**Management of Fixed Income Securities**
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**Lecture - 52**
**Mortgage Backed Securities - II**

Welcome back. So, in the previous session we started the discussion on the mortgage-backed securities. So, there what we have seen that the value or the cash flow of the mortgage backed securities generally depends upon the underlying asset. And we have started the discussion on the residential mortgage loans and we discussed about certain cash flows in all these things. And there what we have seen there is one important feature that is basically the prepayment of the loan or prepayment of the mortgage that basically plays a significant role.

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In this context today we will be discussing about the concept of the prepayment risk and the other one is the default risk because there is a probability of default against that particular type of loan which is the underlying asset of the mortgage-backed securities. So, in this context we will be discussing that what exactly the prepayment risk is and if there is a prepayment risk how that particular risk is going to affect the cash flow from that particular asset.

And as well as if there is a default risk then what are the different ways the default risk is also going to affect the cash flow.

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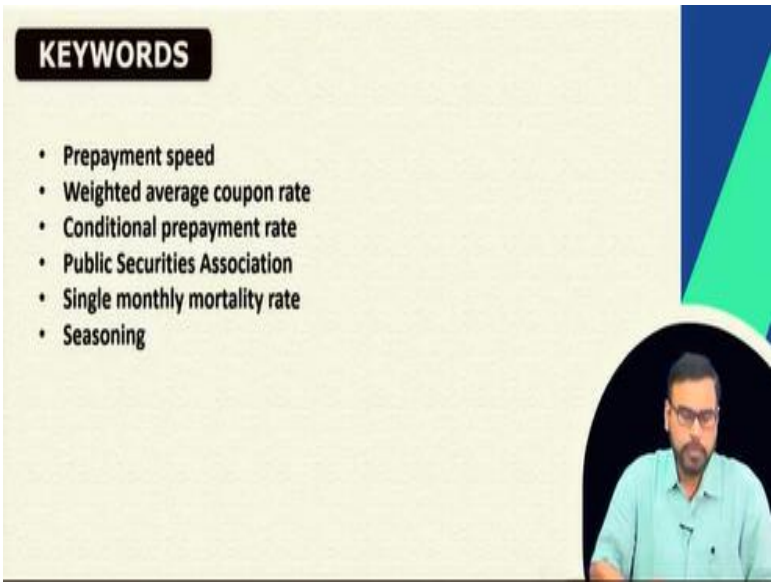


So, you will come across certain keywords in this particular session like your prepayment speed, the weighted average coupon rate, conditional prepayment rate, the public securities association, single monthly mortality rate, seasoning all kinds of concepts or all kinds of keywords we will come across over this particular session while discussing about the two broad concepts of the prepayment risk and the default risk.

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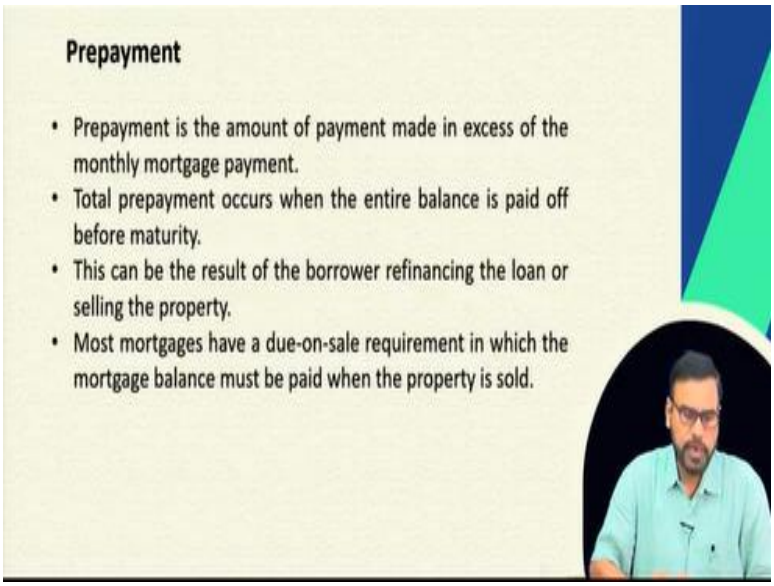


So, let us see that what exactly the prepayment is all about. Prepayment means that whenever there is a loan against that particular loan always there is a high chance that the particular borrower can go for the prepayment of the loans. Even if it is not there in the previous schedule

there is a possibility that the prepayment will be possible in that particular context. So, if there is a prepayment how this particular prepayment is going to affect the cash flow.

So, that's why already what we have discussed just now. The prepayment is the amount of the payment which is paid in excess of the monthly mortgage payment, monthly whatever stipulated amount you have to pay instead of paying of that particular fixed amount which has been fixed beforehand. So, any kind of borrower can go for the extra payment or they can prepay the particular loan in advance.

So, whenever there is a prepayment then what will happen that the total prepayment generally occurs when the entire balance is paid off before the maturity? If there is a prepayment then what will happen that the total balance which was supposed to be over by a particular time that can be always over before the maturity. So, because of this what basically will happen that or this can be the result of the borrower refinancing the loan or selling the property.

So, in that particular case most of the mortgages have a due on sale requirement in which the mortgage balance must be paid when the property is sold. So, always there is a chance of the prepayment whenever there is a kind of mortgage loan we have and there is a maturity period I can start.

