

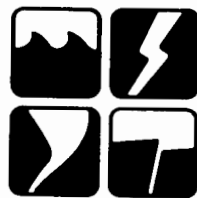
Natural Hazard Research

NOTES ON
INSURANCE AGAINST LOSS FROM NATURAL HAZARDS

by

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PREFACE

This paper is one in a series on research in progress in the field of human adjustments to natural hazards. It is intended that these papers will be used as working documents by the group of scholars directly involved in hazard research as well as inform a larger circle of interested persons. The series is now being supported mainly from funds granted by the U.S. National Science Foundation to the University of Colorado, Clark University and the University of Toronto.

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NOTES ON
INSURANCE AGAINST LOSS FROM NATURAL HAZARDS

Insurance and Natural Hazards*

A recurrent theme in natural hazards research has been how people prepare for hazards in nature. One such adjustment is to purchase insurance to cover the possibility of economic losses. We can ask several questions of the use of insurance. How does insurance help protect people against natural hazards? Who are the people who buy insurance against natural hazards, and where do they live? Do people use insurance in planning for the possibility of death by purchasing life insurance? If so, are life insurance statistics indicative of the amount of money spent on insuring against natural hazards or, more generally, of the propensity to insure?

Function of Insurance¹

How does insurance help people deal with natural hazards? The primary function of insurance is distributing the cost of certain types of economic losses suffered by an unlucky few to many who share the same risks. A loss which might severely tax the individual farmer or property owner is recovered without much trouble by sharing the cost among others who face similar risks. This function is beneficial as

*I wish to give credit to Kenneth E. Boulding, whose suggestion prompted this study. Thanks also go to Tapan Mukerjee who gave assistance in the early stages of the project, to Donald G. Friedman, who read and commented on an early draft, and to Don Miller for his work on graphic material. I am grateful most of all for the patient guidance and encouragement of Gilbert F. White.

it reduces economic uncertainty and, in the case of loss, assures rapid recovery to prevent disruption of a society.

Insurance does not work directly to reduce direct losses from hazards, but rather to assure recovery in time of loss and thereby to reduce the indirect losses resulting from individual or social disruption.

Insurance accepts the fact that losses will occur, and an insurance program can function smoothly without giving much attention to the job of reducing losses. Indeed, it has been the stated policy of certain marine insurance institutions to pay no attention to the problems of loss prevention. They have, on the other hand, pointed out that the higher the level of premiums, based on the loss experience, the higher potential for underwriting profit.² Fortunately, this position is not popular, and most institutions recognize their interest in reducing the potential for loss among their policy holders.

An interest in reducing fire losses and offering lower insurance rates, along with a need to calculate as accurately as possible the risks in fire insurance, led to the formation in the United States and Canada of Underwriter's Laboratories. The purposes of Underwriter's Laboratories are to investigate and scientifically test building materials and other products to determine whether they meet all safety requirements with respect to fire prevention and fire protection.³

Underwriter's Laboratories does not test materials and products for their resistance to specific natural hazards, however, their work in controlling the quality of construction materials may have contributed to the reduction of damage from natural hazards. There

is no similar organization that specifically tests materials for their resistance to natural hazards.

Insurance systems in other countries are also concerned with loss prevention. Rommel claims that the insurance systems of the Soviet Bloc set aside portions of the profits for loss prevention as well as for reserves.⁴ He reports that the Soviet Union contributes fifteen percent of profits towards loss prevention but he makes no mention of how loss prevention is carried out.

The cost of operating such a system which shares losses due to hazards is considerable. When figuring the total cost of hazards to society, the cost of insurance must be added in.⁵ A system of insurance which operates with a loss ratio of 50%, pays out in indemnities only half of what it collects in premiums, which essentially doubles the cost of direct losses for which indemnity is paid.

Direct losses from natural hazards, such as property damage, crop damage, personal injury or loss of life, can be covered by property insurance, crop insurance, accident or health insurance, and life insurance respectively. Some indirect losses from natural hazards may also be insured. Business disruption insurance and employment insurance guard against unforeseeable business interruption and loss of income. While each of these types of insurance work to reduce stress in times of loss this paper will deal mainly with insurance against direct damage to property and agricultural production from natural causes.

Hazards Covered

The principle of insurance can be applied to cover the risks

of a wide variety of natural hazards. Table I lists natural hazards for which insurance may be purchased in at least one country. The list is indicative of the variety of hazards covered and should not be considered exhaustive.

TABLE I

NATURAL HAZARDS COVERED BY INSURANCE

Affecting Property and Agricultural Production

1. Water: Thunderstorm, flood, tide.
2. Rock Movements: Falling rocks, earthquakes, volcanic eruption, earth and rock avalanche, earth depression.
3. Storms: Hurricane, cyclone, tornado, foehn, rain, hail, and snowstorm.
4. Hailstones.
5. Snow avalanche and snow pressure.
6. Fire, lightning.

Affecting Agricultural Production

7. Dryness, drought.
8. Wetness.
9. Cold, frost.
10. Insects
11. Parasites.
12. Diseases.

Source: Curt Rommel, "International Elemental Hazard Insurance," in International Insurance, e. by Hardy F. Glass (New York: International Insurance Monitor, 1960), p. 47.

Insurance may be applied to hazards of atmospheric origin or geologic origin. Those hazards for which water is the primary damaging element are inland flooding and tidal or coastal flooding. Hazards in which wind is the chief element are cyclone, tornado, foehn or chinook.

It should be apparent that for most hazards in the atmosphere, wind combines with some form of precipitation to cause damage. We can class thunderstorms, hailstorms, and snowstorms accordingly. The damage from a hurricane is also delivered through a combination of wind and water conditions. Storms may be responsible for lightning and lightning-caused fire. Hazards primarily of a tectonic origin are earthquakes, volcanic eruption, landslides, and landslip. Snow avalanches are a result of a combination of atmospheric and geologic factors.

One extreme event may be responsible for triggering one or more other events. Earthquakes are often responsible for setting fires, causing tsunamis, touching off landslides, and causing dam-burst floods. The indirect effects may cause more serious damage than the initial event itself. The fact that hazards often occur in combination can make insurance adjusting a difficult task, especially if one hazard is covered and another is not. Policies are not unusual which cover against wind damage, but exclude water damage. It becomes the job of the adjuster to determine the cause of damage.

Insurance is available for extremes in weather conditions which might damage agricultural production. The destruction of crops by insects, pests, and diseases may also be insured.

Where Can People Buy Natural Hazards Insurance?

A search of insurance literature tells us something of the distribution of property and agricultural insurance against natural hazards in the United States and other parts of the world. The next few paragraphs list nations known to have some form of natural hazards insurance. Undoubtedly, there are other nations, not reported, which

have insurance against natural hazards, but no data were found. Statistics for life insurance, property insurance, and social insurance written in a country are generally available, but figures which might represent the investment in natural hazards insurance are not presented as such. The variety of insurance systems and the variety of hazards covered make meaningful statistical information difficult to obtain. In spite of the lack of statistical data, we can list the countries known to have some insurance against natural hazards.

In Europe crop-hail insurance is available in all nations.⁶ Coverage against property damage from natural hazards is also available in most of Europe, though the hazards covered vary from country to country. All-risk property insurance is available in Norway and Switzerland and is compulsory in Yugoslavia, Spain, and countries of the Soviet Bloc. The Soviet countries also have a form of compulsory crop insurance.⁷

In North America property insurance covers various natural hazards. Windstorm, hail, and earthquake may be insured by extended coverage to the fire insurance policy in Canada and the United States. Flood insurance has recently been made available on a widespread basis in the United States. Canada, the United States and Mexico have crop insurance.

In South America, the specific coverages differ from country to country. Property insurance coverage can be purchased in Brazil for "extreme hazards" such as windstorm, hail, smoke, and falling aircraft, but damages from volcanic eruptions or earthquakes are excluded.⁸ In Venezuela the standard fire and lightning policy can be endorsed to cover earthquake.⁹ In Chile fire insurance follows the British

form which excludes fire following such perils as war, strike, explosion, windstorm, volcanic eruption, and earthquake.¹⁰ These exclusions may be eliminated by endorsement, but it is not certain whether direct damage from these hazards may be covered.

The standard conditions of insurance policies in Argentina are based on the French system. The basic fire policy does not insure against earthquake, hurricane, and other atmospheric disturbances.¹¹ Wells does not report whether these exclusions may be lifted by extended coverage.

For Africa we are unable to offer an accurate report on the distribution of natural hazards insurance. Wells does mention extended coverage property insurance in the Union of South Africa against earthquake, landslip and subsidence.¹² Supple mentions operations of the Royal Exchange Assurance in Egypt, West Africa and East Africa, but makes no reference to natural hazard coverage.¹³

In southern Asia, Supple mentions premium income of the Royal Exchange Assurance from India, Burma and Malaya, but again, with no suggestion of natural hazards covered.¹⁴ Neither does Sharma discuss the types of natural hazards covered in India.¹⁵ Ceylon has a system of all-risk coverage for growing rice.¹⁶

Forms of Property Insurance

Single Hazard, Combined Hazards or All Hazards¹⁷

Insurance against property damage from natural hazards falls into three forms. There is insurance written against one hazard, such as flood. This type of insurance is the simplest form. Success with operation of a single hazard insurance system usually leads to the additional coverage of other related hazards.

Combining hazards under one policy is less expensive than offering separate policies for each hazard. A large part of the natural hazards property insurance written is of the combined type. Extended coverage is added to the basic fire insurance policy and may cover a number of hazards both social and natural. In the United States the usual natural hazard coverages added are windstorm and hail, earthquake, but not flood. The hazards covered are carefully specified. In addition to the convenience of one policy, combining coverages gives insurance companies additional strength by further spreading their risks.

A third form of natural hazards insurance is all-risk. This form is basically different from single or combined hazard insurance as the rates are set by evaluating the total risk from all natural hazards in a place. All-risk natural hazards insurance is available in New Zealand, Norway, Switzerland, the Soviet Union, Poland, Yugoslavia, Spain and Great Britain.¹⁸

In all the countries mentioned, except Switzerland, the government played an important role in establishing the coverage. Because catastrophe risks in all-risk insurance tend to be heavy and the loss experience unpredictable, private companies find the market unappealing. As Rommel

points out, the only private companies offering all-risk insurance are in Switzerland.¹⁹ Elsewhere, the all-risk insurance programs are governmental enterprises, which are not out to make a profit, but rather operate on the principle of mutual service.

