Economics of Banking and Finance Markets
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Lecture - 28
Economic analysis of regulation: measuring risk

Welcome to this session. Now, we are going to discuss an economic analysis of financial regulations. The topics that we are going to cover- why a financial regulation is important, what all makes financial regulation relevant and in order to regulate financial sector, what all the tools are being used by the regulator.

So, to begin with, first we are going to discuss why do regulators use value at risk as the measure to minimize investment risk.

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So, in this context why regulators use a 'value at risk' as the measure. So, in this topic we further discuss this theme, by what is meant by risk, in the case of investment what is meant by investment risk. And then we will discuss some of the statistical measure used in analyzing or measuring investment risk.

Then we will see what kind of measure regulators are interested to use. And then subsequently we will discuss other kinds of risk, the systematic and idiosyncratic risk, and some of the strategies for risk reduction, including hedging and diversification.

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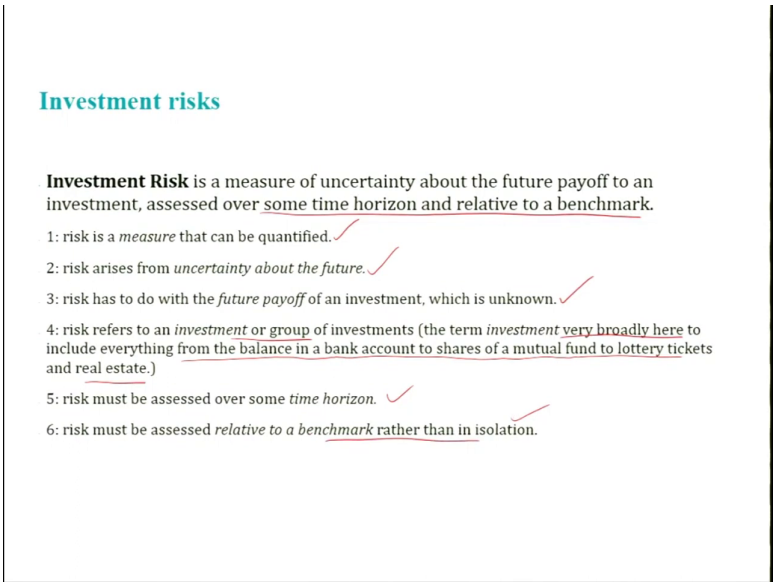

So, coming to the first part, investment risk is a measure of uncertainty about the future payoff to an investment assess some time horizon and relate you to a benchmark.

So, it has several features, the characteristics of investment risk, when as per our definition. So, one you know that is a measure that can be quantified, the second one is that risk arises from uncertainty about the future. And the third one is risk has to do with the future payoff of an investment, which is unknown. The future payoff in most investment is uncertain, that is what is all about, the investment is going to make is riskier. So, that is the third aspect.

And the fourth one is that risk refers to an investment or group of investments so; that means, the term investment here broadly include everything from the balance in a bank account to shares of a mutual fund to a lottery ticket and real estate. So, these are all investments that we refer here. Risk must be assessed over some time horizon, every investment has a time horizon, someone hold some investment for a day or 2 and others for many years.

So, in most cases the risk of holding an investment over a short period is smaller than the risk of holding it over a long one. Finally, risk must be assessed relative to a benchmark rather than in isolation.

So, someone tells you that an investment is risky so normally we say that relative to what investment is risky, but relative to what. So, that is another important area that the relative to

an investment with no risk at all that is the benchmark that we will be using; that means, the benchmark is a risk-free investment.

