Risk measurement

MODULE 3

Frequency and severity of losses.

▶ Frequency of loss refers to number of times in a given pe[riod]
loss is likely to happen.

▶ Historical data will provide this info. (Eg: frequency of inju[ries]
of injuries in the past/no of worker-years) in the absence [of]
historical data, industry data can be used. Informed judg[ment]
can be used as well.

▶ Severity of loss measures the magnitude of loss per occu[rrence]
One way to estimate is from historical data. (average
severity/occurrence)

▶ Expected loss = frequency of loss*severity of loss. Expecte[d loss]
affects business value and insurance pricing.

3.6

Property Exposures	Frequency	Severity Range	Average Severity	Expected Loss
Damage to automobiles	Medium	$0–$20,000	Low	Medium
Stolen property	High	0–2,000	Low	Low
Small fires	Low	100,000–500,000	Medium	Low
Major fires	Low	500,000–10,000,000	High	Low

Note:

▶ Std deviation for high freque
low severity is low while std
deviation for low frequency
severity is high

▶ Infrequent but potentially lar
losses are less predictable ar
pose greater risk than more
frequent smaller losses.

Risk control

▶ Risk control is the process of implementing measures to reduce risk associated with a hazard.

▶ Benefits of risk/loss control:

Elimination of expenses associated with

- Repair or replacement of damaged property

- Income losses due to distruction of property

- Extra costs associated with maintaining operations

- Adverse liability judgements

- Medical costs to treat injuries

- Income losses due to death/disabilities

Cost of risk control

▶ Installation and maintainance expenses eg sprinkler system

▶ There are associated costs involved like employee benefits apart from salary

▶ Some measures push up utility bills eg power bill

Risk control techniques

1	• Risk avoidance
2	• Risk prevention
3	• Risk reduction

Risk avoidance

▶ Risk avoidance involves not performing an activity that c...
risk. Eg: not buying a property, not flying, not travelling. Th...
loss of opportunities arising out of performing such activiti...
doing a business will avoid risk but one loses on opportun...
profits.

▶ Advantages:

▶ Chances of risk is reduced to zero in case where loss expo...
not started. In situations where exposure has already start...
reduce to zero for future activities. Residual risks may still p...

▶ Disadvantages:

▶ A firm cannot avoid all losses like premature death of an...

▶ It is not feasible/practical to avoid all losses without shutti...
business eg car factory cannot avoid all risks if it has to c...
producing cars

Risk control techniques-Risk prevention

▶ It refers to measures that reduce the freq of a particular loss. This focusses on stopp losses from happening. Important to prev death/injury to people.

▶ Businesses employ loss control engineers identify sources of risks and institute corre actions. Like poor lighting, poor mainten improper security, etc. training is given or aspects

▶ Eg: changing slippery floor, building safet enclosures to dangerous machinery etc

Risk control techniques-Risk reduction

Risk financing techniques- risk retention.

Risk financing techniques- risk transfers.

Risk management decision methods

▶ Risk avoidance

▶ Loss control

▶ Risk retension

▶ Non-insurance transfers

▶ insurance

Pooling arrangements and diversification of risk

▶ Most popular risk management tool is diversification. Es
part of insurance/financial markets

▶ Simple methods like pooling between two to diversifica
amongst many

▶ Pooling arrangement reduces risk when losses are indep
(uncorrelated)

▶ Pooling refers to spreading losses incurred by a few ove
entire group so that everyone bears average loss insted
actual loss.

2-person pooling arrangem

- ▶ Shahrukh and Salman have a possib of an accident in the coming year,

- ▶ 20% chance of an accident with a 2500

- ▶ Probability distribution of accident is highly skewed. (0 – 0.8; 2500 – 0.2)

- ▶ Their losses are uncorrelated.

- ▶ What is the expected loss and stand deviation for each one of them?

▶Expected loss = 0.8*0 + 0.2*2

$$= 500$$

▶Standard deviation

$= \text{Root } 0.8(0\text{-}500)^2 + 0.2(250$

$500)^2$

$$= 1000$$

Pooling arrangement...

▶ Pooling allows them to poo
their risk and split losses equ

▶ What is the expected loss a
standard deviation for eac
one of them?

