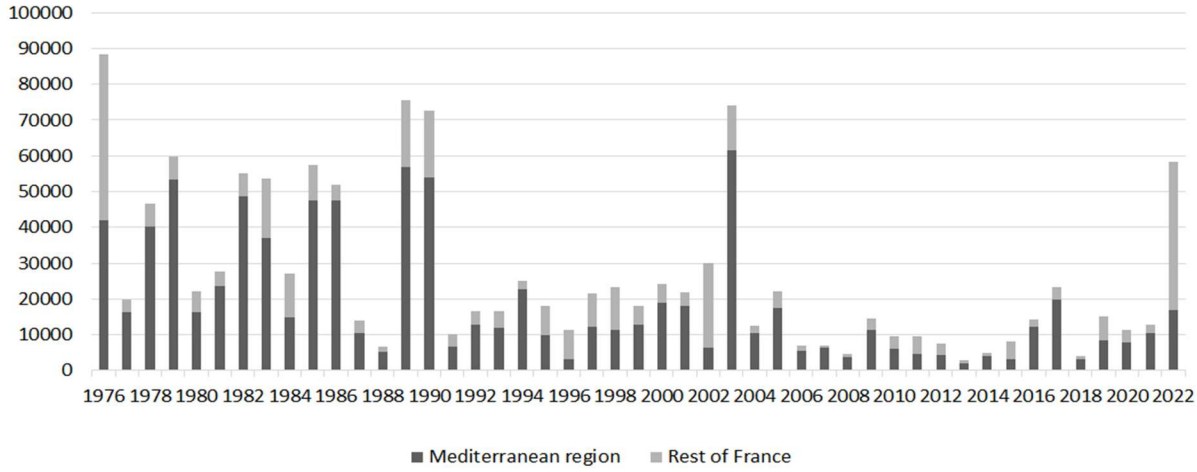

Figure 3: Area of forest burnt each year in mainland France between 1976 and 2022

Source: https://www.statistiques.developpement-durable.gouv.fr/chiffres-cles-des-risques-naturels-edition-2023

Biological hazards often appear when the forest is vulnerable, meaning, most of the time, that it has already been hit by a natural event. For example, bark beetle infestations were observed after the 1999 storms in France, especially on maritime pine in the Landes region and Norway spruce in the Northeast of France (Nageleisen, 2001). In the same way, a major infestation occurred after the storm

in 2009. Indeed, the bark beetle attack increased the total wood loss by approximately 7 Mm3, of which 4 Mm3 was greenwood from standing trees (Caurla et al., 2015). After the wildfires in 2022 in the south-west of France, bark beetles also appeared and considerably increased the total timber damage in the following years, as indicated in Figure 5 where damage increased for the year 2024. More generally, Figure 4 lets appear that the trend is increasing concerning the rate of weighted plots with at least one dead tree due to biological hazard in France for the period 1989 to 2024. France, as other European countries, suffers from an unprecedented outbreak of bark beetles (Washaya et al., 2024). Other pathogens were also responsible for important damages like the chalarosis of the ash tree or the pinewood nematodes.

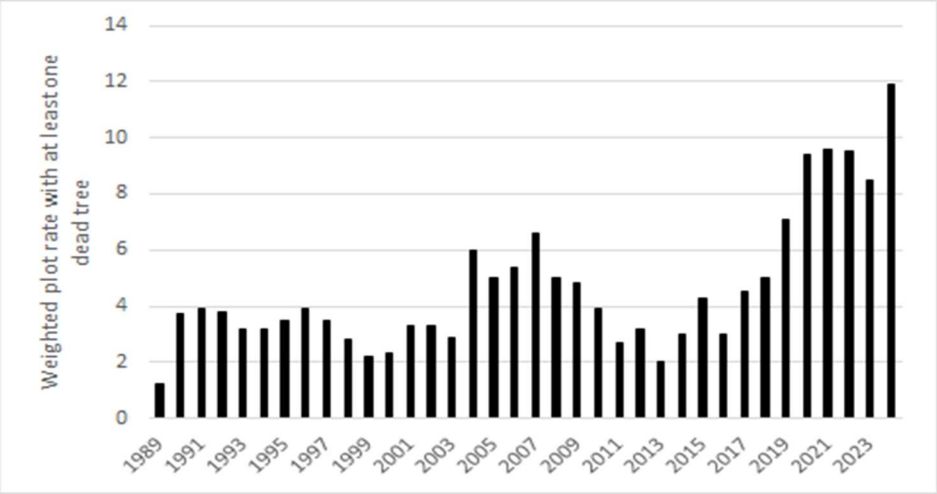

Figure 4: Weighted plot rate with at least one dead tree due to biological hazard in France for the period 1989 to 2024

Source: Forest Health Department, France

3. Forest insurance in China and France

Before describing the forest insurance scheme in each country, we would like to give some important knowledge in terms of insurance economics to make it easier to understand.

3.1 Some knowledge from insurance economics

The first insurance economics model was provided by Mossin (1968). The idea is simple: an individual will take an insurance contract as soon as her satisfaction level (called utility) is equal or higher with the contract than without the contract. The contract is characterized by two variables: the premium, paid by the individuals at each period of time, and the indemnity, paid by the insurer only in case of disaster occurrence. Figure 5 describes precisely how the insurance premium is computed.