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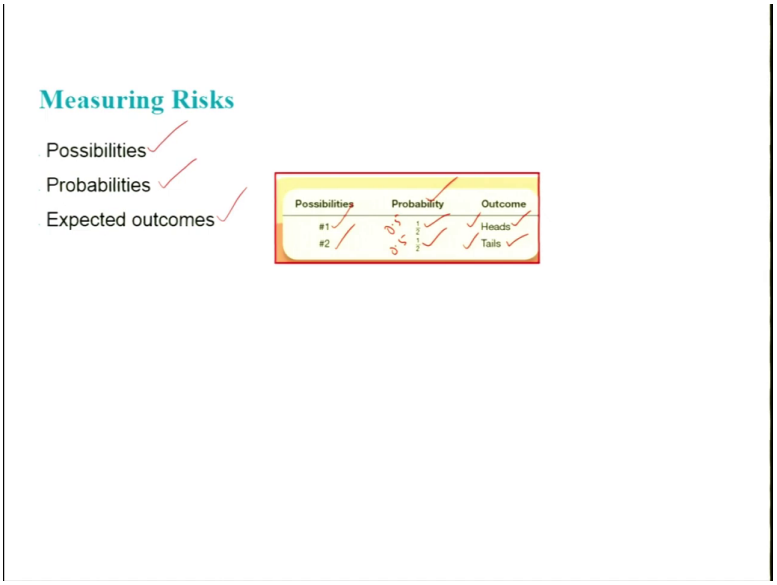

Let us now discuss how to measure risk. Since now you are familiar with the definition of investment risk, let us see what the approaches of measuring risk are. So, in the case of measuring risk, there are three aspects.

One is possibilities and second one is probabilities and the third one is expected outcomes. So, about the possibilities you know what the possible outcomes are when you make an investment. So, it can be explained by using an example of tossing a coin.

So, when you toss a coin, what are all the possible outcomes? Obviously, you know that there are only two and only two; that means, the two possibilities because the coin can come down either heads or tails. So, that is the possibility, two possibilities here we just mentioned. Similarly for investment there will be several possibilities, that we will discuss in appropriate context, sometime some in this session itself, some in the future sessions.

Then coming to the second aspects: probability. What is the probability? Taking the same example of the coin, what is the chance of each one of these two outcomes occurring. So, if the coin is fair, it will come down heads half the time and obviously, tails the other half that is what we mean by fair, here. So, if we tossed a fair coin over and over again, thousands of

times, millions of times it would come down heads half the time and tails other half. So, for any individual toss the coin has an equal chance of coming down heads or tail.

So, when we quantify here, you know that this is the probability of head coming up is going to be 0.5 that the half 50 percentage, 0.5 is the probability and tail; obviously, you know that is also 0.5 that the half, one half so this is the probability. So, probability means that you may be aware that is a measure of the likelihood of an event will occur. So, it is always expressed as a number between 0 and 1. So, closer the probabilities to 0, the less likely it is that the event will occur.

So, that is about the probability, then the outcome here we know already; that means, the outcome is head, and another outcome is a tail; heads and tails. So, then coming to this possibility is that there are two possibilities, and these are the two probabilities, that is 0.5, 0.5 the outcome is heads and tail. This is a simple example of tossing a coin that we are also familiar. So, let us apply this one in the context of investment.

So, what are the possibilities, probabilities, and outcomes, we need to include the expected return of investment as well.

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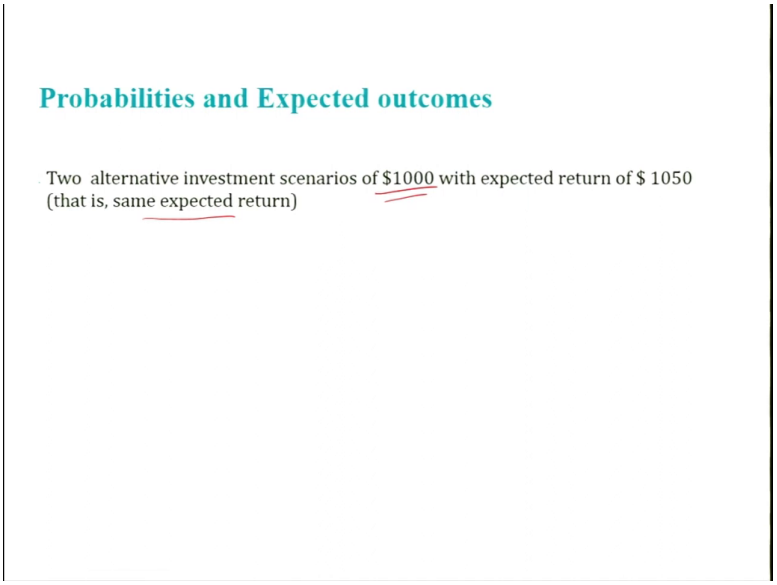

So, to discuss this, let us take the case of two alternative investment scenarios of 1000 dollars. So, throughout this discussion let us take an investment of 1000 dollars with expected

return of 1050. So, that the same expected return we are getting from two alternative investments.