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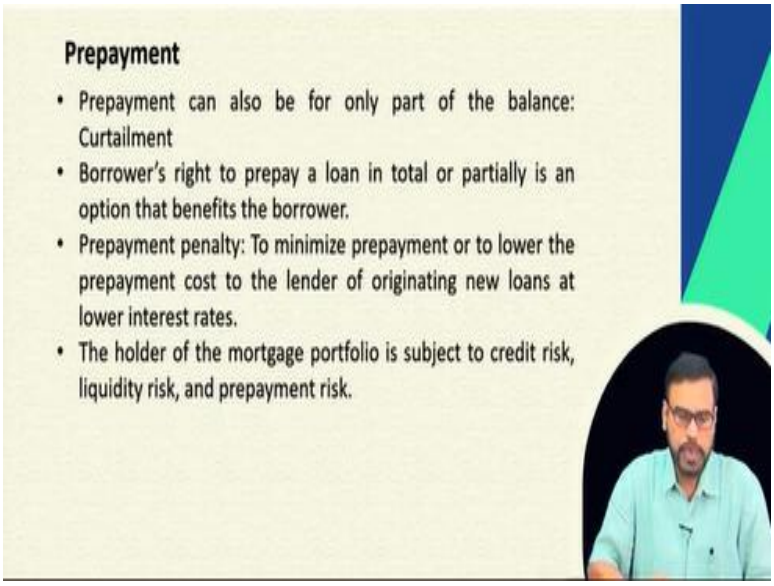


So, if there is a prepayment then what will happen in that case or what are the different ways or different forms of the prepayment can be made. So, prepayment also be for only a part of the

balance that basically call it the curtailment. So, somebody can pay that particular money in advance. So, that's why the balance will be curtailed. So, that particular concept is basically called the curtailment.

So, there is a borrower right to repay a loan in total or partially and that is basically a benefit which has been given to the borrower. So, whatever if you have somebody has taken a loan of 10 lakhs rupees so always there is a chance so there is option available to him. If, your monthly payment is let 1 lakh rupees so instead of 1 lakh somebody can pay 2 lakhs rupees in advance which can be deducted from the principal amount.

So, what basically will happen that benefit the borrower always can enjoy but that will have the impact on the particular cash flow of the security particularly the mortgage-backed security whose cash flow or whose price is derived from that particular loan? So, because of that in some cases what generally we see there is a prepayment penalty. So, the particular lender does not always encourage for the prepayment.

So, but there is a chance of the prepayment as a legal provision somebody can prepay that particular loan. So, that's why they can go for a prepayment penalty to minimize this prepayment or to lower the repayment cost to the lender of originating new loans at a lower interest rate. So, when there is a prepayment possible whenever the borrower is going to refinance that particular loan so in that particular possibility will arise whenever there is a low interest rate prevails in the market.

So, that's why there is a cost always involved with reference to the lender. So, to avoid that particular loss or avoid that particular cost sometimes what the lender can do they can go for a prepayment penalty. And with this prepayment risk the holder of the mortgage portfolio is also subject to credit risk and as well as the liquidity risk and the prepayment risk. So, we are here talking about the prepayment risk first, then we will we can come back to your default risk part.

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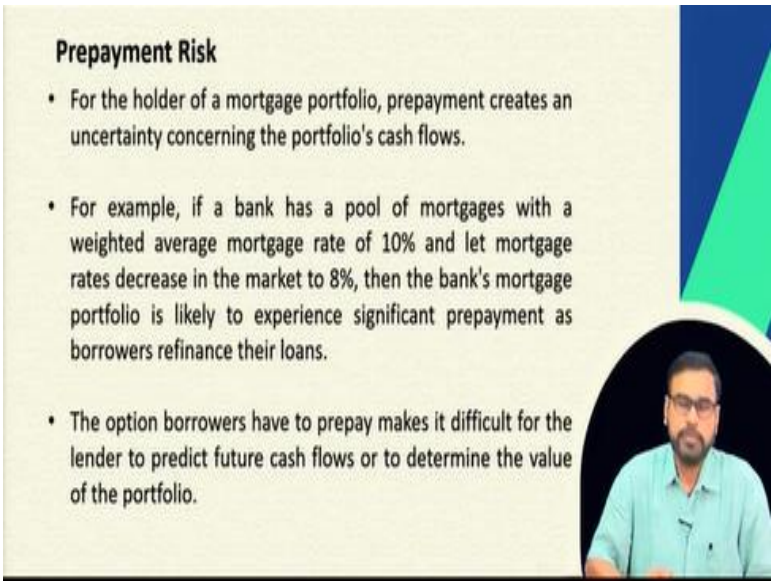


So, in this case if you talk about the prepayment risk for the holder of the mortgage portfolio the prepayment basically creates an uncertainty concerning the portfolios cash flow. Already from the beginning what we have discussed if there is a prepayment then obviously the prepayment is not predicted beforehand by the lender. So, in that particular case there is a high chance in terms of the uncertainty about the cash flow from that particular portfolio.

So, for example if a bank has a pool of mortgages with a weighted average mortgage rate of let 10% and let the mortgage rates decrease in the market to 8% then what will happen then the banks mortgage portfolio is always likely to experience significant prepayment as borrower wants to refinance their loans because the interest rate in the market is relatively low. So, in that particular case the always lender can experience that particular prepayment risk or the lender can always can be exposed towards this prepayment risk.

The option basically the borrower have to prepay makes it difficult for the lender to predict the future cash flows or to determine the value of that particular portfolio because the lender is not aware that when this particular prepayment will occur. If the lender is not aware about the timing of the prepayment of that particular money, then there is a high chance that the lender may not be able to predict the cash flow which can be generated from those particular portfolios.

So, because of that the security which is derived from that particular mortgage or particular loan that is also exposed to this particular prepayment risk. So, there is a high chance that the cash flows are going to be highly affected by that.

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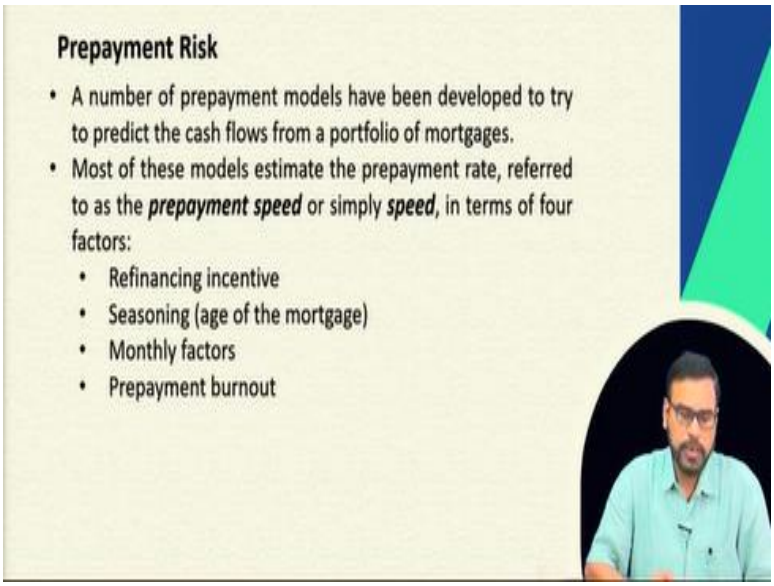


So, then what basically generally in the market we observe. There are number of prepayment models generally are developed to predict the cash flows from a portfolio of the mortgages. So, assuming there is a prepayment or the borrower can go for the prepayment then what happens that many kinds of or many types of the prepayment risk models have been developed to predict the cash flows from the portfolio of the mortgages.