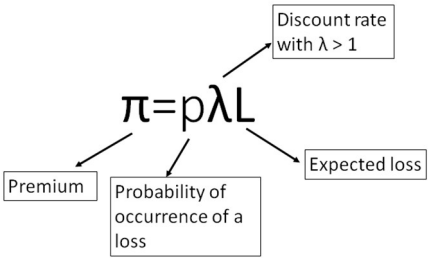

Figure 5: Computation of the insurance premium

The premium is thus the product of the probability of occurrence of a loss, the discount rate and the expected loss amount. The discount rate is specific to each insurer and is used to cover the costs associated with the contracts. Let's take a very simple example. For an annual probability of fire of 0.2% (variable *p*) as considered in Brunette et al. (2013), a discount rate of 30% (variable *λ*) and an expected loss of €2000/ha, the insurance premium is €12/ha.

Sometimes, the insurance contract covers the real loss or a part of the real loss, and then the insurer has to evaluate *ex ante* the value of this potential loss. Sometimes the contract covers only the replantation costs and, in that case, the owner chooses the indemnity that s/he wants to receive in case of disaster occurrence. It is a lump sum payment. This means that for the computation of the premium as presented in Figure 5, the indemnity chosen replaces the "expected loss".

It is easy to understand that lots of variables from the forestry context presented above can impact the premium computation. For example, the probability of occurrence of a loss depends on the forest stand location (i.e. higher probability of occurrence of fire in the south of France than in the north) and on the hazard covered (higher premium for higher number of hazards covered) whereas the expected loss depends on the tree species (some species have a higher value than other, for example broadleaved have a higher value than coniferous) and the stand age (the higher the age is, the higher the potential loss will be).

With this basic knowledge, we can now describe in greater detail the insurance scheme in each country.

3.2. Insurance scheme in China

3.2.1. Development of forest insurance in China

In 1981, in order to strengthen forest resource management and reduce losses from forest disasters, the Ministry of Forestry of China (now the State Forestry and Grassland Administration) and the People's Insurance Company of China jointly launched a forest insurance research project. In 1983, the two sides completed the "Research Report on Forest Insurance Issues in my country". In the same year, the People's Insurance Company of China drafted China's first "Forest Insurance Clauses", which made preliminary provisions on the coverage, actuarial rate calculation, and loss compensation of forest insurance business (Qin et al., 2022). In 1984, the government of China began piloting forest insur (Qin et al., 2016). Guilin, a southwestern city in Guangxi Province, became the first Chinese pilot site of forest insurance. Guangxi is a prominent forestry province. In 1984, the People's Insurance

Company of China (PICC) provided forest fire insurance for collective fir forests as a trial (Qin et al., 2022). Following the reform of the collective forest rights system, which began with exploratory initiatives in southern China in 2003, the majority of forest farmers, as forest owners and operators, have paid more attention to the preservation of forest assets. Due to slow development, only 2% of China's total forest area had been insured by the end of 2008.

Nevertheless, the reform of the collective forest rights was extended to the entire country in 2008. This created a need for insurance in the forest sector and led to the rapid development and establishment of forest insurance mechanisms in China. Then the government initiated the trial of the Forest Insurance Premium Subsidy Policy (CFIP) in 2009. This policy has enabled China's forestry insurance industry to make considerable progress. Although this method is called a "subsidy," it does not provide financial compensation to forest farmers after they purchase insurance. Instead, the government provides funds directly to insurance companies to encourage them to reduce premiums so that forest farmers can purchase forest insurance at a lower price. Furthermore, it is an important financial supporting measure to promote the reform of the collective forest rights system. By the end of 2022, the trial had expanded to 28 provinces, and the insured area represents 71.1% of Chinese forest area (National Forestry and Grasslands Administration, National Financial Regulatory Administration in China, 2023), that is 30 times more compared to 2008.

In China, insured ecological forest area is much larger than commercial forest. This can be explained by (i) the higher subsidy for ecological forests (almost above 95% of the insurance premium) than for commercial forests (around 70% of the insurance premium); (ii) the higher proportion of ecological forests than the commercial one (57% of China's forest area is non-commercial forests and 43% is commercial forests).

Figure 6 provides a synthesis of this evolution of forest insurance in China.

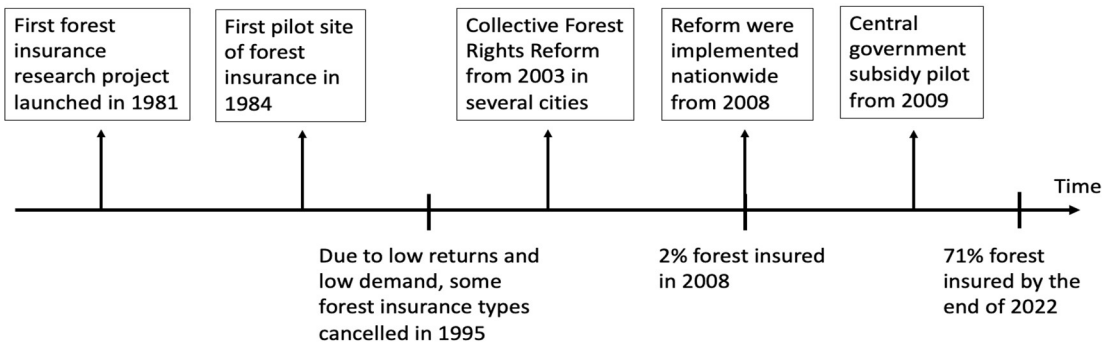

Figure 6: Development of forest insurance in China

3.2.2. Insurance companies

At present, there are 29 agencies in China's forest insurance market that carry out forest insurance business. In terms of insured area, PICC Property and Casualty Insurance, which ranks first in recent years, has an insured area of 71.6 million hectares in 2022, accounting for 43.54% of the industry's