Pooling arrangement..

Possible outcome	Total cost	Cost paid by each person	Probabilit
Neither Shahrukh nor salman	0	0	0.8*0.8=0.
Only Shahrukh	2500	1250	0.2*0.8=0.
Only salman	2500	1250	0.2*0.8=0.
Both of them	5000	2500	0.2*0.2=0.

▶ Expected cost = 0.64*0+0.32*1250+0.04*2500 = 500

▶ Standard Deviation =

Root of $0.64*(0-500)^2 + 0.32*(1250-5$ $(2500-500)^2 = 707$

▶ Pooling arrangement doesn't chan either person's expected cost but reduces the standard deviation. (1 707)

▶ This is how risk gets reduced by diversification. Loss has become m predictable.

Many-people pooling

▶ Assume that now Amir khan who has the same
probability of risk also joins the pooling arrange
If anyone meets with an accident, each will sh
one-thirds of the average loss or expected loss

▶ *As more and more people join the pool, the m
loss remains the same but standard deviation
down hereby reducing the risk for each partic.*

▶ *Expected loss or mean remains the same but t
standard deviation further decreases making t
normal distribution less skewed and more bell*

▶ Note that here the risk is not transferred to any
else, but it is reduced as a whole for each poo
participant.

Fig 4.2 page 59

▶ Graph with pooling

▶ Graph without pooling

summary

▶ As the number of participants in a pooling arrangement goes up, the standard deviation coming down as near to zero as possible for ea participant. Probability of extreme high or low outcome is reduced. This leads to the law of lar numbers.

▶ Law of large numbers states that "The greater number of exposures, the more closely will actu results approach the probable result that are expected from an infinite number of exposures tossing a coin a million times)

▶ Also, as the number increases the probability distribution curve of average loss tends to beco more and more bell shaped tending towards a Normal distribution. This reflects central limit the

Solve

▶ Suppose each participant in a poo
arrangement has USD 0 to 4000 loss
with each participants expected lo
usd 1000, sketch the probability
distribution of average losses if the l
across the participants are indeper
and if

▶ 1. there is 1 participant (no pooling)

▶ 2. there are 100 participants

▶ 3. there are 1000 participants.

Pooling with correlated loss

Positive correlation because of:

▶ Catastrophe and epidemic hit a large populati
the same time

▶ When losses are correlated then increase/decre
one leads to increase/decrease in another.

▶ Therefore, Pooling arrangement reduces risk for
participant even when the losses are positively
correlated *but to a lesser degree.*

▶ Assuming Shah Ruk and Salman's accidents are
correlated, then probability of shah Ruk having
accident knowing that Salman has had an acc
> 0.04

Changing scope of financial management

Changing scope of risk management

▶ Traditionally risk management focused o
   loss exposures including property risks,
   risks and personal risks.

▶ In 1990s new trend emerged whe
   management included speculative fir
   risks.

▶ Recently some businesses have expande
   scope to include all risks.

Financial risk management

► Financial risk management refer
identification, analysis and treatme
speculative financial risks which includes

  - commodity price risk

  - interest rate risk

  - currency exchange rate risk

► Commodity price risk: it is the risk of
money if the price of a commodity cho
Both producers/sellers and users have t
Eg: agri grains

Futures&options can be used to hedge t

Financial risk management

▶ Interest rate risk:

Risk of loss caused by averse interes
movements. Eg: a bank has loaned h
loan for 20-30 years at a particular interes
If rates go up, they have to borrow deposi
higher rate. Similarly a corporate may
issued bond o public at a rate, they have
pay the coupon rate

▶ Currency exchange rate:

Exchange rate is the value at which
country's currency is converted to a
Nation's currency. This affects both impor
exports.

History of Managing financial

► Traditionally pure risk and speculative ris
different and handled by separate departm

► Pure risk by risk retention, risk transfer a
control.

► Speculative risk handled by finance
through contractual provisions and capital
instruments.

- contractual provisions include call feat
bonds and adjustable interest rate provis
mortgages

- capital market approaches include fo
futures options and swaps

History

▶ In the 1990s some companies started taking a
  view of pure and speculative risk to achiev
  advantage by combining both the risk coverag

▶ In 1997, Honeywell became the first company t
  into an "integrated risk program" with AIG.