So, most of these models what they are trying to do they are trying to estimate the prepayment rate. So, that generally we call it the prepayment speed or you can also call it simply speed and that speed generally we are talking about in terms of the four factors. They consider these four factors considering these four factors the prepayment speed or simply the speed always can be estimated.

Then what are those factors? One is your refinancing incentive; another one is age of the mortgage that generally technically we call it the seasoning. Then we have some monthly factors and then another concept related to that that is called the prepayment burn out. So, these are the four things or four factors what always we consider whenever we are trying to the prepayment speed.

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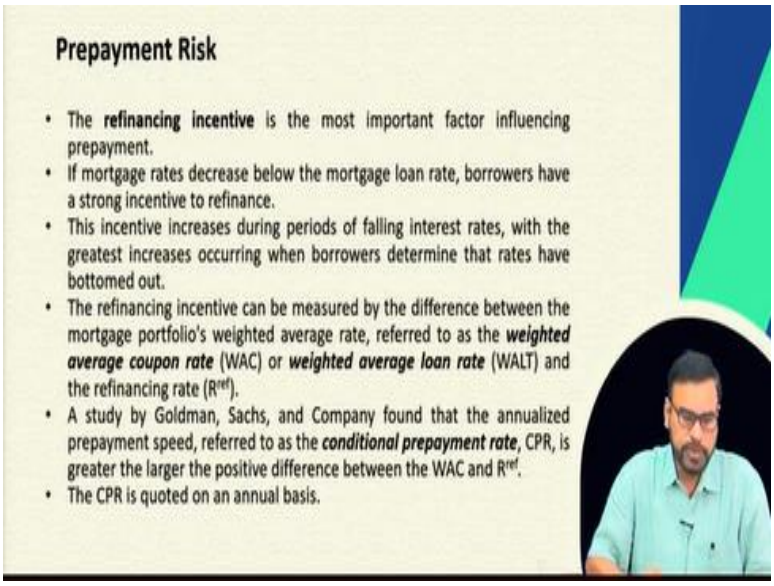


So, let us see what basically the refinancing incentive and this seasoning and other factor is all about. So, whenever you talk about the refinancing incentive this is one of the most important factor which is generally influencing this prepayment. What basically it exactly means? For example, if the mortgage rates decrease below the mortgage loan rate, then what basically will happen the borrower have a strong incentive to refinance.

The market if the interest rate is very low let you have the loan rate was 10% let it has come down to 7% in the market and there is a high chance that the borrower can go for the refinancing of that particular loan. So, in that case what will happen we have to provide certain kind of refinancing incentive. So, this incentive basically increases during the period of the falling interest rate and with the greatest increase basically occur when the borrower determined that rates have bottomed out months.

In the lower rate whenever the rate is quite low according to the borrower's expectations then that kind of possibility always arises. Then how this refinance incentive can be measured? This refinancing incentive can be measured by the difference between the mortgage portfolio's weighted average rate what we call it the weighted average coupon rate and the weighted average loan rate. That is basically called WSC and WALT and this refinancing rate.

This is the way basically the refinancing incentive can be measured. So, popularly study by Goldman, Sachs and Company generally found that the annualized prepayment speed generally,

they call it the CPR, the conditional prepayment rate that is basically is greater the larger the positive difference between your weighted average coupon rate and the refinancing rate.

So, the weighted average coupon rate is nothing but the weighted average loan rates and the refinancing rate. And the CPR is basically quoted on annual basis. This particular conditional prepayment rate what we talk about that is always quoted are always represented on annual basis.

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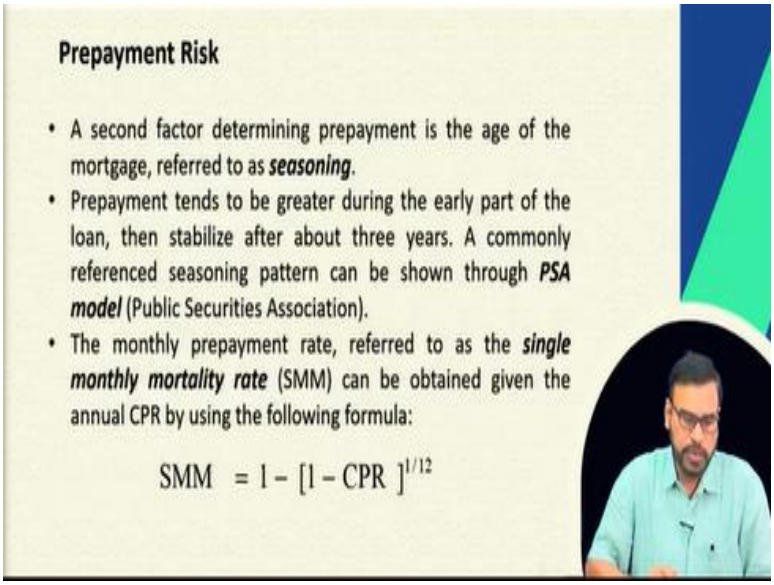


So, here if you see that the other factor is basically the seasoning or the age of the mortgage. So, generally what has been observed the prepayment basically tends to be greater during the early part of the loan then it will stabilize after about three years. So, there is a commonly referenced seasoning pattern can be shown through the PSA model which is popularly used for calculation of the prepayment risk and the monthly cash flow of the particular mortgage whenever there is a prepayment risk.

So, will be continuously using this particular concept that is called the PSA model which is given by the public securities association. So, in this case what basically we are trying to calculate, we are trying to calculate the monthly prepayment rate. So, that generally is known as the single monthly mortality rate in short, we call it the SMM. And how this SMM can be measured?