insured area (The Development Report on Forest Insurance in China, National Forestry and Grasslands Administration, 2023). The following rankings are China Life Property & Casualty Insurance, China Pacific Insurance Company, China Insurance, China Ping An Property Insurance and Groupama SDIG Property Insurance. Groupama SDIG Property Insurance is jointly held by Shudao Investment Group Co., Ltd. and Groupama Assurances Mutuelles with 50% equity each. It is the only joint venture insurance company in China that operates policy-based agricultural insurance business. In 2022, forest insurance premiums reached 3.83 billion yuan, the highest in recent years. In 2022 the amount of compensation was 1.1 billion yuan (National Forestry and Grasslands Administration, National Financial Regulatory Administration in China, 2023).

The simple claims ratio of forest insurance is the percentage of the compensation amount to the premium. It is one of the important indicators for insurance claims accounting. Except for the fluctuation of 31.45% in 2019, the simple claims ratio of forest insurance has dropped from 36.06% in 2016 to 20.99% in 2021, showing an overall downward trend; from 2017 to 2021, the total claims ratio of commercial forest insurance has always been higher than that of public ecological forest insurance.

In China, the premium rates are lacking of differences in the sense that they are not based on classical actuarial methods considering the level of risk, site conditions, tree species, and age. The forest owners received a payment to replant. The current premium rates are still simply based on the administrative divisions. This is because public ecological forests are managed according to the jurisdiction of land and forest rights. County-level forestry departments and county-level insurance companies verify the information of forest land and forest right owners, collect the insurance willingness on the premise of voluntary participation of forest right owners, and organize forest farmers to purchase insurance uniformly. Therefore, local governments will form an insurance operation agency selection team composed of finance, forestry, agriculture, emergency management departments to complete the selection of forest insurance through public bidding. The insurance premium rate offered by the winning insurance agency will become the unified rate for that administrative area. For commercial forests, insurance is provided in various forms. State forest enterprises, forest enterprises, forest cooperatives and large plantation households with large areas under management can be insured separately; plantation households with smaller areas can participate in insurance jointly with the township or village.

As the compensation covers only the replanting fees, it is often considered as too low. In 2020, the average insured-amount nationwide per hectare for ecological forest was less than 1200 euros, and for commercial forests, it was 1400 euros, which were not able to meet the actual needs of the clients. For commercial forestry operators whose business purpose is timber production, this only compensates for the cost of replanting to a certain extent, and that cannot make up for all the economic losses of forest farmers who cannot harvest timber due to disasters. That will reduce the purchasing desire and make it hard for insurance companies to expand their market. For example, the current insurance coverage for commercial forests in Guangxi Province is 1,250 yuan per mu (€2400/ha). However, the actual investment period for afforestation of major tree species such as eucalyptus, fir and pine is usually three years, and the cost in the first year reaches about 900 yuan per mu (€1700/ha). For other rare tree species, the planting cost is about 2,500 yuan per mu (€4700/ha) (Guangxi Forestry Bureau, 2023).

3.3. Insurance scheme in France

3.3.1. Development of forest insurance in France

The first forest insurance contract appeared in France in 1947 under the impetus of the "Mutuelle Indépendante des Sylviculteurs du Sud-Ouest" (MISSO) to cover against fire events in the south-west part of France. This MISSO will come later "Groupama MISSO", and now "Groupama forêts assurance", the main French insurer. The first hazard covered was then the fire. Concerning the storms, those of 1982, 1984, 1987 and 1990 were compensated under the Cat Nat system. This is a public fund that compensates for the losses due to catastrophic events. The storm Herta of February 1990, which mowed down 100 Mm3 of wood in northern France, the Benelux countries and southern Germany was the last to be treated as a natural disaster and compensated by the Cat Nat system.[7] To preserve the accounts of the Cat Nat system, the French legislator excluded the effects of wind on forests, considering them as "insurable". The only means to be compensated in case of a storm is then to take out an insurance contract. Private insurance already exists in France to insure fire and storm. Private forest is regarded as property by insurers, so that the contracts offered by insurers are "damage" insurance contracts. These contracts are governed by articles 121 and following of the Insurance Code.

The next major storms of December 1999 (Lothar and Martin) were devastating, especially for the Aquitaine region (south-west France) and the Vosges region (north-east France), the first two French regions in terms of timber production. At the time of the storms, less than 0.5% of forest owners were insured against fire and storms and this represents 700,000 ha (i.e. 7% of French private forest), including around 150,000 ha insured against fire with very limited storm cover.

Before the storms of 1999, the private forest owners in France can insure their forests with two companies: Groupama and L'Equité. These two insurers accounted for over 90% of the market, with the remainder split between a number of other insurers (AXA, AGF, Mutuelle du Mans). The impact of these storms on insurers' accounts has been all the greater because their reinsurance has shown its limits, with reinsurers bearing 55% of the bill, compared with 70% for the storms of 1990. Of the 20 billion francs to be borne by insurers, Groupama paid out 1.2 billion francs for 1999 for 560,000 recorded claims (after reinsurance and reversal of provisions). In parallel, the French government implemented a 91.5 million euros annual compensation for 10 years in order to facilitate the harvesting of the blown down timber, the clearing of destroyed stands, the storage of harvested timber, and reforestation. The compensation covered roughly 20% of the damage (Brunette and Couture, 2008).