Then in this case, let us see how we can relate it with the possibilities, probability, and outcomes.

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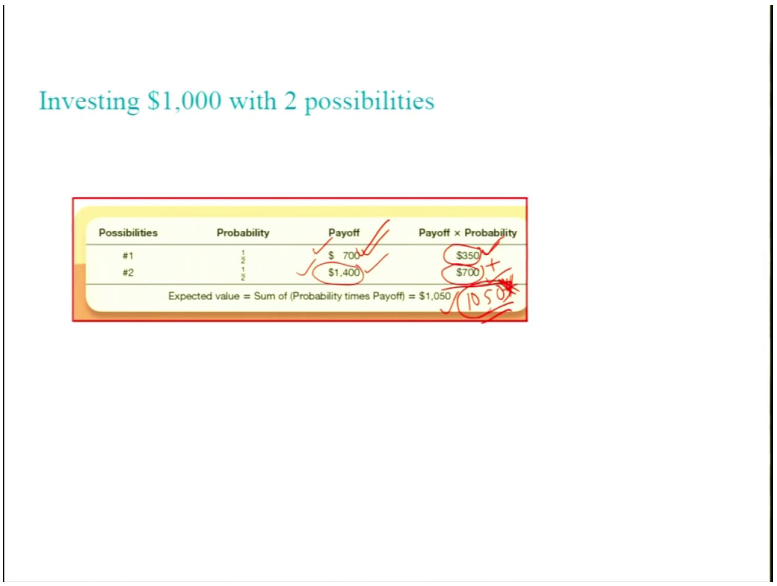

So, let us take the case, one investment, assume that for 1000 you can purchase a stock whose value is equally likely to fall to 700, that is one possibility with a probability of 0.5, when you invest 1000 in stock, maybe when the stock market down it can go down to 700. So, the stock value equally likely to fall to a 700, that is 1 possibility.

Another outcome is going to be it can rise to 1400. So, we will refer the amount you could get back as the investment is payoff. So, what is the payoff here? The payoff here is the probability, right. So, the probability of becoming that the falling the stock price from 1000 to 700 is 0.5. So, the payoff that we are going to get is 700, then the payoff times probability is going to be 0.5 times 700, that is dollar 350 right.

So, that is in the case 1, that the possibility 1. In possibility number 2, when the stock price increases the payoff is 1400 and the probability of getting that one is 700 right, that payoff times probability. So, in this case let us see in this we need to calculate the expected value of the investment.

It is straightforward you know that expected value is the sum of the probability times the payoff. That means, this plus this; that means, when summing you will be getting 1050, that is the payoff the expected value of the investment from this investment is 1050.

So, in general, the expected value concept that the expected value of an investment is a very useful concept, but it can be difficult at first. The problem is that if you make this investment only once we will obtain either 700, you will get either 700 or 1400, not 1050, right. We will not be getting this 1050 once. However, in fact, regardless of the number of times we make this particular investment, the payoff will never be 1050, is never going to be 1050.

But the relevancy here is that what would happen if we were to make this investment 1 million times, maybe half a million times those investment would pay 1400, another half million times we will get 700. So, at the end, again we are going to get if you do the calculation then; obviously, we are going to get the spectral value 1050. However, since the future is uncertain, we do not know exactly how much the payoff will be.

So, since there is uncertainty in that context actually, we can use this expected value as one of the measures to understand what the outcome of the return possible return from the investment is.

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So, in this case, what are the measures that is commonly used to measure this risk, for example, in this investment. In this investment what are the measures of risk that we can use?

There is one measure, that is very commonly used to measure the risk of an investment: variance and standard deviation.