$SMM = 1- [1-CPR]^{1/12}$

Because all the cash flow whenever we always consider with respect to the mortgage-backed securities all these things basically measured with reference to the monthly rate. So, because of this the single monthly mortality rate can be calculated by getting this CPR. The CPR is basically represented or always reflected on yearly basis then if you want to calculate the single monthly mortality rate from that then this can be calculated as 1 - in bracket 1 - CPR to the power 1 by 12. Why 1 by 12? Because we are converting from yearly to the monthly.

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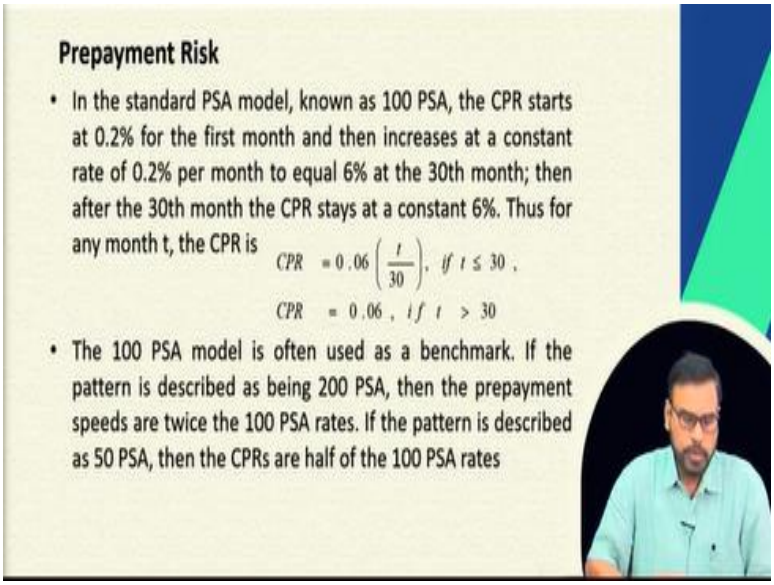


Then if you are talking about the standard PSA model, the standard PSA model is basically 100 PSA. So, as for this PSA model the CPR basically starts with 0.2% for the first month and then increases at a constant rate of 0.2% per month which will equal to 6% at the 30th month and then after 30th month the CPR basically stays at constant of the 6%. So, that is the calculation. The CPR can be also basically is nothing but the conditional prepayment rate which is reflected on the annual basis.

CPR= $0.06\left(\frac{t}{30}\right), if\ t \leq 30$

CPR= 0.06, if t>30

So, whenever you are talking about this 100 PSA model which is a standard model what generally we use whenever we calculate the cash flow of the mortgage back securities. So, here your CPR is basically 0.06 into t by 30 if your time is less than or equal to 30 months. And CPR

will be 6% if your t is greater than 30 and that 30 means you are talking about the months. So, the 100 PSA model is used as a benchmark.

But for example, if somebody is presenting the data on the basis of the 200 PSA then the prepayment speed are twice the 100 PSA rates. If it is described in the 50 PSA then the CPR are half of the 100 PSA rates. So, these are the way basically this PSA model is used to calculate the role of the prepayment risk on the cash flow estimation.

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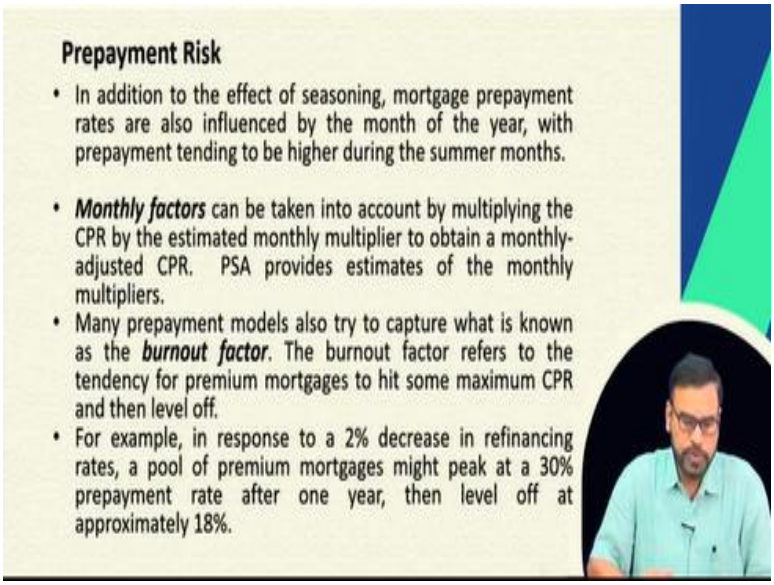


So, then if you see another type of factor is basically what just now, we have highlighted that is basically your monthly factors. So, in addition to the effect of seasoning and the mortgage prepayment rates are also influenced by the month of the year. Because the prepayment is tending to be higher during the summer months that is the general observations. So, the monthly factors can be taken into account by how you can basically consider that one.

By multiplying this CPR by the estimated monthly multiplier to obtain a monthly adjusted CPR. So, again PSA basically provides the estimates of the monthly multipliers. So, the public service association basically will securities association basically provide the estimates of the monthly multiplier. So, then many prepayment models also try to capture what is known as the burnout factor.

The burnout factor basically is nothing but it is the tendency for the premium mortgage to hit some maximum CPR then the level will be off. For example, if you see that in response to 2% decrease in refinancing rates then the pool of premium mortgages might peak at 30% prepayment rate after one year then the level off for the approximately 18%. So, these are all the hypothetical figures but that means there is a maximum rate what particular prepayment rate that some particular portfolio can always attend.

And after that it will come down and it will stabilize at a particular rate for the throughout the period up to the maturity. So, that is called the burn out factor. So, there is no such constant rule which basically tries to measure this burnout factor but this is the way the burnout factor concept can be highlighted.