The insurance industry and the federal government of the United States have shown interest in providing insurance against all natural hazards. In 1956 the Senate Committee on Banking and Currency completed its staff study, Federal Disaster Insurance.²⁰ The study reviewed the current availability of insurance against a number of disasters, both natural and man-made, and past and pending legislation to deal with disaster insurance. While not ignoring other hazards, the study focused heavily on the problems of flood insurance, a coverage not, at that time, available in the United States. Continuing interest in managing flood losses led to the introduction of a joint private industry-federal government flood insurance program. The addition of flood coverage leaves no major natural hazard without some type of property insurance, however incomplete. As all hazards are not covered under one insurance system, the natural hazards insurance in the United States cannot be termed all-risk.

Compulsory Insurance

In some nations all-risk insurance against elemental hazards is compulsory, presumably to assure spread of risk. Compulsory insurance eliminates the need for sales operations, a step that reduces operating expenses. A danger exists with a system of compulsory insurance, however, especially if premium rates do not correspond to the risk accepted. A program of blanket compulsory flood insurance is discussed in Insurance and Other Programs for Financial Assistance to Flood Victims.²¹ Using

estimates of average annual flood damage for the United States, flat flood insurance premiums for all dwellings were calculated at about 5 cents per \$100. of insured value. The study recognizes that such a levy on all dwellings would provide enough revenue to reimburse those suffering flood losses. It is easy to see the inequity of such a system. Moreover, it would have the effect of lifting all existing restraints on the use of the nation's flood plains, as the expense of loss would be transferred from the person choosing to occupy the hazardous zone to society in general. In a short time this would encourage further occupancy of the areas threatened by flood.

In addition to compulsory systems of property insurance operating in the communist countries, Spain and New Zealand have compulsory all-risk insurance programs, both of which grew out of war damage indemnity funds.

The major insured hazards to property in the United States are windstorm, flood, and earthquake. For this reason, attention is given to these hazards and the systems of insurance which have been developed to handle them in the United States. The problem of a consolidation of coverages into an all-risk scheme follows.

Windstorm Insurance in the United States

From an insurance point of view, damage from windstorm is a fairly safe risk to cover. Every property owner is exposed to windstorm risk, and some damage can be expected every year. Since 1938 in the United States, windstorm insurance has been included in the extended coverage package offered to property owners holding fire insurance.²² First introduced in the midwest tornado belt, the extended coverage

endorsement has spread to all parts of the United States and is now generally required by financial institutions granting mortgages.

Rates for extended coverage property insurance are based primarily on the windstorm hazard, and vary with it from state to state and sometimes within the state (see figure 1). Rates are high along the southern and eastern coastlines, as they reflect a high hurricane hazard. Rates are also high in the continental interior where damage from tornado activity is frequent. The low rate for California is a reflection of the low wind and hail hazard. California is spared the destruction wrought by hurricanes and tornadoes.

Heavily concentrated losses pose a problem to insurance companies, as they must maintain enough reserves to settle claims. Generally the insurance industry has worked to find solutions to rating problems in high hazard areas such as adjusted rates and deductible clauses.

A good example of the adjustment of premium rates to meet the risk of a high hazard zone is offered by the experience in the Florida Keys, an area of high hurricane hazard. After extensive research of hurricane experience, a rate for extended coverage has been developed which is double the standard rate for Florida, and includes a \$500 deductible.²³ Property owners who choose to live in this area of high hazard are required to carry a substantial burden of the losses themselves through the higher premium and the deductible.

Such adjustments to premium rates are made on the basis of loss experience accumulated from year to year. The average annual loss for a certain area is figured from the previous years' experience to estimate the expected losses of the following. These methods are well known

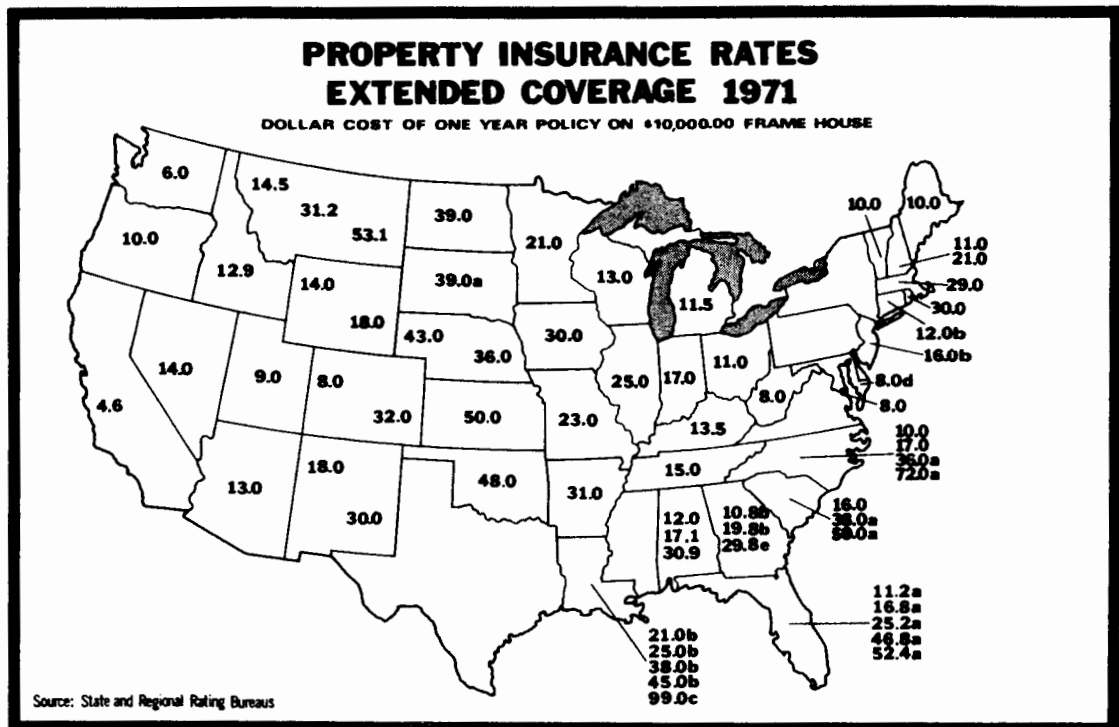


FIG. 1

More than one rate for each state implies different zones of hazard severity. The zones may be divided as regions within the state such as in Colorado, which has an eastern and a western zone. The zones may also be figured in relation to coastal proximity which affects the severity of the hurricane hazard, as in New Hampshire, Georgia, Florida, and other states.

Deductibles-- all rates for \$500.00 except as noted:

- a. \$50.00, all perils except windstorm and hail. Wind and hail is \$100.00, or in some areas optional 1%, 2%, or 5%.
- b. \$100.00, all perils.
- c. \$250.00, windstorm and hail.
- d. Mandatory 1% of amount of insurance.
- e. \$100.00, all perils except windstorm and hail which is optional 1% or 2%.

to the insurance industry and are particularly suited to any peril which causes frequent damage.

Flood Insurance in the United States

Early experience with offering flood insurance in the United States led the insurance industry to maintain that private flood insurance is an impossible coverage on the basis of normal insurance procedures. A Cairo, Illinois company began offering flood insurance in 1897, but because of concentrated losses, closed down the operation within two years.²⁴ Another experiment with flood insurance in the United States seemed to be on sounder footing. A group of insurance companies, which numbered about thirty by 1926, began a private system of flood insurance, but heavy losses in 1927 and 1928 and the lack of sufficient reinsurance arrangements caused the companies to withdraw their coverage.²⁵

The flood hazard is selective of its victims, restricting its toll only to property lying in a flood plain or along the seacoast. It is estimated that less than ten percent of all dwellings in the United States are exposed to any flood hazard at all, and as few as two percent can expect to suffer more than half of the total average annual flood damage.²⁶ As only those who own property in these narrow zones would be interested in flood insurance, adverse selection has been a strong deterrent to the adoption of a workable insurance system. High concentration of losses, often catastrophic in extent, would require companies to build extensive reserves, which are likely to be taxed as excess profits.

A workable system of flood insurance has been the goal of the federal government for some time. In 1956 the Federal Flood Insurance Act

was passed. The program was never initiated, however, as the House of Representatives failed to appropriate the necessary funds. Among the reasons was the lack of a suitable means of setting actuarial rates which differ according to the degree of flood hazard.

After severe hurricane damage in 1965 the Congress directed the Department of Housing and Urban Development to conduct a study to include an assessment of the feasibility of setting actuarial rates for flood insurance. In the report the hydrologic approach to setting rates is suggested.²⁷ The hydrologic approach is based upon flood magnitude-frequency and depth-damage relationships. An average annual flood damage is computed from which insurance premiums are determined.

In 1968 Congress passed the National Flood Insurance Act, Title XIII of the National Housing and Urban Development Act of 1968. The program provides subsidized rates of \$0.40 per hundred dollars of value insured for up to \$17,500 of the value of an existing dwelling and \$0.50 per hundred for the contents valued up to \$5,000. For buildings and contents of value greater than these figures, the program is committed to insure up to an equal amount at actuarially derived rates. A dwelling then may be insured for \$35,000 and the contents for another \$10,000, with the premiums only partially subsidized. Each community applying for flood insurance must be studied on a zone-by-zone basis to determine the actuarial rates. In parts of Fairbanks, Alaska, one of the first communities studied, the actuarial rates were as high as \$46. per hundred dollars of insured value.²⁸ No property owner would buy more than the subsidized insurance. Such a high value suggests that loss is inevitable, and that such property is a poor insurance

risk. The subsidized insurance, available for property already lying in a flood hazard area is intended as a partial substitute for Small Business Administration disaster relief loans.

Under the Disaster Relief Act of 1970 the Small Business Administration and the Farmers Home Administration are authorized to make low interest loans, and to offer partial forgiveness on existing loans for disaster losses, "to the extent such loss or damage is not compensated for by insurance or otherwise."²⁹

Insurance at subsidized rates is not available for new structures, structures substantially improved, or structures which have suffered substantial flood damage. Owners of such property may purchase insurance only at the actuarial rates.