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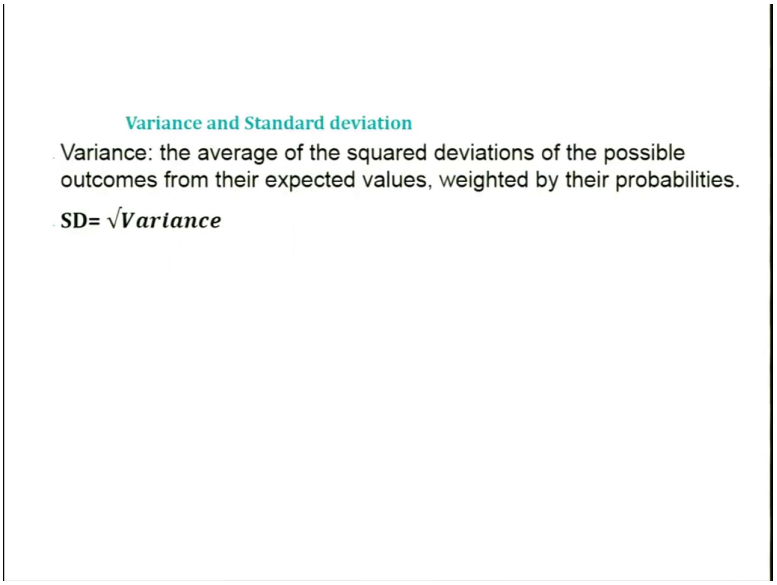

So, in the case of variance is defined as the average of the square deviations of the possible outcomes from their expected values weighted by their probabilities.

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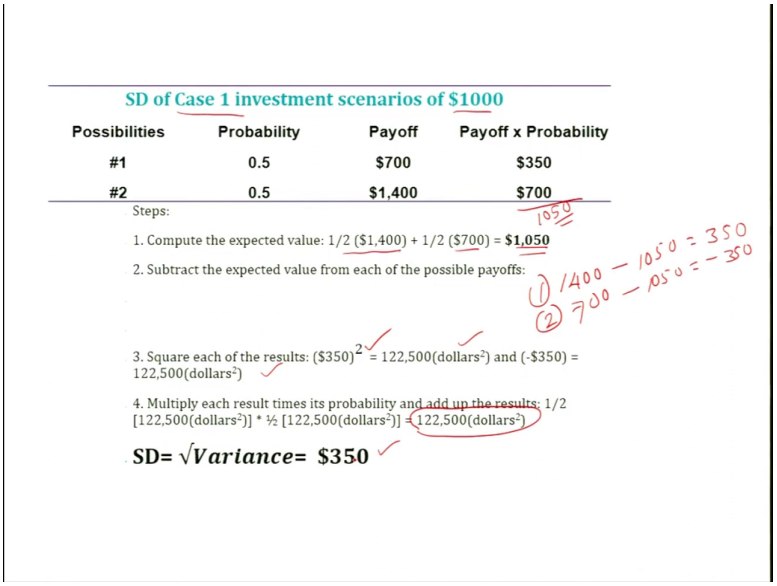

Let us take the example the which we just mentioned now. The two cases, one case we already discussed, that is this one. The case 1 is investment of 1000 with an expected value of

1050 and out of this let us calculate the standard deviation of this investment. So, how to calculate? I think you must be familiar with this kind of concept. So, let us have a quick review of how to calculate the standard deviation of this investment.

So, what you need to do? The expected value expected value is these times this, that is 1050, first calculate the expected value, then calculate this one, that then subtract the expected value from each of the possible payoff. That means, one 1400 minus 1050 is equal to 350, that is one, in the process. So, that is one first 1 step, another we need to calculate 700, that is the payoff minus the expected value that is 1050 is equal to minus 350.

So, then the procedure for calculating SD here is, first the variance calculation, square each of the results, that the 350 square so; that means, you will be getting this and this. So, square each of the results and multiplying the results times its probability and add up to the add up the results. So, finally, you will be getting this as the square of each result. Then calculating the standard deviation is, SD is equal to the variance square root of variance, then you will be getting this one is equal to 350. So, in this case you can see that the standard deviation is going to be 350.