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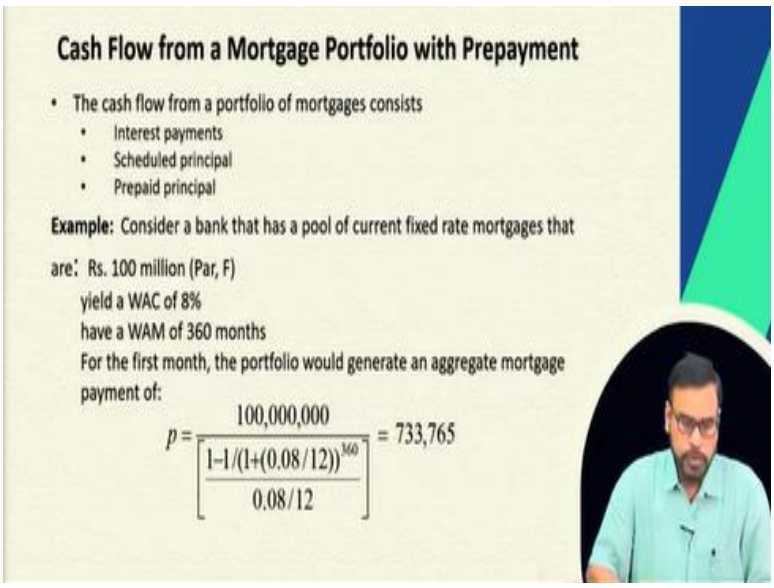


So, whenever there is a prepayment if you want to calculate the cash flow from a mortgage then how it can be incorporated. So, generally whenever you talk about a cash flow from a mortgage of the portfolio what are the components of that particular kind of cash flow. One is your obviously the interest payments, then you have the scheduled principal, then also there is a prepaid principal. If there is a prepayment then that will be deducted from the principal.

Let if you say that consider a bank that has a pool of current fixed rate mortgage let the total value is 100 million then your WAC the weighted average coupon rate is 8%, then your maturity period is 360 months that means 30 years.

$$P = \frac{100000000}{\left[\frac{1-1/(1+\left(\frac{0.08}{12}\right))^{360}}{0.08/12}\right]} = 733{,}765$$

So, this 733765 that include your interest payment and as well as the principal payments that is the component of the interest and as well as the principal.

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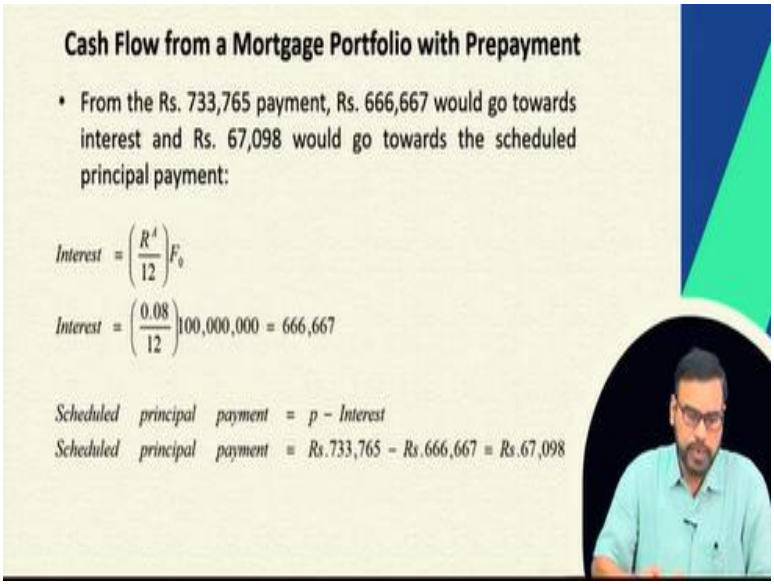


Interest = $\left(\frac{R^A}{12}\right) F_0$

Interest = $\left(\frac{0.08}{12}\right)$ 100000000 = 666,667

Scheduled principal payment= p- interest

Scheduled principal payment= Rs 733765- Rs 666667= Rs 67,098

Out of the total payment what basically can be generated from that particular loan out of them the interest will be 666667 and the principal will be 67098 so that is the scheduled principal.

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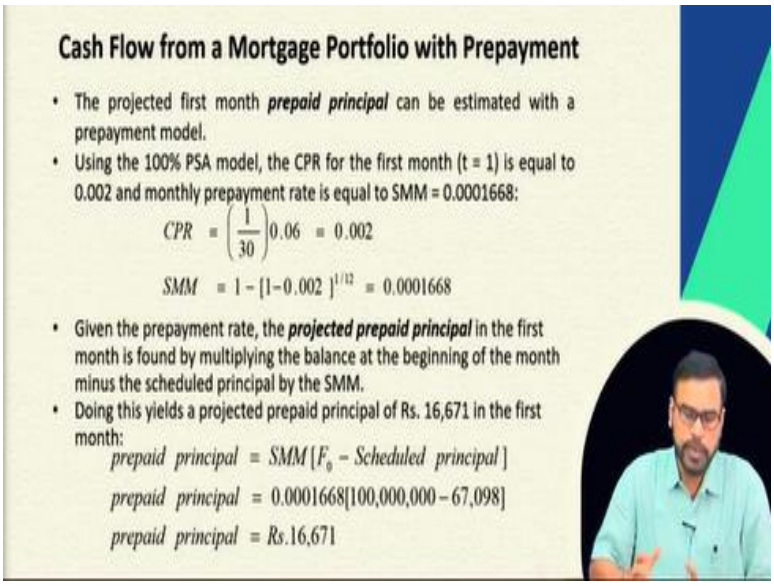


But again, if you see that if you are considering your prepayment concept into that so, then how you can calculate your prepaid principal. So, the prepaid principal can be estimated with a prepayment model. So, already we have discussed that the 100% PSA model is the standard model. So, here if you see that then how you can calculate the CPR for the first month (let t = 1)is equal to 0.002 and this monthly prepayment rate is your single monthly mortality rate that if you talk about that is your that means how much will the CPR.

CPR= $\left(\frac{1}{30}\right)$ $0.06 = 0.002$

SMM= 1-$[1 - 0.002]^{1/12}$ = 0.0001668

So, given this prepayment rate the projected prepaid principal in the first month generally how you can find?