After the storms' occurrence, Groupama and L'Equité increased their insurance premium by almost 300%, and divided the guarantees (by a factor of 4 for Groupama). At the same time, the Forestry Orientation Act of 9 July 2001 removes the link between fire and storms. As a result, insurers are no longer obliged to include storm cover in their fire policies. This decoupling allows insurers to offer fire and storm cover alone. This Act also implemented the tax incentive scheme for forestry investment (i.e., DEFI for ''Dispositif d'encouragement fiscal à l'investissement") that provides a reduction in income tax for taxpayers resident in France who invest in forestry. These tax credits are grouped together under the "DEFI forêt" scheme, and apply to the acquisition of woodland, forestry

[7] https://groupama-forets.com/qui-somme-nous/70-ans-dhistoire/

work and the purchase of insurance for plots of woodland. Such a tax incentive scheme should encourage insurance adoption.

The last major storm in France was Klaus in December 2009. This storm mainly impacted the south-western part of France already impacted by the previous storms of 1990 and 1999. The damages were huge and the government implemented a compensation plan of 138.5 million euros (Caurla et al., 2025). Such a plan doesn't encourage forest owners to insure since they received financial compensation without having to pay a premium in exchange (Brunette and Couture, 2008; Brunette et al., 2013). Consequently, this storm generated legislative changes. Indeed, under the Agricultural Modernisation Act (Loi No. 2010-874, 2010), the French Government decided that from January 2017, public assistance will be provided only to the private forest owners that are insured. The end of public aid after 2017 prompted the French Forest Owners Association “Fransylva” to negotiate with a private insurance company to insure timber. The latest insurance offer appeared: Sylvassur. As this offer was initiated by the French Forest Owners Association, it is expected to meet the expectations and needs of forest owners. Its appearance should therefore increase demand for insurance from private owners.

In 2022, France was hit by severe wildfires with more than 60,000 hectares burnt. These fires did not modify the forest insurance scheme directly, but had consequences in terms of prevention. Indeed, the “wildfire law” of 10 July 2023 aimed at reinforcing the prevention and fight against the intensification and extension of the fire risk. The text makes forest fire protection plans compulsory in at-risk departments, reinforces the legal obligations to clear undergrowth to reduce the risk of fires starting and to protect people, and forest owners are encouraged to take out insurance and build up precautionary savings to cover fire damage. The government wants forest owners to insure their holdings more and better against the risks of storms and fire. To this end, the French government has introduced a number of obligations that will enable private forest owners to obtain the tax credit of the “DEFI Forêt” scheme, including providing proof that their plots of land are properly insured against the risk of storms and fires. The owners must therefore provide an insurance certificate specifying the hectares covered for the current tax year. To further encourage forest owners to insure their plots of woodland, the tax credit is 76% of eligible storm and fire insurance contributions, up to a ceiling of €15/ha (CNPF, 2023). An increase in forest insurance demand is then expected.

To summarize the French situation, we can say that the drivers of the changes in the forest insurance offered in France are the occurrence of major natural hazards, mainly three storms in 1990, 1999 and 2009, and the wildfires of summer 2022. We propose to represent this historical evolution chronologically as in Figure 7:

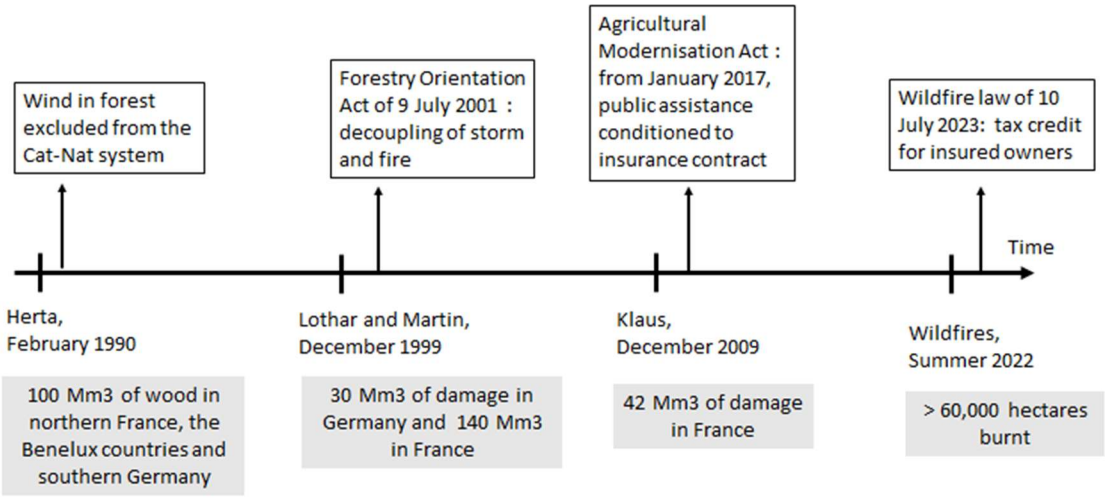

Figure 7: Development of forest insurance in France

In conclusion, we can say that all the conditions are in place for forestry insurance to work in France: increasing natural risks, public subsidies conditional on taking out an insurance policy, tax incentives via the "DEFI forêt" scheme... and yet demand doesn't seem to be increasing. The question is, why not? Perhaps the answer lies in the insurance offer.

3.3.2. Insurance companies

In France, several insurance companies have developed tailored solutions for forest owners to protect against natural hazards. Among the leading players in this niche market are Groupama (through "Groupama Forêts Assurances" or GFA)[8], Pacifica-XLB[9], and Sylvassur[10]. This section outlines the main features of the insurance products offered by these companies, comparing contract's features like coverage options, type of risks, or deductible levels.