▶ An integrated risk program is a risk treatment tec
  that combines coverage for pure and speculat
  in the same contract. Honeywell covered tra
  property and casualty insurance as well as co
  for currency exchange rate risk.

▶ Some companies created a new position calle
  risk officer(CRO) who is responsible for treatr
  pure and speculative risks in the organization.

History

▶ Combining two risks in the same contract makes it cheaper.
Companies who can afford a certain level of loss can go fo
trigger option where the insurance company pays only if tw
specified losses occur like one property claim and another e
rate claim. Such contracts are cheaper.

Enterprise risk management

▶ some companies went a step further and covered pyre risk,
speculative risk, strategic risks and operational risks.

▶ Strategic risk refers to uncertainty regarding the organization
and objectives and the organization's strengths, weaknesse
opportunities and threats.

▶ Operational risk refers to risks that develop out of business op
like manufacturing products and providing service to custom

▶ Combining all these risks in one package reduces risk as lon
are not positively correlated. If they are negatively correlate
be reduced significantly.

History

Advantages of ERM:

▶ Holistic treatment of risks

▶ Advantages over competing businesses.

▶ Positive impact upon revenues

▶ Reduction in earnings volatility

▶ Compliance with corporate governance guidelines

Barriers to ERP:

▶ Organisation culture

▶ Turf battles

▶ Perception of not a priority

▶ Lack of formal process

▶ Deficiencies in intellectual capital and technology

Futures and option basics

▶ Spot market: delivery based

▶ Example- buy wheat at 30,000/ton, sell sugar at 45000/to

Derivative contracts

▶ Futures market: right to buy/sell, usually no delivery, squa
position.

▶ Eg: as a buyer buy wheat futures for june at Rs 25,000/to
market price is 30,000. you square up position by selling s
make Rs 5000. buy physical wheat at Rs 30,000 from spot
Effective price is Rs 25000 which is futures contracted pri

▶ As a seller, sell wheat at Rs 40,000 in the june futures mar
price crashes to Rs 20,000. you square up your position b
spot. You make Rs 20,000. sell physical wheat at Rs 20,00
spot market. Effective price is Rs 40,000

Options contract

▶ Options contract can be used to protect against adverse price movements.

▶ Call option – option to buy at a specified price during a spec period

▶ Put option – option to sell at a specified price during a specifie

▶ Both call and put have buyers/writers and sellers (4 legs)

▶ Many strategies like straddle, strangle, butterfly,...

▶ Simple option to protect a price drop is "covered put option"

▶ Eg: someone has 100 HUL shares at current market price of Rs fears a price drop but feels it may also increase.

▶ He buys a put option for a strike price of 900 paying a premiu

▶ If market drops to 800, then he exercise his 'in the money' opt makes 900-800-5 = Rs 95

▶ If market moves up to 1000, then the option is out-of-money a wishes not to exercise the option and loses only Rs 5 of premiu

Hedging with Futures

Hedging a commodity risk using futures contract:

▶ A corn grower estimates in May about 20,000 bushels of December. He notices a price of $2.90/bushel of futures December. He fears that the actual spot price in Decem be lower. So he books 4 contracts of size 4000 bushels e $2.90/bushel. He will buy back 4 contracts to offset his p

▶ If market price is 2.5/bushel in December.

▶ Sale of 4 contracts at 2.90 in may ….   4*5000*2.90 =   580

▶ Buy-back at 2.50 in December ….   4*5000*2.50 = 50000

▶ Gain on futures contract = 58000-50000 =   8000

▶ Sale of physical stock in December = 4*5000*2.50 = 5000

▶ Total revenue = 50,000+8000 = 58000

Hedging with futures

▶ If market price is 3.00/bushel in December.

▶ Sale of 4 contracts at 2.90 in may ….   4*5000*2.90 =   580

▶ Buy-back at 3 in December ….   4*5000*3 = 60000

▶ Gain on futures contract = 58000-60000 =   (2000)

▶ Sale of physical stock in December = 4*5000*3 = 60000

▶ Total revenue = 60,000-2000 = 58000

▶ So, no matter what the price is in December the farmer g
contracted price of may of $ 58,000.