Such financial considerations are expected to give the uneconomic flood plain occupant an impetus to move to safer ground. The Small Business Administration will also assist with long term, low interest relocation loans. Furthermore, the National Flood Insurance Act authorizes the Secretary of the Department of Housing and Urban Development to purchase insured property in a flood hazard area for the purpose of bringing the property under sound land use management.³⁰

In addition to these measures which are designed to reduce costly occupancy of flood plains, the Act states that the flood insurance program will be made available only to communities which agree to adopt and enforce sound flood plain land use controls. Presently, communities with interim insurance have been given until December, 1971 to comply. As of January, 1971 only three of the 412 communities with interim insurance had satisfied the federal requirements for flood

plain management.³¹ Compliance with the federal stipulations can be expected as local communities begin to implement flood plain zoning.

To avoid duplication of benefits from flood insurance and federal disaster relief programs, loans for the reconstruction of flood damaged structures will not be made in communities which have flood insurance available. Emergency relief such as evacuation, temporary housing, food and medical supplies will continue to be provided as disaster relief.³² Small Business Administration loans for relocation will be available to flood victims also receiving insurance indemnity.

The purposes of the National Flood Insurance Act go far beyond the relief of flood victims and traditional systems of insurance. Built into the program are a number of aspects which should actively inhibit future uneconomic losses to the flood hazard. The measures of success of the program will be found not just in the volume of insurance sold or the number of families receiving indemnities, but in the degree to which it replaces other programs of disaster assistance, and ultimately in the ability to retard or reverse the rising cost of unwarranted flood losses.

Earthquake Insurance

Earthquake insurance has been available throughout the United States for over half a century, but for several reasons it is not popular. While lending institutions require fire and extended coverage insurance on mortgaged buildings, coverage is not required for earthquake damage.

Unlike fire or windstorm, which take a yearly toll, earthquakes are infrequent, but often catastrophic in extent. Instead of keeping

a balance between yearly premiums and losses as for fire insurance, companies which offer earthquake insurance must build up a large reserve fund to cover infrequent catastrophic losses. Such reserve funds are prey for taxation as excess profits.

Insufficient knowledge of the earthquake hazards is responsible for a rate structure which does not reflect the risk undertaken as much as companies would like. "Rates for earthquake insurance at present are established at a level which might be thought of as a balance point between supply and demand; normal insurance methods for determining actuarial rates don't apply due to the infrequent occurrence of earthquake losses."³³

The long recurrence interval for severe earthquakes has been a deterrent to greater insurance sales. Because the probability of a major earthquake occurring in a single year is slight, property owners may tend to consider the probability as zero, or negative certainty. They may, furthermore, believe it will not happen.³⁴ There may also be a tendency to misinterpret probability by imparting to earthquakes a specific cycle of recurrence. A shock with an expressed probability of occurring once in a hundred years may be interpreted as having a definite cycle of one hundred years.

Wider sales of earthquake insurance could be achieved by the requirement by lending institutions that earthquake coverage be included in the insurance folio along with fire and other extended coverage insurance. Such a requirement would necessitate the improvement of present earthquake insurance premium rate making, a goal currently recognized as desirable by the President's Task Force on Earthquake Hazard Reduction.³⁵

Earthquake insurance is sold in two ways. As a portion of the comprehensive homeowner's policy, it is available throughout the country. West of the Rocky Mountains, a separate policy is also offered. Policies sold include a deductible clause, which requires the property owner to assume a portion of the loss. The amount deductible is a specified percentage of the value of the insured property, and varies according to construction and location of the structure. Older buildings which are not earthquake resistant, and buildings located in high hazard zones are not insured.

Any attempt to increase the coverage of the earthquake hazard would include careful studies to develop more accurate means of determining risk. An expanded program of earthquake insurance could also be used to incorporate means of reducing hazardous occupancy of high risk zones, such as along fault lines, or on unstable ground. Subsidies and other incentives much the same as used in the National Flood Insurance Program could be used to reduce occupancy of high-risk zones.

All-Risk Property Insurance

For many years a possible solution to the problem of catastrophe exposure in the United States has been envisioned by forward-looking insurance men.³⁶ The basis of the proposed solution is nationwide, all-risk coverage which would cover against loss from any type of major natural hazard. "Some type of natural disaster hits each geographic area of the United States. With adequate rate, property spread and deductible, all perils can be included."³⁷ Hurricane, tornado, earthquake, and flood could be covered under one policy, if the policy were made available on a nationwide basis. By including coverage against

all significant natural hazards an insurance program can be assured of spread of risk. Insufficient spread of risk which might make insuring one hazard an uncertain venture can be balanced out by adding other coverages with entirely different distributions.

Programs of all-risk property insurance are functional in many European nations. In the United States one impediment for a nationwide insurance program is the variety of legal restrictions which abound at the state level. A policy used in one state may be illegal in the next. To devise nationwide standard, extended coverage policies for homeowners and small businesses would require a high degree of cooperation between companies, their rating associations, state regulatory bodies and the federal government.

As for the economics of catastrophe insurance, a plan for national rating has been proposed, the principles of which were set forth in 1961 in a study by the National Association of Insurance Commissioners.

"The procedure calls for reviewing catastrophe and non-catastrophe loss experience separately and establishing a catastrophe factor or separate element in the overall rate structure in each state. It provides for a ten year experience review period for... Non-catastrophe losses and a catastrophe element calculated on the basis of underwriting loss experience for at least fifteen years.

Catastrophes are defined as any one occurrence which results in state aggregate losses in excess of whichever of the following amounts are the greater: a) \$1 million or b) 50% of the state EC (Extended Coverage) earned premium (adjusted to current rate level) in the year of occurrence."³⁸

The record of catastrophe losses, derived in this manner would yield a catastrophe premium, the proceeds of which would be set aside by insurers to be used only in the case of catastrophic loss. At present, insurance companies fix rates only on a year to year

basis and are hard hit by the unusual catastrophic loss. The profits of a good year are often heavily taxed, which hinders the development of sufficient catastrophe reserves.³⁹ According to the N.A.I.C. plan, companies would be required to hold the catastrophe reserves intact for as long as ten years.

An aspect of all-risk insurance which must not be overlooked is sufficient attention to risk exposure. A program which makes insurance available for property in high hazard areas without rates which adequately reflect the risk might have the effect of encouraging further occupancy of the high hazard areas. Experience with all-risk natural hazards insurance in other countries is worth noting. New Zealand has had a national program since 1949, which though well conceived, has encountered numerous problems reported by O'Riordon.⁴⁰ Fed by a compulsory surcharge levied on all fire insurance policies, the insurance fund continues to grow, and it seems everyone who suffers at the hands of a natural event seeks indemnity from the fund.

Forms of Crop Insurance

Crop insurance may also be offered as single, multiple, and all-risk coverage. Widespread in the United States, Canada, and most European nations is single hazard coverage against hail. A combination of hazards are insured against in the Soviet Union, Yugoslavia, and Mexico.⁴¹ Crop insurance against all natural hazards, including plant and animal pests and diseases, is available in a number of countries including the United States, Japan, Ceylon, and Canada.⁴²

Crop-Hail Insurance

Hail is most severe in the interiors of middle latitude continents where severe thunderstorm activity is associated with jet stream circulation.⁴³ Because of widespread occurrence of hail in middle latitude agricultural areas, insurance has been developed on a sound basis to spread the risk of loss. Crop-hail insurance indemnifies the farmer against "fortuitous loss of crops caused by damage through hail, usually when such damage exceeds a specified percentage of the value insured."⁴⁴

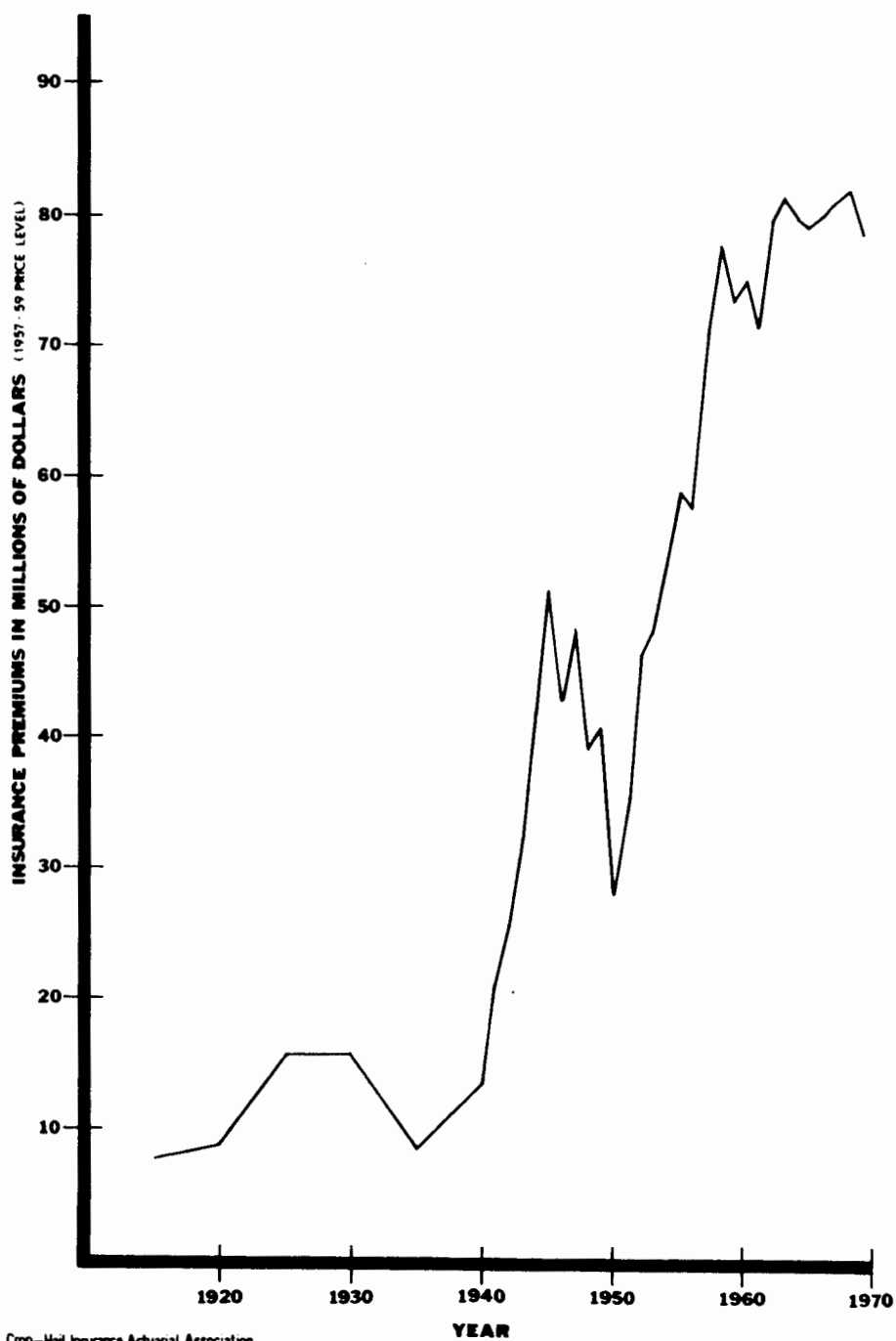
In Germany hail loss statistics are available for every locality, extending back nearly 100 years. Similar data is available for many years for areas in the United States threatened with hail. A history of ten or fifteen years is sufficient to develop a suitable rate schedule. In the United Kingdom the hail hazard does not vary greatly with location. There, yearly rates are fixed for the entire country for each crop. Adjustments in the rates are then made for areas of known higher or lower severity.