One key difference lies in the coverage of storm-related damages (wind, hail, and the effects of snow). Groupama Forêts Assurances allows forest owners to insure against fire alone but does not permit storm coverage as a standalone option. This is similar to Sylvassur, whereas Pacifica-XLB is the only provider that offers standalone storm insurance.

Another important aspect is the calculation of insurance premiums. As explained in section 3.1 with Figure 6, the insurance premium depends on three parameters: the probability of occurrence of the damage, the expected loss and the discount rate. These parameters depend on factors such as the age of the forest stand, the tree species, and its geographical location. While location is formally accounted for in the contracts, in practice, premium variations are structured around three main regions: the southwest, the Mediterranean, and the rest of France. Some companies offer lump sum payments for replantation (avoiding then to estimate the expected loss) whereas others compensate

[8] https://groupama-forets.com/

[9] Pacifica is a subsidiary of Crédit Agricole Assurances, in partnership with XLB. https://www.assuranceforet.com/nos-assurances/

[10] https://sylvassur.com/

also for the loss of timber value. This last option often requires a customized contract with a precise estimate of the value of the stand.

Each insurer also offers unique features and specific conditions within their policies. For example, Groupama Forêts Assurances and Sylvassur allow forest owners to choose whether to insure all or only part of their forested property, but Pacifica-XLB doesn't allow it. Intervention thresholds, deductible structures, and compensation levels also vary. These differences reflect insurers' different approaches to tailoring their policies to the specific needs of forest owners, as well as the challenges posed by different regional risks.

4. Comparison of Chinese and French insurance mechanisms

In this article, we selected two countries with large forested areas and varied areas in terms of insurance with a large insured area in China and a small one in France. Aside from certain non-insurance-related differences, such as the massive plantations realized in China whereas in France regeneration is favored, the existence of commercial/ecological forests in China (and not in France), or the fact that ownership is not really “private” in China, whereas it is for the most part in France, certain differences specific to forest insurance appeared that we will highlight now. We categorize them as characteristics of the insurance contract, public support and insurance market as presented in Table 1. We present this table in detail.

The insurance contracts provided in China and France have some differences that impact premium and/or indemnity.

First, in China the contract is “unique” in the sense that it is the same for all forest owners at the scale of the administrative division (taking the difference between commercial and non-commercial forests into account). This means that in an administrative division, all the forest owners pay the same premium and receive the same indemnity in case of hazard occurrence. This is partly explained by the fact that indemnities paid covered only replantation costs. In France, the computation of the premium is influenced by various variables acting on the probability of the occurrence of a loss (variable *p* in Figure 5) and/or on the expected loss (variable *L* in Figure 5): the age of the stand that impacts the expected loss, its location that impacts the probability of occurrence of a loss and the species composition affecting both. This means that in France each contract is different from the others. In addition, it can cover the replantation cost and/or the production loss. This introduced complexity and required more time to establish the relevant insurance contract associated with a forest property. This also means that the administrative cost to the insurer associated with each insurance contract is high.

Second, the hazards insured are different. Fire is insured in both countries and is among the major threats for both countries in terms of damage. Storm is also insured in each country. However, other hazards may be insured in China and not in France, especially biological hazards like forestry pests and diseases.

The consequence of these differences in terms of characteristics of the contract is that insurance premiums are very different in each country. In China it is €2.7/ha for commercial forest and €3.7/ha for non-commercial forests whereas in France, it ranges between €5/ha and €6.5/ha.

Public support plays a role in each country by providing financial compensation to encourage the adoption of insurance contracts. However, the type of public help is different and takes the form of tax incentives in France and premium subsidy in China. Recall that the Chinese subsidy system is original in that the subsidy is perceived by the insurer and the forest farmer pays the premium net of the subsidy.

Finally, the resulting insurance market is different in the two countries. As mentioned in the previous section, the French forestry insurance market has evolved in line with the occurrence of large-scale natural events, which is not the case in China. General insurance companies are present in both countries. However, in France, we also have forest insurance contracts proposed by an insurance company associated with a brokerage company (Pacifica - XLB), and a partnership between the Fransylva federation and a brokerage company (Sylvassur). In China, the forest insurance market is well-developed and competitive with 29 insurance companies. In France, the market is very small with only three insurers sharing the market, i.e. a high degree of concentration. In France, the market share is the smallest for the last insurer that came into the market, Sylvassur both in terms of insured area and number of signed contracts. In China, the six main forest insurers represent more than 80% of the market share. Note that Groupama is an insurance company that is present in both countries.