Solve,

1. You are having 100 shares of HUL and the current marke
   Rs 900. you fear that the market will crash and sell it in th
   futures market at Rs 950. in june the price of HUL comes t

   Calculate your realisation

   What is your realisation if the price comes down to Rs 90
   your gain in the whole transaction?

2. Colgate palmolive is quoting at Rs 1000/share. You expe
   market to go up. So you buy futures at Rs 1050 for June.
   market goes to Rs 1250. what is your profit? What would
   happened if you had bought spot?

Insurance market dynamics

▶ Risk control, risk retention and risk transfer are t
   methods of risk management

▶ Risk retention by current earnings, loss reserves,
   borrowings or captive insurance

▶ Risk transfer by a property and liability insuranc
   company.

▶ Decision needs to be taken about risk retention
   transfer. It depends upon conditions in the insur
   market-place.

▶ 3 imp factors influencing insurance market are:

▶ - underwriting cycle

▶ - consolidation in the insurance industry

▶ - securitisation of risk

1. Underwriting cycle

▶ Underwriting means "sign and accept liability unde
insurance policy), thus guaranteeing payment in c
or damage occurs"

▶ Underwriting cycle – property and liability insurance
fluctuate between periods of tight underwriting stan
and high premiums called 'hard' insurance market
periods of loose underwriting standards called 'soft'
insurance market.

▶ This is measured in terms of combined ratio which is
paid losses and loss adjustment expenses plus und
expenses to premiums

▶ If Combined ratio is more than 1 (100%) then underw
operation is profitable. Less than 1 is loss making.

▶ Risk managers must study current status of the cycle
making retention-transfer decisions. Buy when mark
and retain when the market is hard

Y underwriting cycle fluctuat

▶ 1. Insurance industry capacity - capacity refers
   relative level of surplus which is assets less liabilit

   They reduce premium and go soft when they
   surplus and increase premium and go hard whe
   are deficit. Competition hastens this process.

   External factors like earthquake, 9/11, katrina a
   increase claims and reduce surplus and harder
   market.

▶ 2. Investment returns- insurance business also is
   investor generating revenues from premium co
   They sell insurance at lower premiums expectin
   investment returns. this is called 'cashflow unde

2. Consolidation in industry

▶ Consolidation means combining of business organisatio through mergers and acquisitions.

▶ A number of trends have changed the insurance marke like

▶ - insurance company mergers and acquisitions

▶ - insurance brokerage mergers and acquisitions

▶ - cross-industry consolidations

▶ (Read george rejda page 68 for examples)

Securitisation of risk

▶ Securitisation of risk means that insurance risk is transfer the capital market through creation of financial instrum such as catastrophe bond, futures contract, options co and other financial instruments.

▶ This increases capacity for insuraers and provides acce capital of many investors.

▶ Weather is another factor that determines risk in insuran weather bonds are floated to securitise it. A weather o provides a payment if a specified weather contingeno
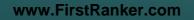
Loss forecasting

Done on the basis of statistical analysis of past losses.

Risk profiling or risk mapping refers to analyzing the severity frequency of various risks involved in the business.

Based on loss forecasting the manager is able to decide of control measures.

Loss forecasting is done on the basis of

▶ Probability analysis:

▶ Probability or chance of loss of an event refers to the lon frequency of accurrence. Probability distribution is mutuc exclusive and collectively exhaustible list of all outcomes out of an event along with probability associated with ea outcome.

▶

▶ Statistical analysis:

▶ It talks about a distribution of losses and parameters asso
with it like mean mode median regression analysis and n
tables.

▶ Regression talks about relationship between one or more
dependent variables and an independent variable. Eg Y

▶ Mortality table indicates probability of death at a particu
mortality rate of 0.001at an age of 25 indicates that 1 ou
insured will die during that year. If all the 1000 are insured
each then the company has to pay 1 lakh. In order to do
company has to collect Rs 1 lakh from 1000 insured whic
to 100 per lakh of sum assured or 1 per 1000 sum assured

▶ Law of large numbers: