Mitigating catastrophic risks through innovative financial instruments

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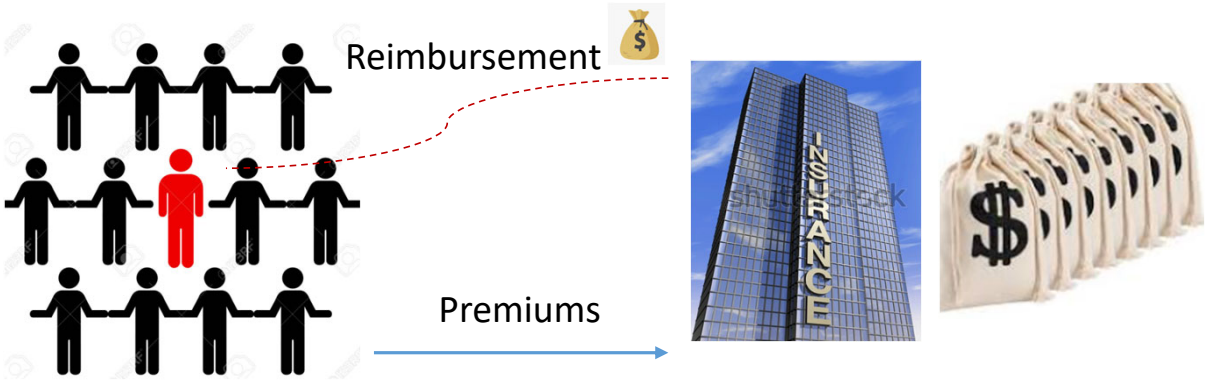
Multiple risks associated with a disaster

- Environmental risk (e.g., structural changes to ecosystem)
- Health risk (e.g., physical/mental injuries, losses of life)
- Financial risk (e.g., repair or replacement costs for damaged assets)
- etc…
- Insurance is a commonly used tool of protection from financial losses.

What is insurance?



- Insurance is a contract, represented by an insurance policy.
- A policyholder receives protection from the insurance company against the financial losses from specified events.
- A policyholder pays premium to the insurance company for receiving the protection.
- The essence of an insurance business: pooling of funds from many policyholders to pay for losses incurred by a few.
- Risk pooling => Reducing loss volatility (Law of large #)=> Affordable insurance.

An illustrative example

- Consider a home insurance which pays $100 had the home damaged in 10 years. Assume
  - the 10-year discount factor is 0.9;
  - The probability of damaging is 0.1.
- The net premium is $100 \times 0.9 \times 0.1 = 9$.
- The present value of loss from a single contract is

$$L_i = \begin{cases} 81, & \text{with prob } 0.1; \\ -9, & \text{with prob } 0.9. \end{cases}$$

- 10% chance of incurring a loss nine times the premium.

An illustrative example con't

- Suppose that the same contract is sold to 1,000 policyholders.
- The average loss for each contract is

$$\overline{L} = \frac{1}{1000} \sum_{i=1}^{1000} L_i,$$

  which has mean 0 and variance 0.729.
- The variation is so small that the probability of having a loss the size of the premium is (almost) zero.

Some key concepts

- Risk-based premium (high frequency and/or severity => high premium)
- Deductible: Reimbursement is made after a loss exceeds certain amount (lowering the frequency and severity).
- E.g., D=100; if L=300, then R=200; if L=50, then R=0.
- Limit: Reimbursement is ceiled if a loss exceeds certain amount (lowering the severity).
- E.g., U=100; if L=300, then R=100; if L=50, then R=50.
- A policy may have both deductible and limit.

Pros and cons of the traditional insurance model

Pros

- Standardization
- Economy scale
- Each policyholder deals with only an insurance company tightly regulated by government

Cons

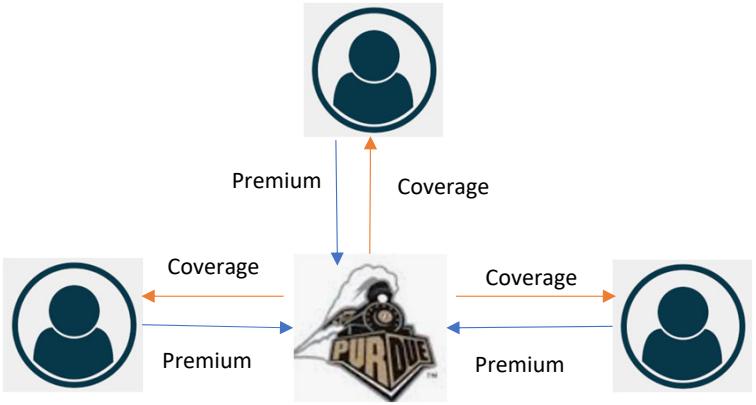
- Insurance premiums are much higher (about 50%) than the actual cost of benefits
- Concentration of market power
- A lack of trust to the insurance industry