	China	**France**
Insurance contract		
Difference in terms of tree species	No	Yes
Age / enhancement of the forest stand	No	Yes
Difference in terms of degree of risk exposure (location)	No	Yes
Replantation cost	Yes	Yes
Production loss	No	Yes
Carbon/biodiversity loss	Yes in non-commercial forests	No
Hazards covered	- Fire -Comprehensive Insurance: Fire, drought, storm, snowstorm, windstorm, typhoon, flood, landslide, mudslide, hailstones, frost, forestry pests and diseases, wild animals	- Storm - Fire - Storm and fire
Cost per hectare (premium)	- Non-commercial forests: €2.7/ha (National average) - Commercial forests: €3.7/ha (National average)	Range from €5/ha to €6.5/ha (Holecy and Hanewinkel, 2006)
Public support		
Public support	Premium subsidy level： - Non-commercial forests: 95% (National average) - Commercial forests: 74% (National average)	DEFI: tax incentive scheme for forestry investment, tax credits

Insurance market		
Type of insurance company	General insurance company Joint venture insurance company: Shudao Investment Group Co., Ltd. and Groupama Assurances Mutuelles with 50% equity each.	- General insurance company - Insurance company associated with a brokerage company - Partnership between the Fransylva federation and a brokerage company
Concentration	29 companies (2022)	3 main insurance companies
Market share	In terms of insured area (2022): - PICC P&C 43.5%, - China Life 11.8%, - CPIC 9.8%, - China Insurance 9.7%, - China Ping An Property Insurance 6.6% - Groupama SDIG Property Insurance 6.3%	In terms of signed contracts: - Pacifica - XLB: 53% - Groupama Forêts Assurances: 30% - Sylvassur: 17% In terms of insured area: - Groupama Forêts Assurances: 45% - Pacifica - XLB: 35% - Sylvassur: 15%

Table 1: Summary table of differences between insurance schemes in France and China

5. Discussion

5.1 Insurance issues in China and France

The issue, both in France and China, is currently to increase the insured forest area to raise the resilience of the forest sector in face of climate change and also to encourage planted forests in China. The potential barriers/brakes come from both sides of the insurance market. Relevant ideas to try to improve the situation in each country may be taken in the practices of the other country.

Indeed, in France, the low coverage rate may be explained by problems coming from the supply side of the market but also from the demand side.

Concerning the supply side, as already indicated in Table 1, the market is very concentrated with few competition leading to traditional problems in economics: few incentives to innovate, higher price level, etc. The low take-up rate (9% of private area insured) suggests very limited mutualization, and potentially higher premiums due to less risk diversification. This may pose a problem of anti-selection (Dionne and Doherty, 1992): only the most at-risk forest owners take insurance contracts, which raises premiums and further limits adoption. The low uptake in France creates a vicious circle: few forest owners take out insurance, implying a poorly distributed risk and higher premiums, which means there is no incentive to adopt. In addition, the proposed contracts cover only two types of hazards, and insure only replantation costs and timber loss (no other ecosystem services).

From the demand side, the explanations may be multiple. First, French forests are mainly held for leisure purposes (Thomas et al., 2022), so owners do not want to commit money to insurance. In addition, the average surface area in France is very small, at 8.8 hectares for 3.5 million owners, meaning that owners of small areas do not see the point of taking out insurance. This fragmentation

of forest ownership in France presents significant challenges for the development and uptake of forest insurance. Indeed, many small owners consider forest insurance unnecessary or unprofitable, given the limited value of their properties relative to the cost of premiums.

Finally, the compensation plans implemented by the French government after windstorms Lothar and Martin in 1999 (€915 million) and Klaus in 2009 (€138.5 million) clearly appeared as "public insurance" and discourage private forest owners to pay for private insurance (Brunette and Couture, 2008; Brunette et al., 2013). It is the classical "charity hazard" as defined by Browne and Hoyt (2000): "the tendency of an individual at risk not to procure insurance or other risk financing as a result of a reliance on expected charity from others such as friends, family, community, non-profit organizations, or a government emergency program".

In China, several problems come from the supply side such as the fact that the insurance premium rate is uniform by administrative division and by forest type. Chinese insurers propose a more mutualized pricing model, which allows for greater adoption but introduces a moral hazard problem (high-risk owners pay the same price as low-risk ones). This can also contribute to adverse selection in the forest insurance market. Adverse selection occurs when insurers are unable to differentiate premiums according to individual risk characteristics, resulting in disproportionate participation by high-risk forest owners, whereas low-risk owners choose not to insure. This can be problematic for the financial viability of the insurance pool, as payouts can exceed premiums collected. Introducing heterogeneity by location, tree species and forest age may encourage forest owners to adopt contracts. In this way, insurers could attract a larger, more balanced group of forest owners, reducing adverse selection and improving market efficiency. In the same way, it appears that the compensation amount is not enough to fully compensate the losses of forestry operators. Covering the production loss in addition to the replantation cost may be a good option. In line with that, another idea is to promote the gradual transformation of forest insurance from a "cost insurance" model to a "value insurance" and "income insurance" model.

On the demand side, Chinese forest owners appear to be unaware of forest insurance, poorly informed and therefore do not understand the importance of insuring their forest (Qin et al., 2016). In addition, the income from forestry is often not sufficient and the premium charged by the insurance companies may be perceived as too high (Wan et al., 2012). Qin et al. (2016) indicated that increasing the income level of Chinese forest owners is the fundamental path to enhance forest insurance demands.

Something common to forest owners in lots of countries is the lack of information available to them on the subjects of the impact of climate change on natural hazards in forest generally, as obtained by Lidskog and Sjodin (2014) in Sweden. However, it seems that more and more the forest owners are aware of the impact of climate change (Sousa-Silva et al., 2016; Thomas et al. 2022) and ready to act, so that we can expect an increase in insurance adoption in the future. Another information going in the same direction, is the fact that private forest owners are found to be risk averse (Musshoff and Maart-Noelck, 2014; Sauter et al., 2016a; Sauter et al., 2016b; Brunette et al., 2017) and from a theoretical point of view, a risk averse economic agent should insure (Mossin, 1968).