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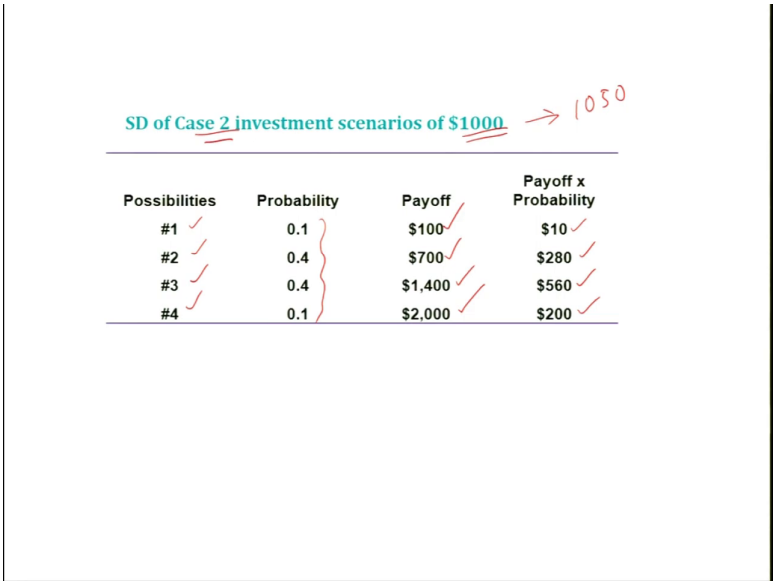

Let us now take another example, another case investment case 2 where the scenario says the investment is same 1000 and again, we are going to get the same expected value here as well, 1050, let us see the payoff, the standard deviation of this investment. So, standard deviation

of this investment, again we have here, we take four possibilities number 1, number 2, number 3, number 4, and the probability we are having these values.

And the payoff in one investment, suppose the same for example, you are buying a stock, you are going to get the stock price from 1000, it may fall to 100; that means, you are going to make a loss of 900. It may rise to 1400 and if there is a huge bull in the market, then the bullish market you can see that it can go up to 2000. So, these are the four payoffs, then the payoff times probability that we can already calculate from here, then you will be getting these values. So, in this scenario how do we calculate the standard deviation?

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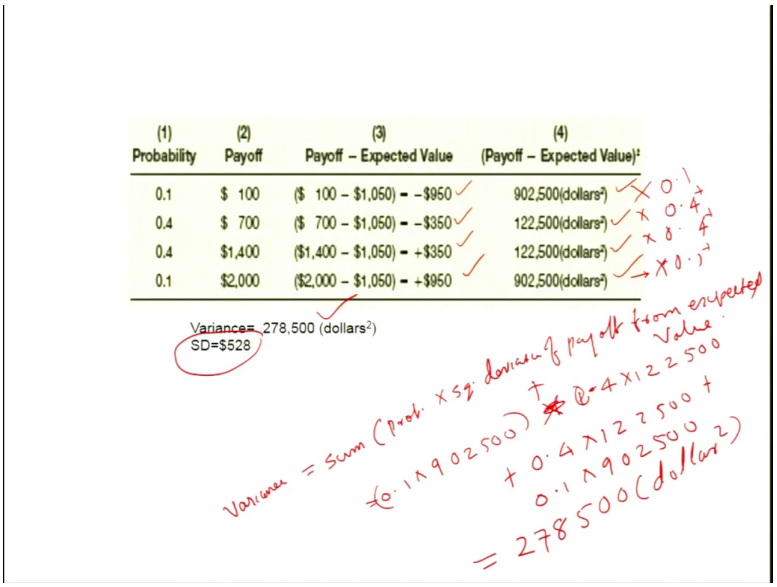

So, the standard deviation you will be getting, we discussed already, payoff minus expected value, then you will be getting these values payoff minus expected value square. Then the variance, variance is the sum of probability times square deviation of the payoff from expected value, that is going to be these times 0.1, this times 0.4 times 0.4 again, times 0.1 this one.