Prepaid principal= SMM[$F_0$ – scheduled principal]

Prepaid principal= 0.0001668[1000000000-67,098]

Prepaid principal= Rs 16,671

So, that will be remaining as the principal and against that again your interest payments has to be calculated.

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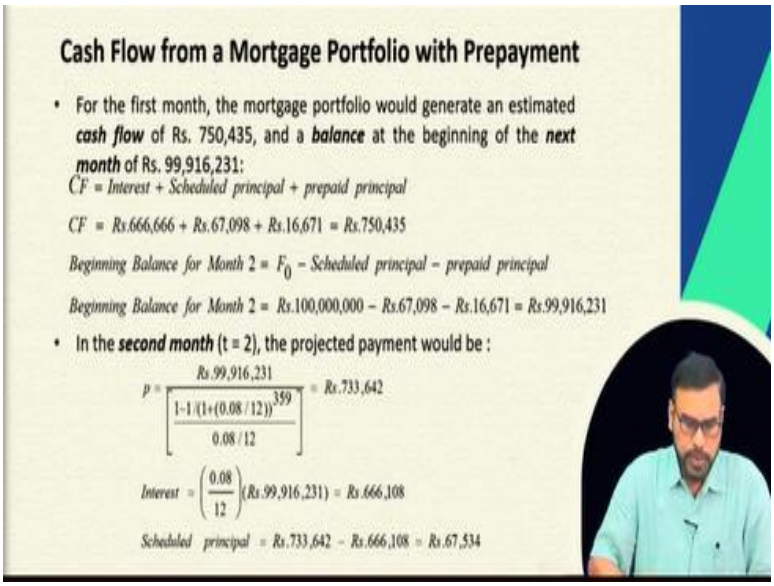


So, then just now whatever basically we have discussed with you.

Cash flow= interest+ scheduled principal+ prepaid principal

CF= Rs 666,666+ Rs67,098+ Rs 16,671= Rs750,435

Beginning balance for month 2= $F_0$- scheduled principal- prepaid principal

Beginning balance for month 2= Rs 100000000-Rs 67098- Rs16,671= Rs 99,916,231

Projected payment= P= $\frac{99,916,231}{\left[\frac{1-1/(1+\left(\frac{0.08}{12}\right))^{359}}{0.08/12}\right]}$ = 733,642

Interest = $\left(\frac{0.08}{12}\right)$ $Rs$ 99,916,231 = $Rs$ 666,108

Scheduled principal = Rs 733,642-Rs 666,108= Rs 67,534

So, for the first month the mortgage portfolio will generate an estimated cash flow of . That means your total cash flow is nothing but your interest plus your scheduled principal plus your prepaid principal. So, that means it is 666666 + 67098 + 16671 that will give you total value will become 750435.

So, then the beginning in the balance for month two that will be already I told you that is $F_0$ minus scheduled principal minus your prepaid principal that means this is your 100 million - 67098 - 16671. So, this will be remaining as the principal amount in the beginning of the month two. So, then if in the second month you are trying to calculate the projected payment then you can first calculate what is the mortgage payment from that particular year.

So, here now it is 99916231 divide by then one month is already left that is we have taken 359 then this will be the total cash flow and that includes your interest payment and as well as the scheduled principal. Then what is the interest payment? Interest payment 0.008 divided by 12 into your beginning of the month balance that will give you 666108. Then your scheduled principal will be basically your 733642 - 666108 then that will give you your scheduled principal.

And again, if you want to try to capture the prepayment part then again, the same process you can follow to find out the how much component can go to the projected principal which is arising out of the prepayment. So, that is where basically it will go on.

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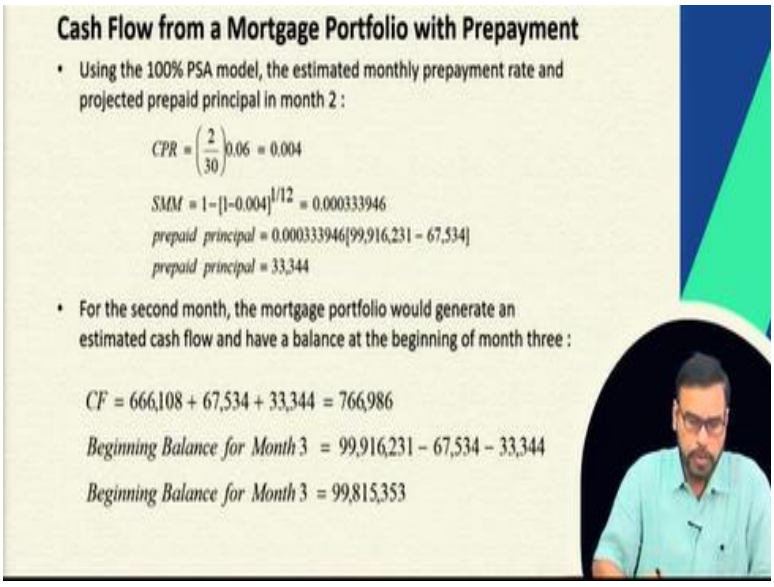


So, now if you want to calculate this 100% PSA model ;

CPR= $\left(\frac{2}{30}\right)$ $0.06 = 0.004$

SMM= 1-$[1 - 0.004]^{1/12}$ = 0.000333946

Prepaid principal= 0.000333946[99,916,231-67,534]

Prepaid principal= Rs 33,344

CF= Rs 666,108+ Rs67,534+ Rs 33,344= Rs766,986

Beginning balance for month 3= Rs 99,916,231-Rs 67,534- Rs33,344

Beginning balance for month 3= 99,815,353

So, that is the way it will go on that means we are capturing the how much principal can be generated out of the prepayment.