In this context, we can see that each country has already done lots of efforts to develop traditional forest insurance with not much success, especially in France. This observation, let us think that innovative insurance products may be necessary to try to increase the forest area insured in each

country. This observation is in line with Fuhrer et al. (2006), who recommend implementing adaptive management strategies and developing new forest insurance products as climate change risks increase.

5.2 Innovative insurance products

The two countries experiment with several innovative products that may be promising. We present some of them using the three categories identified in Table 1.

Insurance contract

On one hand, the two countries share the idea to insure something different than "replantation cost" and/or "production loss", and they innovate on that point. Indeed, in the context of climate change, when it comes to forests, there is a growing interest in the ecological functions of forests, such as carbon storage and biodiversity conservation, and wood production is becoming secondary.

In China, it is possible to insure forest carbon sink (Qin et al., 2022; He and Ren, 2023), or to insure biodiversity loss through an insurance contract. The insurance of carbon sinks has been a topic in forestry for a long time (Manley and Watt, 2009) but few countries currently propose it and China is one of them. Carbon sink insurance represents a promising innovation in forest insurance, offering financial protection for carbon sequestration (Chiti et al., 2024). By insuring the value of carbon sinks, forest owners and project leaders can protect their investments in carbon compensation initiatives. In addition, insuring carbon sinks aligns with global climate objectives, with the aim of achieving carbon neutrality under international agreements such as the Paris Agreement. This type of insurance also encourages sustainable forest management practices, such as species diversification and fire prevention, which not only protect carbon storage, but also enhance forest resilience and biodiversity. The insurance of biodiversity loss is less developed and more confidential, but already in place in China. Indeed, in July 2023, the PICC Ningbo Branch signed China's first forest biodiversity insurance policy with the Government of Longguan Township, Haishu District, Ningbo City. Haishu District, a national ecological civilization demonstration area, has a forest coverage rate of 49.8% and 2,232 species recorded in the area. The insurance is based on the Nature-based Solutions (NbS) principle, with forest resources, rare species, wildlife, water sources, vegetation and human-animal conflicts in the insured geographical area as insured subjects. If, during the policy period, risks such as natural disasters, accidents, invasion of alien species and attacks by wild animals on humans occur in the area, also difficulties for living creatures to survive reproduce, vegetation destroyed and needs of protection and treatment for the relevant ecosystems, the PICC Insurance Ningbo Branch will provide a total of 2 million yuan of coverage for the necessary and reasonable protection and rescue costs to treat and repair the insured objects and improve the ecosystem.[11] A few months later, in February 2024, the region suffered from a cold wave, which resulted in significant tree lodging and forest damage due to the combination of ice and snow. After investigation, PICC determined that 100,000 yuan would be used for forest repair and ecological protection work in the affected area, aiming to conserve local biodiversity.[12]

In France, to our knowledge, Groupama has begun experimenting with insurance policies specifically designed to cover plantation failures. At this end, Groupama Forêts Assurances has joined

[11] http://www.haishu.gov.cn/art/2023/8/4/art_1229829112_59019170.html
[12] http://www.haishu.gov.cn/art/2024/3/8/art_1229100495_58993606.html

forces with “Stock CO2”, an intermediary between the “Label Bas Carbone” and the forest owners, to propose an insurance contract protecting plantations against drought, in addition to storm, fire, frozen and hail.[13] This development is all the more relevant as forest plantations are becoming increasingly popular, due to efforts to reforest and improve carbon sequestration. However, plantation failure, caused by factors such as drought and pests, represents a significant risk for forest owners. Indeed, as indicated by Brèteau-Amores et al. (2023), the seedling stage is known to be the most vulnerable phase in the life cycle of a forest stand since the young plants may be subject to various stresses including abiotic (e.g., frost, hail, high temperatures, drought); biotic (attacks by insects and fungi, which are often specific to very young trees, tree competition, grazing); or anthropogenic (inappropriate soil work, preparation or storage of seedlings, planting or other silvicultural operations). For example, in France, the dry summers of 2018, 2019, and 2020 are responsible for important damage to the forests and decreased planting success (Boutte, 2021). Almost 89% of the plants died due to abiotic causes of which 60% perished due to drought (Boutte, 2021). Recognising this emerging threat, this insurance product aims to mitigate the financial losses associated with plantation failure. It can be used to finance the replanting and work required in the event of a hazard. Such an insurance product may be very relevant in China where the plantation area is quite large. In addition, Groupama is already present on the Chinese forest insurance market.

On the other hand, the innovation may simply concern the type of insurance contract mobilized.

Another innovative approach to consider is the implementation of co-insurance mechanisms in forest insurance, where several insurers collaborate to share the risk associated with large-scale natural hazards. This allows a better mutualization of the risks. Given the increasing scale and frequency of climate-related risks, joint coverage of these risks by two or three insurers could be an interesting approach to strengthening the insurance system. This model is already practiced in China, where insurers share the burden of large payouts, reducing individual exposure while ensuring adequate compensation for policyholders. These contracts first appeared in China's agricultural sector and have since been extended to forestry insurance. The introduction of co-insurance in France could offer similar advantages. By spreading risks between several insurers, this approach could help to stabilise the market, reduce financial pressure on insurance companies and make forest insurance more sustainable in the long term.