Growth of crop-hail insurance in the United States for the years 1915 to 1969 is shown in figure 2. Premium values are adjusted for price changes.⁴⁵ The sharp decline in premium volume for 1950 was the result of the poor prospect for the wheat crop in the southern great plains and small declines in premium volumes in other parts of the country.⁴⁶ With the poor outlook for the wheat crop there was no good reason to insure heavily.

In the United States, areas are classified by township or county, for which rates are based on the all-time record of losses. Data for counties are complete from 1915 and for townships from 1924. Data are analyzed by the Crop-Hail Insurance Actuarial Association, an organization of member companies that write crop-hail insurance. The association determines premium rates and recommends these to the state regulatory commissions.

Rates are much higher for crops than for property, reflecting the greater susceptibility to damage. Rates for insuring grain may run as high as fifteen to twenty dollars for one-hundred dollars worth of insurance, depending upon the geographic location. The crop-hail policy is in force only while the crop is growing and occasionally protects harvested grains for a few days, while they are in wind rows.⁴⁷ When a farmer purchases a policy it does not go into effect until twenty-four hours after it is signed, a safeguard that prevents the farmer from analyzing the current weather, then rushing to his insurance agent to cover himself against an expected loss. Policies are usually deductible and can be made for certain percentages of the expected value of the crop. Indemnification for loss is determined

CROP HAIL INSURANCE PREMIUMS UNITED STATES



Source: Crop-Hail Insurance Actuarial Association

FIG. 2

by expert adjustors. If damage occurs early in the season and the farmer can replant, the insurance might only pay for the new seed and the labor expended for the replanting.

All-Risk Crop Insurance

While hail damage is a major concern to farmers, it accounts for only a portion of the average annual farm losses to natural hazards. Drought, hot winds, insects, disease, frost and flood also threaten the development of a crop. The average percent of indemnities paid by the Federal Crop Insurance Corporation for specific hazards is shown in table II. Recognizing a need for broader coverage than for hail damage alone, private farm insurers in the United States have from time to time offered multiple-peril agricultural insurance. The federal government stepped into the field in 1939 after a number of hard-hit private companies withdrew their multiple peril coverage. The Federal Crop Insurance Corporation was created as a result of the passage of Title V of the Agricultural Adjustment Act of 1938. The expressed purpose of the Crop Insurance Act includes several points.

"The farmer should be protected from the hazard of crop failure, consumers protected against shortages and extremes in prices, and assistance given to business and employment by providing an even flow of farm supplies, and establishing stability in farm buying power.

Crop insurance offered to agricultural producers by the corporation provides protection from losses caused by unavoidable natural hazards, such as insect and wildlife damage, plant diseases, fire, drought, flood, wind, and other weather conditions. It does not indemnify producers for losses resulting from negligence or failure to observe good farming practices."⁴⁸

TABLE II
AVERAGE PERCENT INDEMNITIES ATTRIBUTED TO
SPECIFIC HAZARDS 1939-1966 BY THE
FEDERAL CROP INSURANCE CORPORATION

Drought	36.4%
Hail	10.3%
Excess Moisture	15.4%
Frost, Freeze, Cold, and Winterkill	12.4%
Flood	3.1%
Wind	6.0%
Insects	8.9%
Disease	4.6%
All Others	2.9%

Source: U.S. Bureau of the Census. Statistical Abstract of the United States. (91st edition) Washington: Government Printing Office, 1970.

In 1966 federal crop insurance in force totaled \$636 million. Of \$25.4 million paid in indemnities, \$4.6 million was for hail damage.⁴⁹

Premium rates for federal all-risk insurance are similar to those for crop-hail insurance offered by private insurers. This is possible even with the additional coverage because of different adjusting procedures used by the F.C.I.C. The F.C.I.C. insures a minimum yield per unit area for the farm as a whole. Indemnity is paid only if the yield per unit area of the farm drops below a guaranteed value. The guaranteed value is seldom much higher than the cost of production of the crop.

The members of the Crop-Hail Insurance Actuarial Association have in the past offered an all-risk weather perils contract to explore the possibility of re-entering this market,⁵⁰ but the F.C.I.C. still remains the chief insurer offering all-risk agricultural insurance in the United States.

Outside of the United States all-risk crop insurance programs have been initiated in several other countries. Japan initiated its program in 1939, the same year as the United States. The initial success of both the Japanese and United States programs led to the adoption of all-risk crop insurance on limited bases in the Soviet Union, Brazil, Canada, Ceylon and Mexico. Sweden adopted a nationwide program in 1961. In 1967 Costa Rica and India were beginning to make their programs operational. Colombia, Cyprus, Egypt, Israel, Taiwan, Turkey and Yugoslavia have had programs under consideration for sometime.⁵¹

As developed in Japan, all-risk crop insurance is a combination of insurance and mutual relief.⁵² Following the passage of the Agricultural Insurance Law of 1938, revisions were made in 1947 and 1963. While the law of 1947 put emphasis on mutual relief, changes in the law of 1963 included a shifting of a greater burden of losses to the farmer's mutual organization at the local level.

The hazards covered include almost every peril. The insurance is compulsory for all growers of specified crops above a certain pre-determined acreage, once a local relief organization is set up. Responsibility for the payment of the premium is shared between the farmers and the government, with the government's share varying from region to region depending upon the severity of loss. Based on experience, three rates are established, an ordinary standard rate, an extraordinary standard rate, and a super extraordinary standard rate. The government pays in full the premium at the super extraordinary standard rate and part of the extraordinary standard rate. From 1939 to 1963 the government contributed an average of sixty percent of the premium cost for cereal crops. Up to 1957 the combined average yearly cost to the government amounted to U.S. \$34 million.⁵³ Such expenditure is rationalized on the ground that the program promotes agricultural productivity and stabilizes the rural economy.

In Canada all-risk crop insurance had been under study for two decades before the Parliament enacted legislation in 1959 to authorize the government to make grants and loans to the provinces for purposes of crop insurance. The programs are administered by provincial government agencies and insure against loss by hail, drought, flood, excessive

rainfall, frost, wind rust, and pests, but not from poor farming practices. In dividing the responsibilities of the program, the federal government agreed to pay a percentage of the premium not exceeding twenty percent and a share of the cost of administration not exceeding fifty percent, and to loan funds to a province in which the crop insurance reserves in any year are insufficient to meet claims. The provinces may contribute up to twenty percent of the premium. This could leave the farmer with a bill for only sixty percent of the premium.

In Ceylon insurance is compulsory for all paddy growers in the areas designated for insurance. Coverages are applicable when the insured farmers follow certain minimum farming practices outlined in the Crop Insurance Act No. 13 of 1961. An additional coverage is available to farmers who follow special approved methods. By 1964, total area of insured paddy had risen to 200,000 acres out of a total of 4,636,000 acres under cultivation.

Indemnities are payable at rates set from time to time by the government. These vary according to the stage of production at which the crop was lost and in proportion to the loss. No indemnity is paid where the loss does not exceed thirty percent of the average total yield from the insurance unit. Insurance does not cover a smaller loss which must be borne by the farmer, but the government does bear the administrative costs and subsidize premiums.

Since its initiation the program has had a favorable loss ratio. According to Ray, the program is cautious and has limited goals. It has been integrated with other agricultural development plans, and since its inception the weather conditions have been favorable.⁵⁴

The all-risk crop insurance programs of each of these four countries show wide ranges of government subsidy, acreage insured, crops protected, hazards covered, and the requirements for participation of the farmers (see table III).

In terms of the number of crops covered, the United States leads the other nations considerably. Canada and Japan have similar numbers of crops covered under all-risk insurance. Ceylon has coverage against only one crop, paddy. The range of crops covered may simply reflect the greater variety of crops grown in the United States, and the emphasis on rice cultivation in Ceylon. It may also reflect the longer experience with crop insurance in the United States and Japan. When the Federal Crop Insurance Corporation began it only offered coverage for a restricted number of grains, and in the three decades of operation has expanded to cover at least twenty different crops.

It appears that there are no major differences in the types of hazards covered against, as each is in principle all-risk insurance.

The administrative costs in all four programs are paid chiefly by the governments. The United States does not contribute one hundred percent as do Japan and Ceylon. Canada may also pay one hundred percent of administrative costs out of various governmental funds.

The premiums are paid in full by the farmers in the United States and are subsidized to various degrees in the other three nations. For agricultural insurance, as well as property insurance, compulsory and subsidized programs may have the effect of insuring participation, and gaining adequate spread of risk but also suffer some drawbacks.