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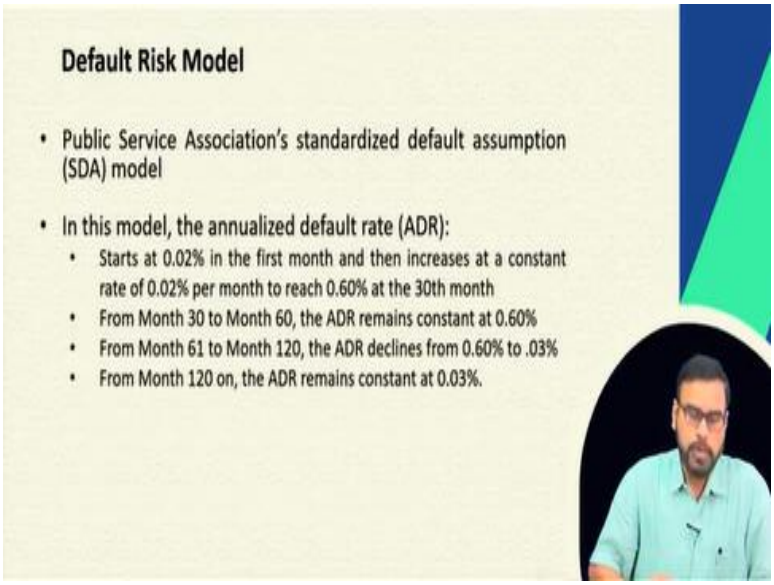


Then we have the default risk model. The public service association is again has given a kind of model for capturing this default risk. So, that is basically called the default assumption model. So, here in this model the annualized default rate they have given. It starts at 0.02% in the first month then increases at a constant rate of 0.02% per month to reach the 0.6% or the 30th month then from month 30 to month 60 this annualized default rate remains constant at 0.6%.

Then from 61 months to 120 months it will decline from 0.6 to 0.03% and from month 120 onwards this annualized default rate remain constant at 0.03%. So, that is the public service association has this PSA has basically given that calculation. This is the way basically you can calculate your default rate or you can use your default rate for calculation of your cash flow.

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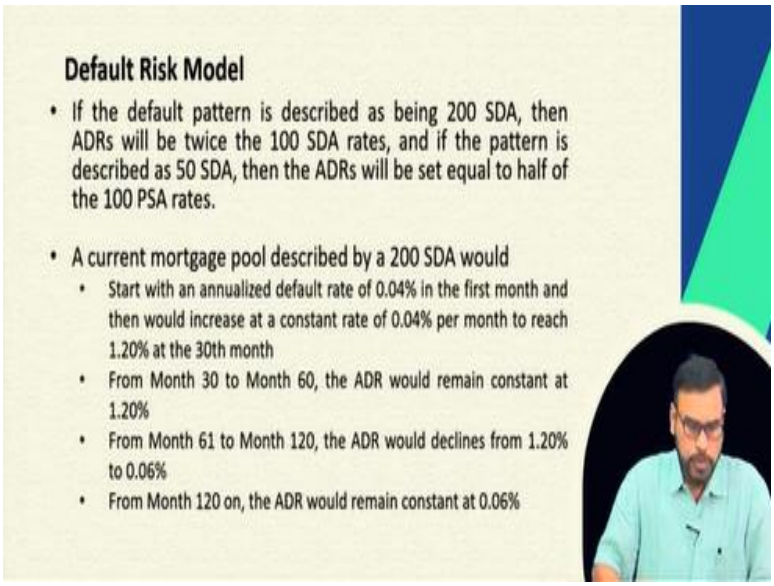


So, if you are going for a default risk model if the default pattern is described being the 200 SDA, then your ADR will be twice of the 100 SDA rates, and if the pattern is described as 50 SDA, the same thing then the ADR will be set equal to half of the 100 PSA rates. So, the current mortgage pool if you talk about described by the 200 SDA then it will become 0.04 then from it will go up to up to 30th month from 0.04 to 1.2% from 30 to 60 it remains constant at 1.2%.Then from 61 to 120 months it will decline again from 1.2 to 0.06% and from month 120 onwards it will remain constant at 0.06%.

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MDR= 1-$[1 - ADR]^{1/12}$

Monthly default loss= MDR(beginning balance- monthly scheduled principal payment)

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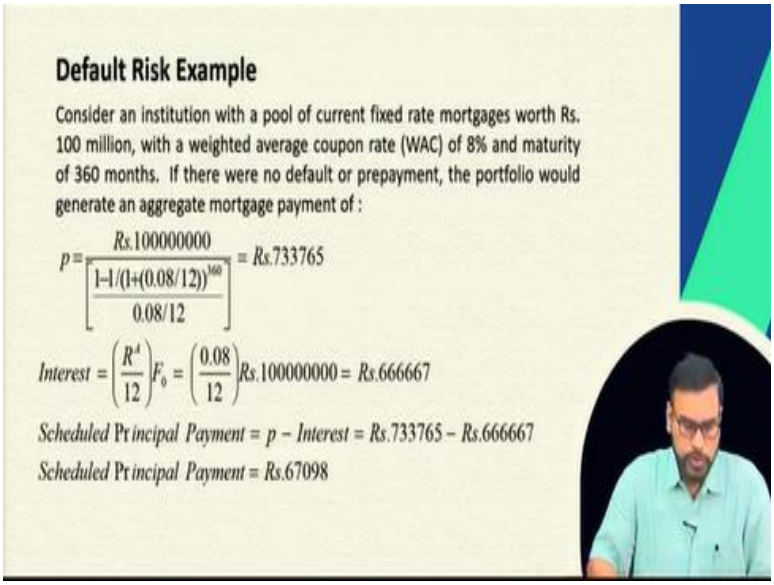


So, then if you now use that particular concept with an example let that is the same example, we have taken that is the total mortgage value is 100 million your WAC = 8%, maturity period is 360 months and let if you assume that there is no default or prepayment then your cash flow already,

P= $\frac{100000000}{\left[\frac{1-1/(1+(\frac{0.08}{12}))^{360}}{0.08/12}\right]}$ = 733,765