Other innovative products that had not been experienced may be to use index insurance. The principles of index insurance based on meteorological indices were initiated by Halcrow (1948) and further developed by Dandekar (1977). This type of insurance was initially proposed in agriculture. It is used in France for some agricultural risks but not yet for forestry hazards even if, from a scientific perspective, it has already been envisaged to cope with drought (Brèteau-Amores et al., 2020). Index insurance for carbon sinks exists in China. Index insurance works by linking payments to predefined indices, such as rainfall levels, wind speed or temperature thresholds, rather than to the assessment of actual damage. This approach would eliminate the need for on-site damage assessment, reducing administrative costs and enabling forest owners to be compensated more quickly. The potential benefits of index insurance for forestry are considerable. Firstly, it is a more transparent and predictable system, as payments are triggered automatically when the index reaches a certain threshold. Secondly, it reduces moral hazard and adverse selection since payments are based on observable and objective indicators. Finally, it could make forest insurance more accessible and

[13] https://groupama-forets.com/app/uploads/2025/01/NEWSLETTER-GFA-JANVIER-2025.pdf

affordable by reducing insurers' operating costs, which could translate into lower premiums for forest owners. However, implementing index insurance in the forestry sector would require a number of challenges to be overcome. For example, accurate and reliable indices need to be developed to reflect the risks faced by forests, such as fires, storms or droughts. This means that the availability of high-quality meteorological and satellite data is crucial if such products are to be designed and implemented effectively. Another challenge lies in attribution, i.e. being able to establish the causal link between the observed damage and the occurrence of a precise natural event.

Public support

This category mainly deals with the government support for forestry insurance. Currently, in France, the public support is granted directly to the forest owners (demand side of the market), in the form of tax incentives. In China, the subsidy is directly perceived by the insurer allowing the forest farmers to pay the net insurance premium. The way public support is implemented in China is in line with some studies in the literature suggesting that a more efficient approach would be to allocate these supports directly to insurance companies (supply side of the market), especially for the subsidies (Song and Peng, 2019; Loisel et al., 2020). By subsidising insurers, the government reduces administrative complexity and encourages insurance companies to develop more competitive and accessible products for forest owners. This approach also encourages insurers to expand their coverage and invests in risk management innovations, ultimately increasing the uptake of forest insurance. From the demand side, the forest owners will pay directly the net insurance premium (premium minus the public support), and not receive the public support several months later. Such a way to allocate subsidies improves the overall efficiency of the insurance system. Note that such a direct subsidy to the insurance company is currently in place in Spain on the agricultural insurance market where the farmers pay the insurer the net insurance premium (premium minus the subsidy). The Spanish agricultural insurance market is currently an example of success for lots of other European countries like France, whose last reform was clearly inspired from Spain (Koenig and Brunette, 2022).

The consequences are that, for France, the way public support is granted in China may be inspiring. Indeed, rather than (or in complement with) tax incentives, we can imagine the French government subsidizing the forest insurance premium (as already done for agricultural insurance in the context of the Common Agricultural Policy). In addition, the subsidy may be transferred directly to the insurer to increase the efficiency of the public support.

Insurance market

In China, agricultural insurance and forest insurance are linked and correspond to only one insurance market, whereas in France these two markets operate separately. Most of China's forest managers are also farmers, and they are increasing their economic income by adopting the agroforestry integrated management model. In 2009, the Chinese government issued guidance required all localities to integrate forest insurance with the overall arrangement of agricultural insurance.[14] Therefore, many insurance companies in China provide both agricultural and forestry insurance. We can imagine linking them also in France since more than one third (34%) of the private forest owners representing more than one third of the private forest area (36%) declared as socio-professional

[14] In 2009, the People's Bank of China, the Chinese Ministry of Finance, the China Banking Regulatory Commission, the China Insurance Regulatory Commission and the State Forestry Administration jointly issued the Guiding Opinions on the Reform of the Collective Forest Rights System and Financial Services for Forestry Development https://www.gov.cn/jrzg/2009-05/26/content_1325324.htm

category “farmer” (Agreste, 2014). This dual status suggests that many forest owners are also farmers, and that a combined insurance product could rationalise cover, reduce costs and provide a better response to the risks faced by these actors.

6. Conclusion

This article presents the forest insurance scheme of two countries, France and China. We compare them in order to highlight differences and similarities between the two countries that can explain the low level of insurance adoption in France. We focus on both sides of the insurance market. We also present innovative insurance products that can improve the risk transfer on this market.
The description of the insurance schemes in both countries show that forest is considered differently in both countries with the existence of “commercial” and “non-commercial” forests in China whereas in France the forest is assumed to be multi-functional. In addition, the forest is mostly private in France whereas the notion of forest property is just catching on in China. Beyond these differences, not directly linked to forest insurance, we observe similarities and differences in direct link with insurance and related to insurance contract (type of coverage, hazards covered, etc.), premium (level and public support) and market (insurance companies, market share). Finally, we provide some “innovation” that may allow to increase the adoption of forest insurance contracts in both countries but also more globally. These innovations also deal with insurance contracts (the loss covered, the type of contract), public support (the way it is provided) and market (linking agriculture and forest).

Several perspectives can be envisaged. First, in this article, we focus on two countries whereas a multi-countries comparison may be relevant. However, the knowledge of the forest insurance scheme in a country is not so easy to apprehend and succeeding to have a precise description of this scheme in France and China is a small victory in itself. Something that may be interesting is to conduct such a comparison between two countries having small levels of forest insurance like France and Germany, or at the opposite, two countries with high levels of insurance like the northern ones (Sweden, Norway, Finland, Denmark). Second, as indicated in the article, Groupama is an insurance company that is present both in France and China. A comparison of the forest insurance contracts offered by Groupama in these two countries may be very interesting. In the same way, having access to real forest insurance data can considerably improve this comparison. However, information related to forest insurance is quite difficult to obtain.

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