TABLE III

COMPARISON OF FOUR ALL RISK CROP INSURANCE PROGRAMS

	<u>CANADA</u>	<u>CEYLON</u>	<u>JAPAN</u>	<u>UNITED STATES</u>
% of Gross Domestic Product from Agriculture a.	7	48	15	4
Arable Land and Land Under Permanent Crops 1000 Acres b.	103,399	4,636	14,836	457,511
Hazards Covered c.	Hail, drought, flood, excess rainfall, frost.	Not Specified	Weather Hazards, storm, flood, cold weather, snow, blight, noxious insects, birds or beasts.	Wildlife, insect infestation, plant diseases, earthquake, drought, flood, freeze, winterkill, lightning, fire, excessive rain, snow, hurricane, tornado, and any other adverse weather condition.
Insured Crops c.	Wheat, oats, barley, flax.	Paddy (rice)	Paddy (rice) wheat, barley, naked barley, oats, rye.	Wheat, cotton, flax, corn, tobacco, bean, citrus, soybean, barley, grain, sorghums, oats, rice, raisins, pea, peanut, potato, apple, cherry and tomato.
Farmer Participation c.	In 4 test areas in Manitoba, 25,000 farmers. 1/3 million acres (1960)	Compulsory for all paddy growers	Compulsory for growers of crops above specific acreage. Voluntary for small farmers.	Voluntary in a county where 1/3 or 200 farmers apply for insurance.

TABLE III (cont.)

	<u>CANADA</u>	<u>CEYLON</u>	<u>JAPAN</u>	<u>UNITED STATES</u>
Government Participation Premiums c.	Federal Government will pay up to 20% -- Province 20%	Exact amount of subsidy unknown.	55% Government 45% Farmers	Premiums paid by farmers.
Administrative costs	50% Federal 50% Provincial	100% paid by the government.	\$34 million average government expenditure annually.	Subsidized in part by Federal Government.
Experience c.	For 1960, premium indemnity ratio of 1:12.	1958-9 to 1962-3 premiums due US \$200,000 farmers paid US \$66,460 indemnities US \$47,800	1947 to 1957 total premiums US \$286.1 million farmers paid US \$129.0 million Indemnities US \$31.0 million	1938 to 1955 premiums \$302.4 million 1966 insurance in force, \$636 million indemnities, \$25.4 million. d.

- a. U.N. Statistical Yearbook, 1966.
- b. FAO. Production Yearbook, 1966.
- c. Ray, Agricultural Insurance, Chapter VII.
- d. U.S., Congress, House, Department of Agriculture and Related Agencies Appropriations Bill, 1970, H.R. 91-269, 91st Cong., 1st sess., May 23, 1969, page 62.

The disadvantages of compulsory insurance are related to the inequitable nature of blanket coverage. Lacking the competition between rival companies, the risks tend to be insufficiently classified and the rates poorly differentiated, with the result that the farmers in less hazardous zones pay for the losses of farmers in high risk zones. Should the program be subsidized, as well, the farmers who suffer loss receive benefits at the expense of the general taxpayers.⁵⁵ This situation may tend to promote increased risk-taking among farmers whose losses are covered by subsidized insurance.

Insurance and Economic Indicators

The volume of life insurance held in a nation is one measure of the degree to which people plan for the economic loss accompanying death. The following two sections attempt to find out what factors are associated with life insurance sales at an aggregate level, what factors are associated with sales of insurance against natural hazards, and whether there is any correspondence between the two.

The Ratio of Life Insurance in Force to National Income

Direct comparison of national life insurance statistics, such as premiums or life insurance in force is unhelpful because nations vary widely in terms of economic conditions, population, and standards of living and health. The Life Insurance Fact Book suggests the ratio of life insurance in force to national income as a more useful indicator. The world map (figure 3) shows this ratio for thirty-three nations for which data are available. The nations with the higher ratios are those which have highly developed industrial economies.

Per Capita Life Insurance and Per Capita National Income

To explore the relationship of national income and life insurance in force we divided the values by the population to get per capita figures for both. Using life insurance data from the Life Insurance Fact Book, 1969, we were able to find proper income, exchange rate, and population data to get per capita life insurance in force and per capita national income for twenty-seven nations.⁵⁶ The test of correlation for all those countries is significant with $r = +.7996$. The graph (figure 4) shows some interesting groupings of countries.

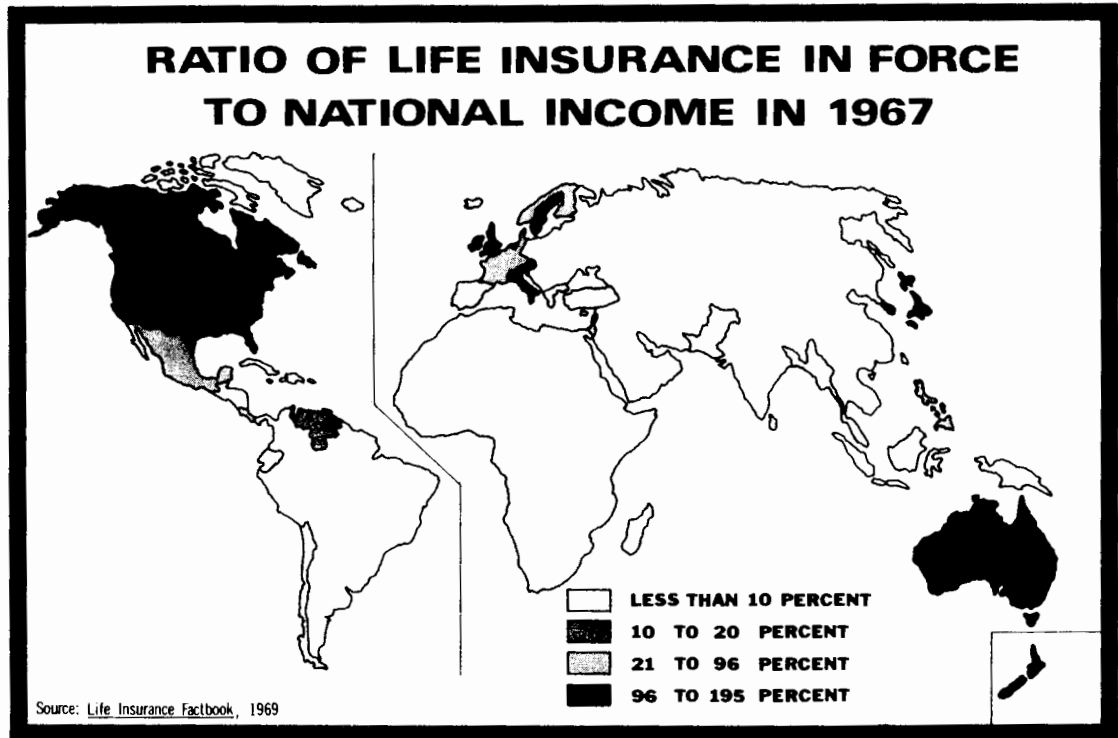


FIG. 3

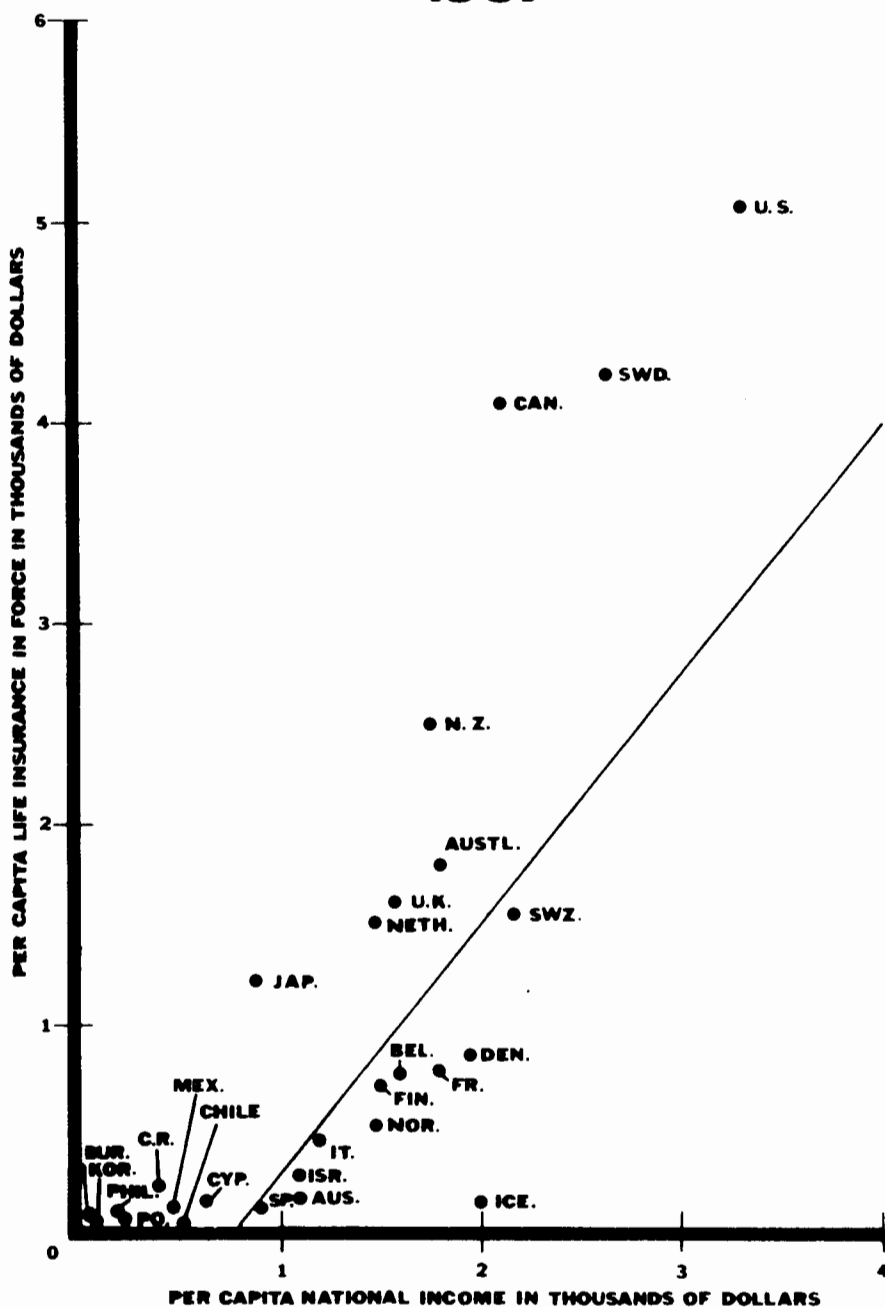
Australia98%	France38%	Norway 34%
Austria12	Germany.45	Pakistan.7
Belgium51	Greece 2	Philippines . . . 26
Burma 6	Iceland. 6	Portugal.8
Canada.195	Israel32	Spain8
Chile 3	Italy.16	Sweden.158
Costa Rica. . .28	Japan.110	Switzerland . . . 72
Cyprus.18	Korea.16	Turkey.1
Denmark40	Mexico22	United Kingdom. 98
Ecuador 3	Netherlands, 121	United States .164
Finland46	New Zealand. 148	Venezuela 17

The countries with higher per capita life insurance in force, from Japan upwards and to the right towards the United States, show a definite linear trend. As per capita national income increases per capita life insurance in force increases also, and at a greater rate. For these nations the propensity to insure appears to grow with per capita national income at roughly twice the rate.