Then what are the value that we are getting, we need to add this one together, maybe we can say here the variance that you are getting here is variance here is equal to sum of probability times square deviation, square deviation of payoff from expected value that we will be getting 0.1 times 122500 plus 0.4 times 500 plus 0.1 times 92500. Then you will be getting the value that you will be getting from this calculation is 2785-dollar square dollar square, this is the value you are going to get.

So, the standard deviation of this one, that, this is the value that we are going to get. So, the standard deviation of this one is going to be 528. So, let us look at the previous case, that we got the standard deviation of 350 from this investment and in the second investment we are going to get a standard deviation of 528.

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So, looking from these two investments, one is having a standard deviation of 350 and another is having a standard deviation of 528. So, normally a firm, an investment fund, they will be preferring the investment, investment strategy of case 1 in fact. This one they will be preferring because the standard deviation the risk spread is low, and they will be preferring this investment. This is from the perspective of an investor or an institutional investor, for example.

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This is the most common measure of risk, but in the perspective of regulator, we need to take a different approach of measuring risk. This may not yield the correct measurement of the risk, let us see why.

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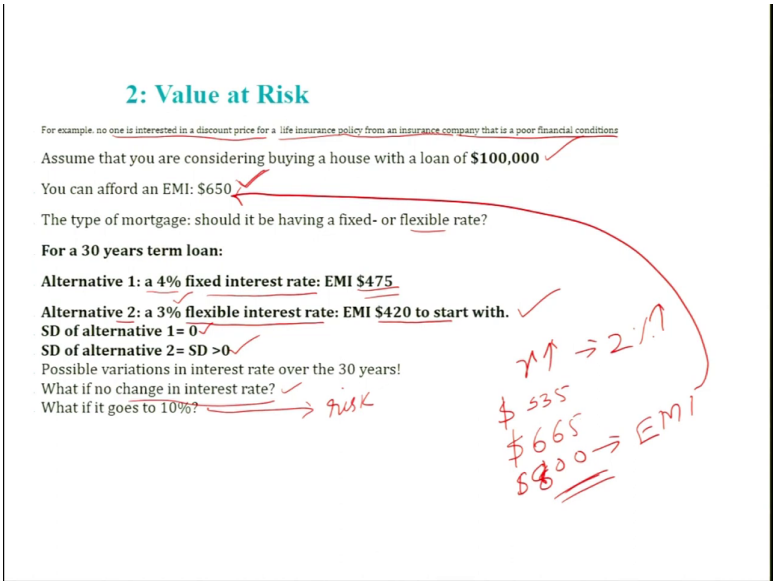

So, because here, suppose, the risk is very low, but at the same time you know that no one is interested in a discount price for a life insurance policy from an insurance company with poor financial conditions. No one wants the local bank to close its door, even if it is giving the standard deviation the measure that we are getting is very low and is giving high payoff. But

similarly, neither the customer nor the government, regulators care how well or how badly a financial institution shareholders fare so long as they do well enough to keep the doors open.

So, in this case, suppose what if the insurance company collapse? What if the bank collapse? That is a catastrophic loss. So, even no one, individual investor, institutional investor, or government, they do not want to see that kind of outcome, that the worst outcome they do not want to see. So, in this case the concept used to assess this sort of catastrophic risk is called value at risk.

So, let us examine how the concept called value at risk. So, to understand this one, let us take an example of that you are considering buying a house with a loan of 1 lakh. Let us take this example and given your economic condition you can afford an EMI of dollar 650, the assumption here is that you cannot afford given your salary pay conditions and all, you can afford beyond 650 EMI per month.

So, here the question is the type of mortgage, what kind of mortgage suppose you find a nice house and you want to buy, and you can afford only 650, but when you want to take a loan, you need to decide on the type of mortgage to get. So, should it have a fixed or flexible rate, that the adjustable rate.

So, the answer is different for different people. So, in your case let us see if we can organize our thinking with the regard to this example and see clearly that this person cannot afford more than 650 per month, then in this case let us see take the case of a mortgage loan, mortgage loan for a 30-year term loan.