Decentralized insurance model

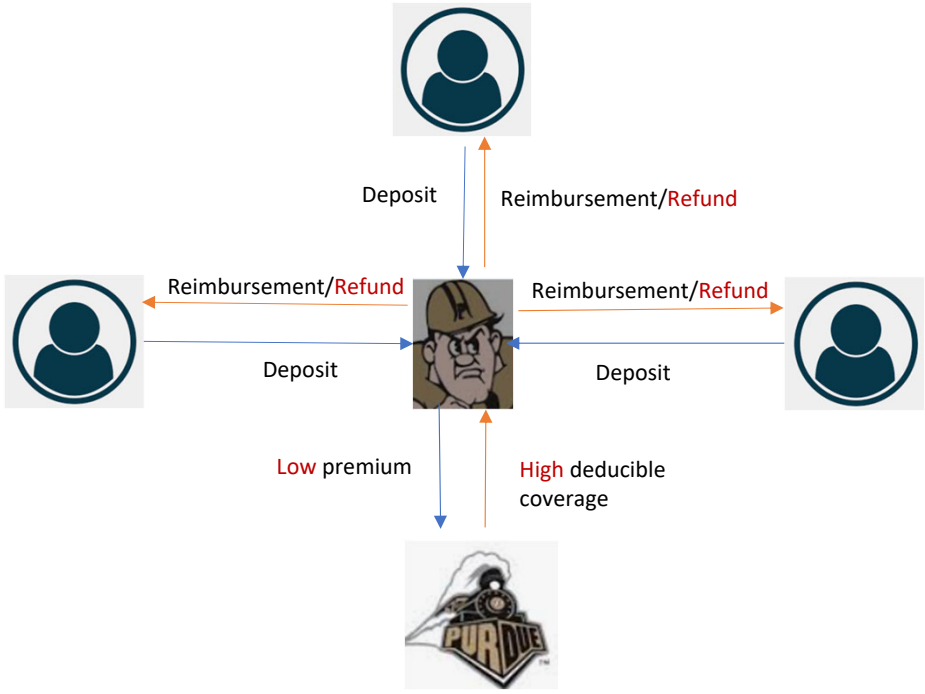
An insurance company

A common fund agent

Traditional insurance

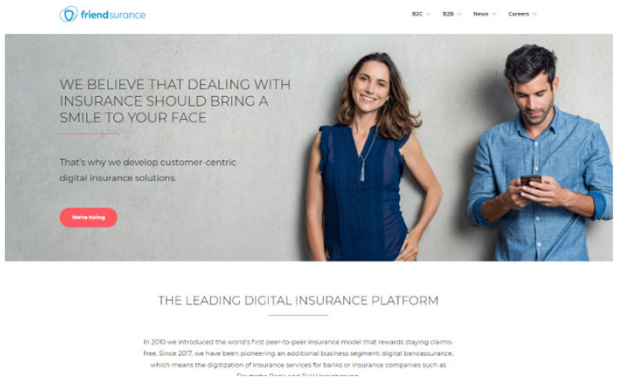


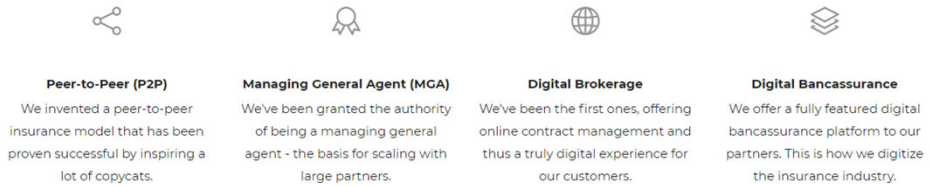
P-2-P insurance (low cost, transparent)



Traditional v.s. P-2-P insurance

- Lower administrative costs
- More transparent
- Is the common fund agent reliable?
- How about your peers? Are they much riskier than you?





Catastrophe (CAT) bonds

- Insurance is not always available
- Transfer the insurance risk to the capital market via CAT bonds
- Issued by insurance companies or state catastrophe funds
- A traditional bond with principle $100: Pay the bond price at the beginning => Receive interest payments periodically = $100*interest rate => Receive the principle = $100 at the end.
- A CAT bond with principle $100: Pay the bond price at the beginning => Receive interest payments periodically = ($100-$D_t$)*higher interest rate => Receive the principle = ($100-$D_T$) at the end.
- D_t increases whenever a disaster event occurs.

The creation of modern property insurance

- The Great Fire of London, 1666, when there was no insurance nor fire brigade
- Destroyed 13,000+ homes, left 100,000+ people homeless and in financial ruin
- First property and fire insurance companies were established
- Pay claims to customers that had their property or contents damaged
- Premium depends on the size and made (e.g., wood vs brick) of building

By 1700…

- Cheaper to put out the fires than to pay for damages
- Insurance companies hired their own firefighting units
- Insurance not only provides protection against losses, but also promotes risk prevention
- But the system was inefficient and flawed:
  - Once a fire happened, many firefighting units would come
  - Stayed and watched if the burning buildings were not covered by insurance
- Multiple insurance companies supplied money and equipment to establish a united firefighting unit
- Latter on, municipal fire brigades were formed

A closing question

Can insurance industry extend its historical role in addressing root causes (e.g., as founders of the first fire department, building codes, and auto safety testing protocols) to one of preventing and/or mitigating losses at a much larger scale (e.g., natural disaster, the global climate)?

Thank you!!!