There are two other clusters of nations that also warrant recognition. Beneath the lower end of the group just mentioned lie a group of European nations which have a similar range of per capita national income, but have considerably lower values for per capita life insurance in force. For one reason or another life insurance is not as widely held in these countries despite indications the countries have similar standards of living as the predominantly anglo countries with more insurance. We must look elsewhere from per capita national income to explain this obvious difference in preference or ability to buy insurance. We suspect that the answer may lie within basic differences in social structure of these groups of nations, which might reflect upon the necessity or willingness to hold life insurance. Quite possibly family ties are stronger in Belgium, Denmark and France than in the United States, Sweden, Australia or the Netherlands and economic losses may tend to be shared within a tighter family group, rather than by purchasing life insurance. Lower amounts of life insurance held may also be an effect of more developed programs of social welfare, which could reduce the need for life insurance.

There is a third cluster of countries which rank low on both scales. Per capita life insurance seems independent of per capita national

PER CAPITA LIFE INSURANCE COMPARED TO PER CAPITA NATIONAL INCOME 1967



Sources: *The Life Insurance Factbook*, 1969 and *U.N. Statistical Yearbook*, 1967

FIG. 4

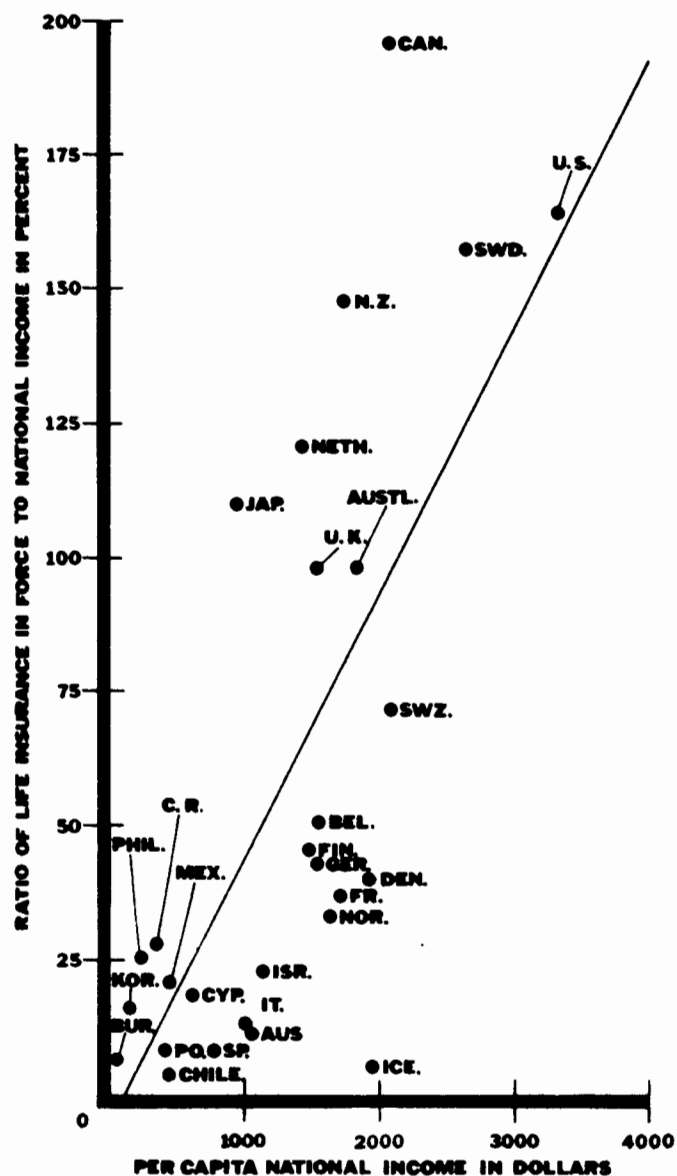
income below a value of \$1000.00. It appears that countries which have per capita national incomes above this threshold value begin to have increased per capita expenditures for life insurance in association with per capita national income.

A second correlation, comparing the ratio of life insurance in force to national income with per capita national income gives a positive correlation of $r = +.6890$ and a similar, if more dispersed clustering of data (see figure 5).

Life Insurance and Central Planning

If life insurance responds to national income, might it not also respond to other economic indicators? To see if free market countries differ significantly from countries with controlled economies in terms of the amount of life insurance held, three indices of life insurance were compared with the degree of central planning. The degree of central planning is a measure developed by Myron Ross.⁵⁷ Ross sent a questionnaire to a score of economists, who were asked to rank nations in order of degree of central planning practiced. Those nations with no central planning were ranked as 1, nations with a small amount of central planning as 2, those with a moderate amount, 3, and those totally planned, 4. Upon return of the questionnaire Ross averaged the scores for each country and ranked them accordingly. The three measures of life insurance were the ratio of life insurance in force to national income, life insurance in force, and per capita life insurance in force. When compared to the degree of central planning none of the three measures correlated. Per capita life insurance in force compared to degree of central planning is shown in the graph (figure 6).

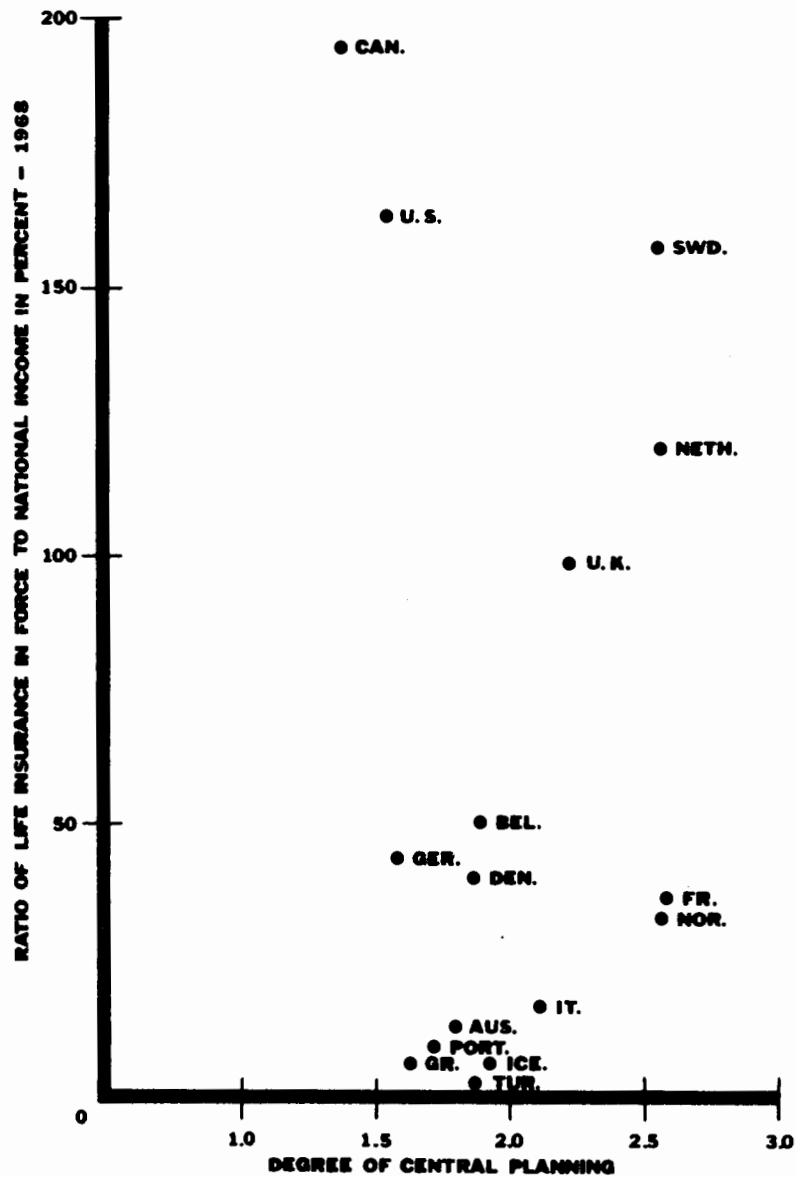
RATIO OF LIFE INSURANCE IN FORCE TO NATIONAL INCOME COMPARED TO PER CAPITA NATIONAL INCOME



Sources: The Life Insurance Factbook, 1969
 "Estimates of Total and Per Capita National Income"
U. N. Statistical Yearbook, 1967 p. 576.

FIG. 5

RATIO OF LIFE INSURANCE IN FORCE TO NATIONAL INCOME COMPARED TO DEGREE OF CENTRAL PLANNING



Sources: Life Insurance Factbook, 1969

Ross, Myron H., "Fluctuations in Economic Activity: Planned and Free Market Economies, 1950-60: Comment", American Economic Review, Vol. LV, No. 1 p. 158-61.

FIG. 6

Natural Hazards Insurance and Economic Indicators

Since we have found that expenditure for life insurance in a country is related to measures of national income we might expect to find a similar relationship of expenditure for insurance with loss from natural hazards.

Because crop-hail insurance protects against loss from one specific hazard, because the relationship of premiums to hail hazard is well established in the United States, Canada and Europe, and because statistics on sales for a number of European nations and the United States were available, crop-hail data were used.