So, in the case of a 30-year term loan, 1 alternative is a fixed interest rate, that is 4 percentage per month. So, the 4-percentage interest rate the EMI, accordingly the EMI is going to be 475, that is a monthly payment of 475, which is within this person's budget because maximum he can afford is 650.

So, another alternative here is alternative 2; is a 3-percentage flexible interest rate. That is the starting interest rate is 3 percentage, but the concern here is that this interest rate is flexible; that means, it may go up or it may go down. So, in this case if there is no change this is the flexible interest rate; that means, when the market interest rate goes increase, then this interest rate go will increase to 4 percentage, 5 percentage, 6 percentage like that.

So, suppose if the market rate is going to be same, that is no change in market rate of interest then the EMI is going to be 420 to start with. So, you know that in the case of investment 1, you know that the standard deviation is 0 right, standard deviation is 0. In the second case, obviously, you know that we do not know exactly how much the standard deviation is without getting what is going to be the market rate of interest, but; obviously, we know that is going to be greater than 0, because there is a possibility that market rate of interest will change.

There is possible variation in interest rate over 30 years. So, two scenarios; one what if no change in interest rate, then; obviously, you know that if there is no change in interest rate alternative 2 is the best option. Because, instead of going for simple calculation, instead of going for a 4-percentage fixed interest rate is better to go for the lower rate 3 percentage, if there is not an increase in interest rate. Even if it decreases, if go to 2 percentage then is even further, even better. What if it is keep on increasing? So, think about the scenario what if the rate of interest increase.

If the rate of interest increases; that means, this is the risk, risk is here mainly when the rate of interest increase. For example, when it goes to 10 percentage. So, that initial monthly payment, ok, it looks attractive, but when we know that, when the rate of interest keeps on increasing in the market. Suppose initially it raised to 2 percentage, suppose the interest rate could raise 2 percentage per year for the next 4 years; that means, suppose the rate of interest r is going to increase to every year is going to increase 2 percentage.

So, then you know that, the risk is that you need to increase pay initially the 535, if you will take the rate of interest is not 3 percentage instead if you take 5 percentage this going to be 535. 2nd year if it goes further then you are going to pay 665 and if it goes further then, 3rd year you are going to pay 800. This keep on increasing so; that means, if the 2-percentage increase in the rate of interest per annum when we offer flexible, you know that the EMIS is going to become, in the 3rd year EMI is going to become 800.

So, you already seen that this person can afford only 650, what if it further increases. You know that if keep on increasing then this person, all his financial plans get all derailed and you know that he will be sometimes he may loss even his mortgage house, because he cannot pay back. So, in this case what we can see that this is a kind of worst scenario.

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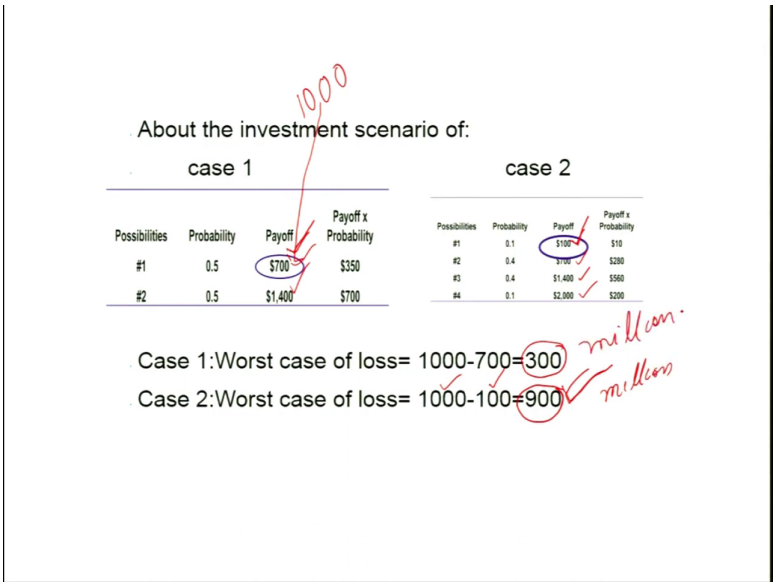

The concept that we are going to discuss here that is called the value at risk.