Interest = $\left(\frac{R^A}{12}\right) F_0$

Interest = $\left(\frac{0.08}{12}\right)$ 100000000 = 666,667

Scheduled principal payment= p- interest

Scheduled principal payment= Rs 733765- Rs 666667= Rs 67,098

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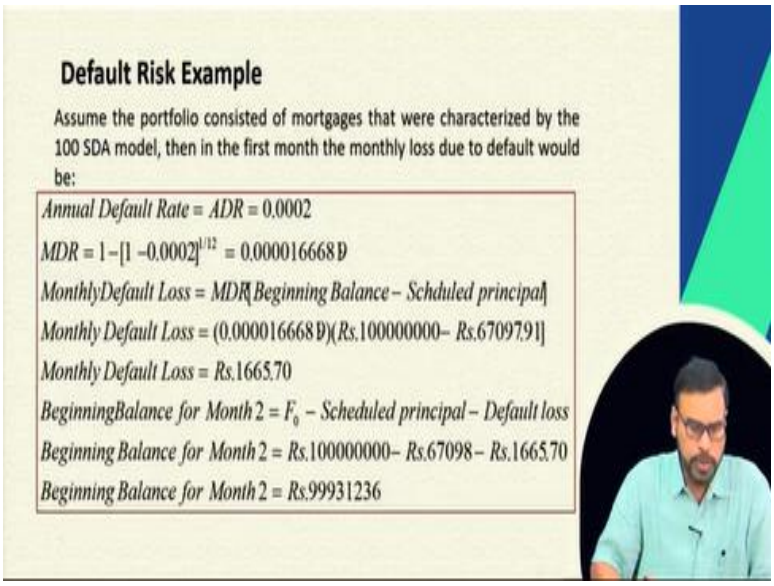


Now if you assume that the portfolio consisted of the mortgages that were characterized by the 100 SDA model then the first month the monthly loss due to the default will be how much.

Annual default rate= ADR= 0.0002

MDR= 1-$[1 - 0.0002]^{1/12} = 0.000016668$

Monthly default loss=MDR(beginning balance- scheduled principal)

Monthly default loss= (0.000016668) (Rs 100000000-Rs 67097.91)

Monthly default loss= Rs 1665.70

Beginning balance for month 2= $F_0$- scheduled principal- default loss

Beginning balance for month 2= Rs 100000000-Rs 67098- Rs1665.70= Rs 99931236

So, your annual default rate is your ADR will be 0.0002 then your MDR will be 1 - 0.0002 to the power 1 by 12 so that is basically your MDR. Then your monthly default loss will be your MDR into beginning balance minus scheduled payment.

Then your beginning balance is 100 million then scheduled payment is this then your monthly default loss will be this multiplied by this then monthly default loss has become 1665.7. And obviously the beginning balance for month 2 is $F_0$ minus scheduled principle minus default loss.

Here we are not talking about the prepayment part we are only capturing this default risk part then again; the default loss has to be deducted then beginning balance for the month two will be this much.

So, the PSA has provided the standard models for capturing these prepayment risk and as well as the default risk and those things have the influence on the cash flow whatever is generated from that kind of mortgages.

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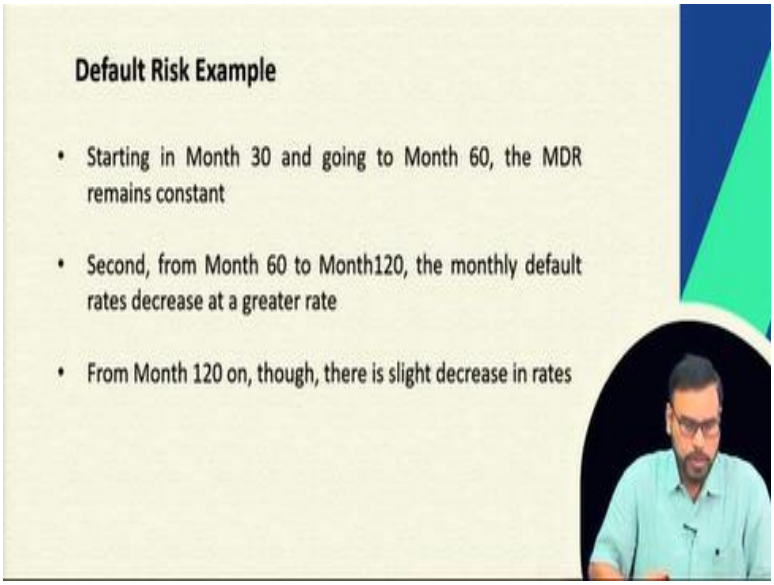


So, starting in month 30 and going to month 60 the MDR remains constant. From 60 to month 120 the monthly default rate decreases at a greater rate and from month 120 onwards there is a slight decrease in the rates. That already as per their model that basically we can assume.

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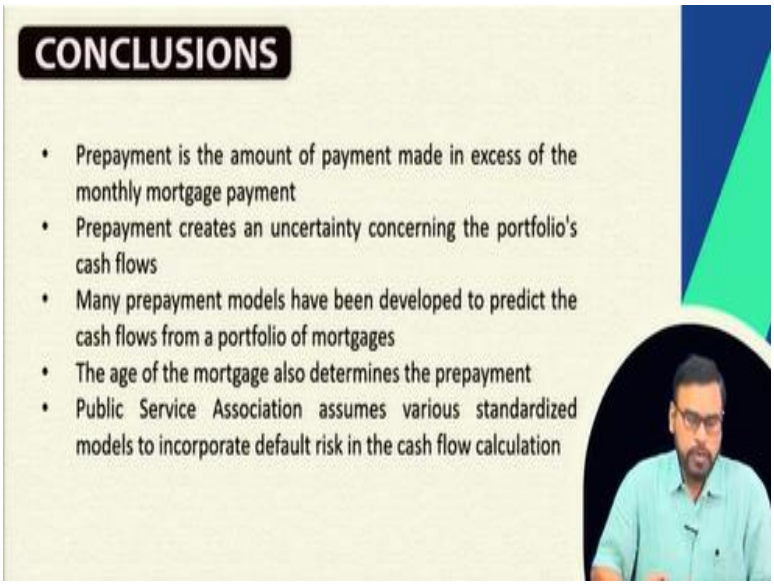


So, what basically we have discussed in this particular session? The prepayment is the amount of payment made in excess of the monthly mortgage payment. The prepayment basically creates the uncertainty concerning the portfolio cash flow and many prepayment models have been developed to predict the cash flows from a portfolio of the mortgages like 100 PSA, 200 PSA, 50 PSA all kinds of thing.

The age of the mortgage also determines this prepayment and the public service association generally assumes various standardized models to incorporate the default risk in the cash flow calculation what just now we have discussed.

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So, these are the references, thank you.