Property insurance in excess of fire coverage generally covers several hazards, both social and natural which would confuse comparisons between countries. For these reasons crop-hail insurance data was chosen for a comparison of the propensity to purchase insurance against natural hazards.

Because the cost of crop-hail insurance is dependent on several factors, direct comparison of premium volume for each country would be misleading.

Factors Affecting the Expenditure for Crop-Hail Insurance

Among a number of factors, the cost of insuring against hail damage depends upon the susceptibility of the specific crop to such damage. The susceptibilities of most crops are well known and classification schemes have existed for over 100 years. French insurers place crops in four classes, Great Britain in five, and West Germany

While the results tempt us to suggest there is no relationship between the amount of life insurance held in a country and the degree to which its economy is centrally planned, two problems make conclusive statements difficult. One is the subjective nature of Ross' measure. More troublesome was the lack of life insurance data for Soviet bloc countries, so that the countries ranked highest in degree of central planning were left out of the calculations.

It would be interesting to compare the degree of central planning to other factors such as the development of nationwide all-risk property and agricultural insurance.

in nine classes. In Texas there are eleven crop classes, each with a different insurance rate.⁵⁸

The insurance rates for crops in Texas, shown in Table IV indicates that the cost of crop-hail insurance is dependent upon the crop type as well as the frequency and severity of hail. The table shows the variation of rates for each crop type in three of twenty-seven zones of severity or rate groups. The crops in classes A,G,H, and I have rates that reflect higher susceptibility to hail damage.

Variation of the hail hazard from place to place may be related to a number of topographic and atmospheric factors. Within the middle latitudes where hailstorms are most common, elevation is suspected to be a critical variable. Along the high plains of central United States this relationship is evident in variations in the loss ratio. In southeast Kansas at elevations of 1000 feet the loss ratio is \$1.00 per \$100.00 of insurance. In central Kansas where the elevation is between 1500 feet and 2000 feet the average loss ratio is between \$3.00 and \$6.00 per \$100.00 of insurance. In those Kansas counties with a surface above 3000 feet the loss ratio reaches \$12.00 per \$100.00.⁵⁹ The relationship of loss ratio to elevation is particularly linear in Kansas (figure 7), but it is also evident in the other plains states. In addition to elevation, latitude, longitude, roughness of terrain, and slope are also suspected of influencing the severity of hail damage.⁶⁰

Another factor which confuses direct comparison of crop-hail premium statistics is the variability of acreage in permanent cultivation in each country. We can account for some of the disparity between

TABLE IV
 REPRESENTATIVE CROP-HAIL INSURANCE RATES FOR TEXAS
 MARCH 1963

Class	Crops	Cost per \$100. of Insurance		
		Rate Group 7	Rate Group 17	Rate Group 27
A	Wheat, other small grains such as barley, buckwheat, emmer, millet, oats, rice, rye and spelt.	\$22.70	\$ 9.20	\$4.70
B	Miscellaneous crops such as citrus fruits, potatoes, safflower and sunflowers.	15.00	6.00	3.00
C	Corn, flax, popcorn.	15.20	6.20	3.20
D	Sorghum crops such as broom-corn, cane, combine maize, hegari, kafir corn, sargo, Sudan grass, and all other grain sorghum.	6.20	2.60	1.40
E	Peanuts, sugar beets (not grown for seed).	6.00	2.40	1.20
F	Crops grown for hay such as alfalfa, clover, millet, and timothy.	7.50	3.00	1.50
G	Beans, peas, soybeans and cowpeas, sesame.	more than 24.00	9.80	4.90
H	Crops grown for seed such as alfalfa, blue grass, clover, crested wheat grass, lespedeza, sugar beets, and timothy.	more than 24.00	12.00	6.00
I	Cantaloupes, cucumbers, pumpkins, squashes, and watermelons.	more than 24.00	18.00	9.00
L S	Cotton - Long staple. - Short staple.	Rates figured for each location.		

Source: CHIAA, in Ray, Agricultural Insurance, pp. 42 & 47.

HAIL RISK AND ELEVATION IN KANSAS

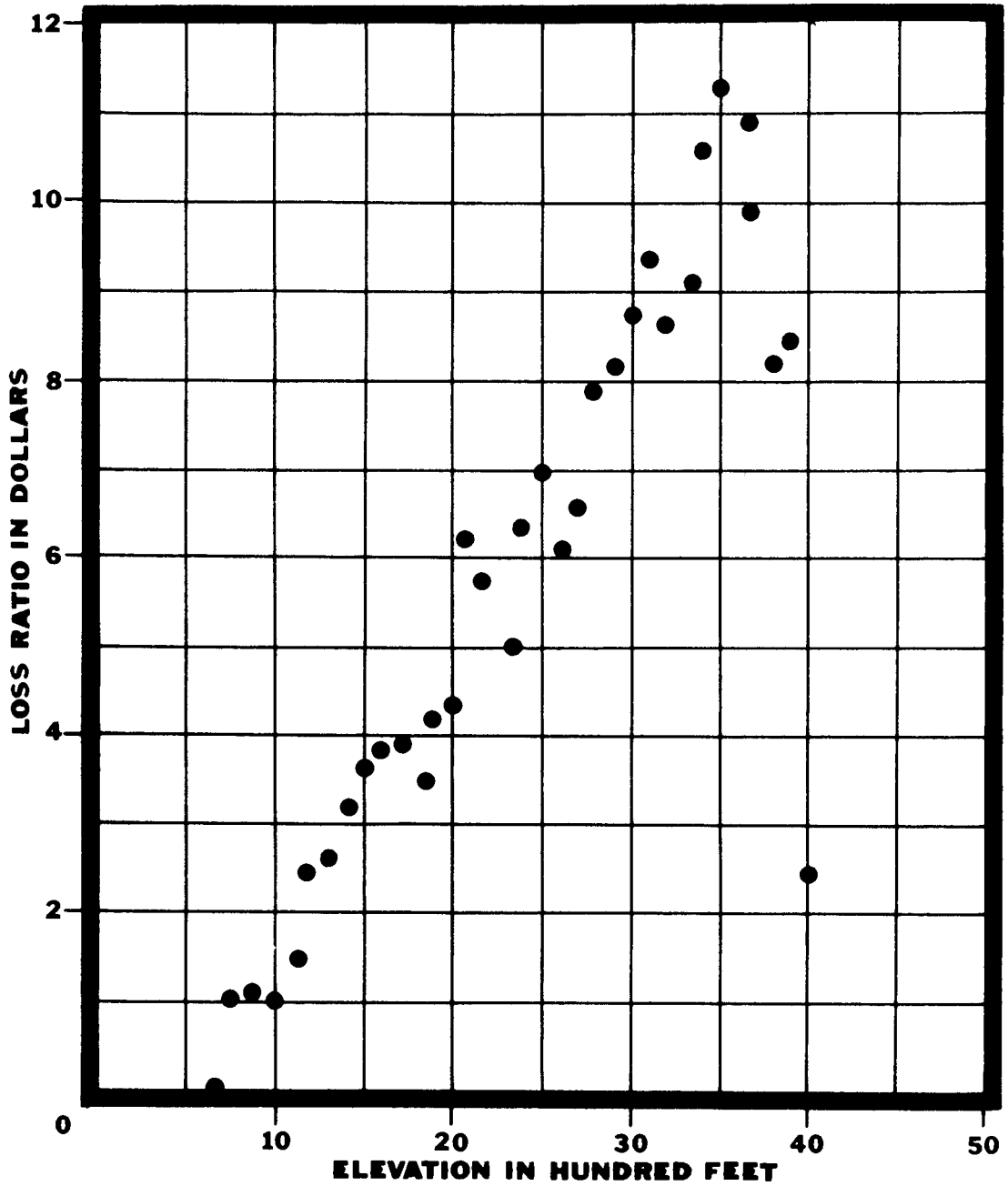


FIG. 7

Source: CHIAA, in Flora, Hailstorms in the United States, 1956

agricultural acreage by dividing the total crop-hail premiums paid in a nation by the area under cultivation. We must remember, however, that not all agricultural areas are exposed to the same hail risk. This presents a problem since figures for acreage exposed to hail are not available.

It is possible to take only the acreage in crops that are particularly susceptible to hail damage and to divide this acreage into the total premiums for crop-hail insurance. For our purposes the acreage of all cereals, grapes, tobacco and tomatoes is divided into the crop-hail premiums to give us a representative expenditure for each nation, expressed in U.S. dollars per hectare.

Keeping in mind that we have not accounted for differences in the severity of the hail hazard, we compared the expenditure per hectare of land in all crops and the expenditure per hectare in specific crops to a number of economic indicators (see Table V).

The higher expenditures per hectare in Austria, West Germany and the Netherlands may be related to higher hazard severity. Possibly, a larger percentage of the area under cultivation is in crops that are more susceptible to hail damage.

Higher expenditure may also be affected by the value of the crop to the farmer. If his farm is small he might face the possibility of losing much of his investment in one storm whereas if farms are more extensive, a single loss may be more easily absorbed. Ownership of the crop may have an effect on insurance purchases. A farmer who has borrowed to buy seed and equipment would be foolish to be uninsured against crop loss whether his creditors required insurance or not

TABLE V

COMPARATIVE DATA FOR EUROPE AND THE UNITED STATES

COUNTRY	PERCENT GROSS DOMESTIC PRODUCT FROM AGRICULTURE a.	PER CAPITA NATIONAL INCOME (US\$) a.	PER CAPITA LIFE INS. IN FORCE (US\$) b.	CROP-HAIL INSURANCE PREMIUMS (US\$) c.	CROP-HAIL INS. EXPENDITURE PER HECTARE, LAND IN PER- MANENT CROPS d.	CROP-HAIL INS. EXPENDITURE PER HECTARE IN CEREALS, GRAPES, TOBACCO, AND TOMATOES d.
AUSTRIA	10	970	101.8	3,834,221	2.22	4.20
BELGIUM	6	1,428	659.6	196,319	.21	.38
DENMARK	11	1,677	571.2	581,430	.21	.36
FRANCE	8	1,448	510.9	19,241,558	.92	1.78
W. GERMANY	5	1,455	575.5	14,821,816	1.76	2.95
GREECE	25	570	8.8	1,152,396	.30	.56
ITALY	13	884	128.0	13,490,309	.87	1.71
LUXEMBURG	6	1,553	207.8	60,682	.84	1.21
NETHERLANDS	8	1,274	1,489.9	2,480,989	2.54	5.09
SWEDEN	7	2,248	3,278.0	714,006	.22	.51
UNITED STATES	3	2,910	4,114.3	80,722,576	.46	1.32

a. U.N., Statistical Yearbook, 1967

b. Life Insurance Fact Book, 1969

c. Wallace J. Burt Jr., "Hail Experience," National Underwriter, December 9, 1966.

d. Land use figures from FAO, Production Yearbook, 1969

whereas farmers operating with less capital investment would not have the same need for insurance.