So, look at here, these two investments, in the two investments look for example, suppose investment that case 1. In case 1 you can see that the worst case there are two payoff, two possibilities, one is with the payoff 700. The person invests 1000, that is the example we have taken, but the stock value can go down to 700. Then 2nd option is that a second possibility is that the stock price can increase to 1400. So, look at the case 1, if the going down the worst case of loss here is this one; that means, he invested 1000, but it became 700. So, the worst loss in case 1 is 300.

And, in case 2, the worst case you know there are 4 possibilities, the payoff in each possibility, each outcome you can see that 100, 700, 1400, 2000 etcetera. But if the worst loss happening because, either of this one will happen, suppose the worst loss is for example, this outcome the possibility 1 happens. Possibility 1 happen, then the worst loss that their investment is 1000, but the payoff is only 100, then the loss is going to be 900. What if this investment, instead of an individual investor, take this one for example, the case of an institutional investor.

For example, a pension fund has made this kind of investment and you know that, in this case 2, you can see that this is the worst-case loss. And suppose we add this one instead of this 100, that 900 this one if you add million after it, suppose these are all million or billion dollars then you know it matters.

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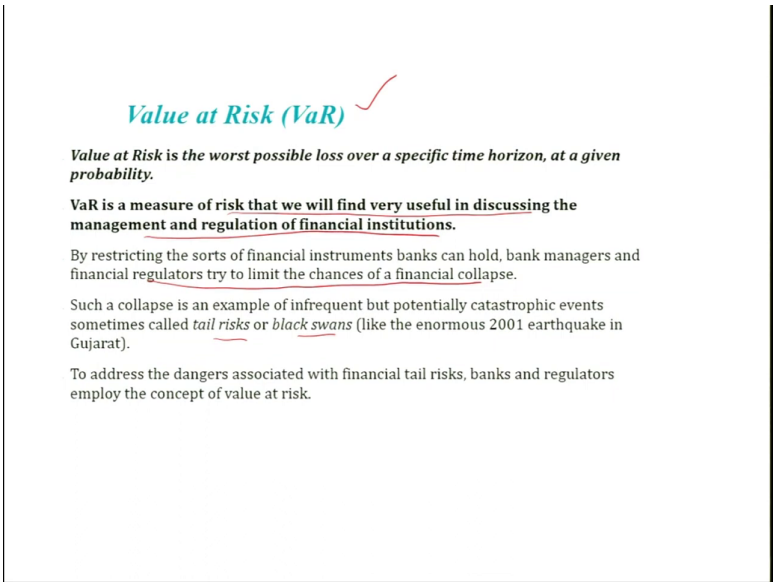

So, when it comes to this part, value at risk is the worst possible loss over a specific time horizon at a given probability. So, in this case value at risk is this, 900, is the value at risk; that means, using the value at risk we can see that case 2 is the worst one as compared to case 1.

Because here the maximum loss is 300 in case 1, but in case 2 the maximum loss is 900. So, let us summarize this concept. So, the value at risk is the worst possible loss over a specific time horizon at a given probability. And especially, this measure, we will find very useful in discussing the management and regulation of financial institutions. So, by restricting the source of financial instruments, bank managers, financial regulators try to limit the chances of financial collapse.

So, importantly such a collapse is an example of infrequent, but potentially catastrophic even sometimes called tail risk or black swans. Like for example, enormous earthquake, the earthquake happened in Gujarat. Similarly, when you approach this one, put this one in the investment case, if there is a huge loss or even an insurance company, insuring some uninsurable risk that actually the regulator will not allow.

So, simply to summarize this point, regulators especially use this concept of value at risk when they advise, when they look at the different investment strategies of investment funds.

For example, particularly public funds including pension funds, the regulator look at what is the maximum worst case of loss, the kind of investment with minimum worst loss will be encouraged.

And in the next session we will continue our discussion with some more concepts related to risk. And subsequently, we move to discuss what are the rational for regulation in the financial market.

Thank you and see you in the next session.

Keywords: investment risk, probability, possibility, outcomes, variance, standard deviation, value at risk, regulators