Crop-Hail Insurance and National Income

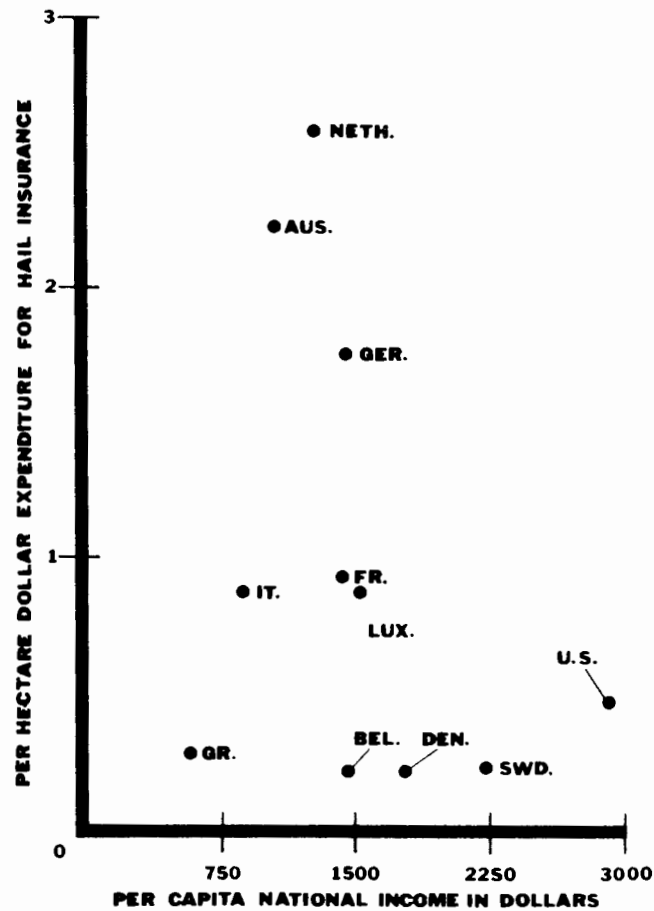
Using crop-hail premium data for ten European nations which suffer crop loss from hail and for the United States, the expenditure for crop-hail insurance per hectare in permanent crops and the expenditure per hectare in specific crops susceptible to hail damage were compared to per capita national income. Neither of the tests showed any significant correlation. Figure 8 shows crop-hail insurance expenditure per hectare in all crops in relationship to per capita national income. The lack of correlation may be related to the small sample size and the fact that most of the countries rank high in terms of per capita national income.

Crop-Hail Insurance and Agricultural Production

The two measures of crop-hail expenditure per hectare were compared to the percentage of gross domestic product from the agricultural sector of the economy. It was thought that an inverse relationship might exist. Countries with a low percentage of gross domestic product from the agricultural sector tend to be industrialized and their economies more developed. With mechanized farming, cash cropping, and agricultural credit, farmers may be more concerned with avoiding financial losses. Farmers in developed countries may also have greater access to insurance facilities.

In our sample Greece stands out as the country with the largest percentage of gross domestic product from the agricultural sector. Its expenditure for crop-hail insurance is below average. However,

CROP-HAIL PREMIUM EXPENDITURE PER HECTARE COMPARED TO PER CAPITA NATIONAL INCOME 1965



Sources: U. N. Statistical Yearbook, 1966
 FAO, Production Yearbook, 1966, Table 1
 Burt, Wallace J., "Hail Experience"
 National Underwriter, Dec. 9, 1966 (Sect. 2) p. 28.

FIG. 8

the data as a whole show no significant degree of correlation. If data were available for crop-hail expenditure in other, less developed nations we might have positive substantiation for our hypothesis.

Crop-Hail Insurance and Life Insurance

A third and last analysis was made to determine if a relationship exists between the average amount spent on crop-hail insurance per hectare and per capita life insurance in force. No significant correlation exists.

The negative results of these tests suggest that the important factors affecting crop-hail premiums may not be national income or the importance of agriculture in the economy, but something else. It is known that severe hail producing thunderstorms are related to jet stream movement, which means that severe hail is restricted to certain latitudinal limits. It has also been shown that the severity of the hail hazard in the Great Plains of the United States is related to climatic conditions correlated with elevation. This brings us to the conclusion that in high income countries geographic and atmospheric factors maybe more responsible for variation in hail insurance premiums than national income or the importance of agriculture to the economy. While the hail hazard varies greatly from place to place, there is no comparable variation in the hazard of death. Moreover, the amount of life insurance in force is more a function of the economic value placed on life, than a function of any variation in risk of death.

We might now ask if what we have found of hail insurance use in mid-latitude high income countries is indicative of insurance against other hazards. Would the amount of insurance purchased for other

natural hazards would be unrelated to national income. It is important to recognize each natural hazard has its own unique distribution. The cost of insurance will depend upon differences in the severity of a specific hazard from place to place. A hazard with the widest possible distribution, such as windstorm, or even fire might have a variation in premiums which would correlate with national income. Hazards with distributions restricted to geomorphic or climatic zones (such as hail) and differing greatly in severity from country to country are much less likely to have specific natural hazard insurance expenditures that would relate to national income or life insurance expenditures.

Summary and Conclusions

Insurance is one means of dealing with losses from natural hazards. Rather than attempting to reduce losses, however, insurance works primarily to distribute the cost of losses suffered by a few to a larger group of people who share similar risks. The cost of operating an insurance system must be added to the cost of direct losses.

Insurance may be used to cover a wide variety of losses both atmospheric and geologic in origin for both property and agricultural risks.

Insurance against natural hazards is sold in many nations, though the majority of insurance is sold in economically well off nations.

Natural hazards insurance may be written against one specific hazard, a number of specified hazards, or against all hazards. A small number of primarily European nations have insurance that covers all risks to property. While the United States has insurance against nearly all hazards, it does not cover them under one policy, so its system is not truly all-risk. Some countries operate compulsory insurance against all natural hazards, though inequities in such systems may lead to greater risk taking and increased losses.

The major natural hazards to property in the United States are windstorm, flood and earthquake. Windstorm has widespread distribution and causes damage each year. Insurance has been available for several decades and rates for windstorm insurance are closely associated with risk because of extensive experience.

Flood insurance in the United States is only now being made widely available. Because of the catastrophic nature of flood damages, insurance

companies had formerly considered flood uninsurable. A joint federal government-private industry flood insurance program is making subsidized insurance available to property owners in flood-prone areas. In addition to indemnifying flood losses, the program is designed to help limit future uneconomic flood damage.

Earthquake insurance has been available in the United States for several decades, but is incomplete.⁶¹ Because of long recurrence intervals adequate knowledge of earthquake risk is lacking and present rate schedules do not necessarily reflect the risk.

All-risk property insurance which is common in Europe and a few other developed countries is not available in the United States despite interest in such coverage. Such a system would cover all natural hazards. Experience with all-risk insurance in other countries suggests that with inadequate rate determination, an all-risk program can be inequitable. Subsidizing the losses of persons occupying high risk zones has the effect of inviting further occupancy of high hazard zones and increased losses.

Crop insurance is also available as single, multiple and all-risk coverage. The predominant single coverage offered is crop-hail insurance. Multiple and all-risk coverage take care of most or all of the natural hazards to farming.

Crop-hail insurance is well established in Europe and Anglo-America with total premiums increasing at a considerable rate each year. Multiple and all-risk crop insurance is available in a small number of nations, though interest has been shown by several others. All-risk crop insurance is nearly self sufficient in the United States,

but takes on the appearance of farm relief in Japan as the annual amount of losses exceeds premium income and the government makes up the difference.

In exploring what factors influence the sales of natural hazards insurance, several tests of correlation were carried out. It was thought that sales of life insurance might be a useful analogue for the sales of natural hazards insurance or an indicator of the propensity to buy insurance of any type. Per capita life insurance in force was compared to per capita national income for a selected group of countries outside of the Soviet bloc. A significant positive correlation suggests an association between the average income of a nation and the inclination or ability of its people to purchase life insurance. Comparison of life insurance statistics with the degree of central planning for several nations without complete central planning shows no significant correlation.

As an example of insurance against a natural hazard, crop-hail insurance expenditure per hectare was compared to national income for a selected group of industrialized nations, but without significant correlation. A comparison of crop-hail insurance expenditure per hectare, the same measure, was made to the percentage of gross domestic product from the agricultural sector with no significant correlation. The amount spent on crop-hail insurance in those countries appears to be independent of the importance of agriculture to the economy.

A test of correlation between per capita life insurance in force and crop-hail insurance expenditure per hectare gives no significant correlation. For these countries sales of crop-hail insurance are

unrelated to sales of life insurance.

Because the distribution and frequency of other natural hazards are different than hail, we cannot assert that premiums of insurance against another hazard would also be unrelated to national income and life insurance in force.

FOOTNOTES

1. P.K. Ray, Agricultural Insurance, (New York: Pergamon Press, 1967), p. 17.
2. Victor Dover, "International Aspects of Marine Insurance," in International Monitor, 1960), p. 3.
3. Natalie A. Hay, ed., The Insurance Almanac, (New York: The Underwriter Printing and Publishing Company) 1971, p. 162.
4. Curt Rommel, "Principles and Forms of International Elemental Hazard Insurance," in International Insurance, ed. by Hardy F. Glass, (New York: International Insurance Monitor, 1960), p. 51.
5. Robert W. Kates, Hazard and Choice Perception in Flood Plain Management, (Chicago: University of Chicago, Department of Geography Research Paper No. 78, 1962), p. 122.
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