Micro Foundations of Macroeconomics
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Lecture - 30
New Keynesian Sticky Prices IV

Welcome back. So, we are going to start the new session. And in this session as I discussed in the last session, we have talking about the; we have finished the new classical understanding. And now we are moving towards the new topic which is about the output gap about the monetary policy stand. How the central bank decides about? What will be the appropriate rate of policy rate? Which can be in the form of either increasing or decreasing the policy rate?

So, how central bank decides about this thing? When I mention about. So, let me give you the background what we are going to discuss about the monetary policy in today's session in this session is about how we can understand the role of monetary policy or we can think about what will be the appropriate rate of policy rate? So, in case of India we have the repo rate and reverse repo rate.

Repo rate is the rate at which central bank lends to the commercial banks and the scheduled commercial banks. So, you can think about the lending happening from the central bank to the banks. When banks are having excess liquidity and they feel that they have excess reserves, excess cash and the central bank also feels that they have excess liquidity in the economy. Then it allows the commercial banks to keep money with this central bank.

So, central bank will be offering some rate of interest on that. So, that is what we call it the reverse repo rate. Let us first understand about the repo rate because repo rate is always higher than the reverse repo rate and rep rate plays very important role. So, in case of India we have something called the liquidity adjustment facility. So, LAF, under liquidity adjustment facility typically it happens that the central bank decides about increasing or decreasing the money supply based on increasing and decreasing the policy rate.

Repo and reverse repo and they adjust the liquidity in the economy through these two rates. Whenever they feel that you have less liquid in the economy so they decrease the rate of interest and pump the money through the repo rate. And whenever they see that their excess liquidity then they will be going for either increasing the reverse repo rate. So, reverse repo rate means either banks will be incentivized to save or they will be simply increasing other parameters.

For example, cash reserve ratio and SLR requirements. But in typical case the policy rate matters a lot because on this you have the money supply decided. So, if your money supply is moving around the repo rate or the policy rate then it becomes really important that what will be the appropriate rate and which all parameters will determine this rate. When the central bank or RBI reserve bank of India is going to decide about the rate of interest that the repo rate which is 4% this time.

So, if it is going to be 4% then this 4% will be based on where which all indicators will play a very important role. That understanding is crucial in the macroeconomic setup. And in this particular setup we will try to understand that which all factors specifically the parameters play important role in deciding about the appropriate policy rate. In case of US, you have the federal fund rate. So, maybe we will be having examples from that.

But it will be really interesting to see that in real life how it works. The reference book remains same here this Stephen D Williamson we will be also covering the chapter 15. But here we will be also focusing on the Williamson part and also, we will be referring the Mankiw book of macroeconomics. And there will be talking about the dynamic system under that you have the quick adjustment in the economy the short run adjustment.

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So, new Keynesian school of economic thought is more about the new Keynesian idea. New Keynesian school of economic thought is more about the short run adjustment in equilibrium. So, we will be talking about those things.

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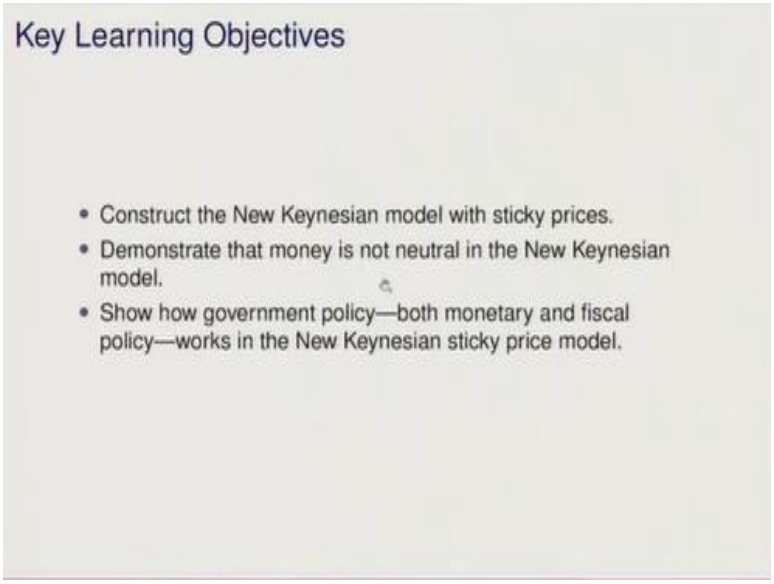

Otherwise, the objectives remain same not much change.

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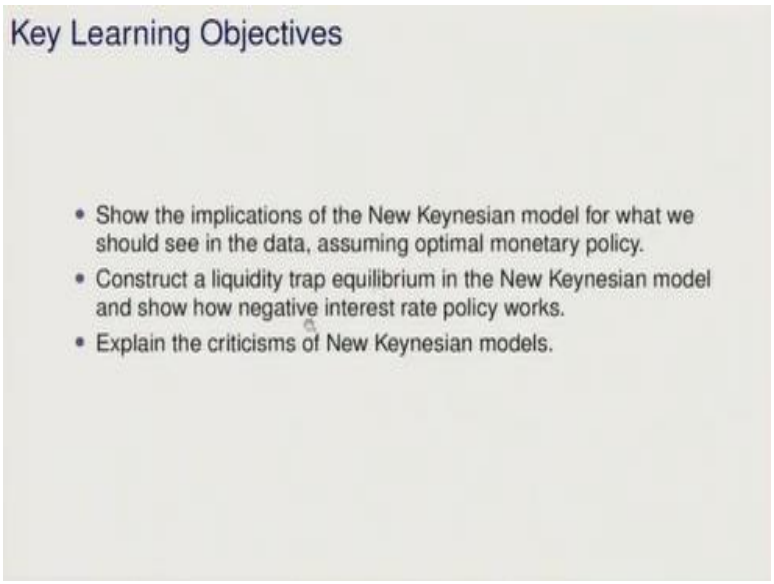

So, here we will be talking about the condition under which we are discussing this part.

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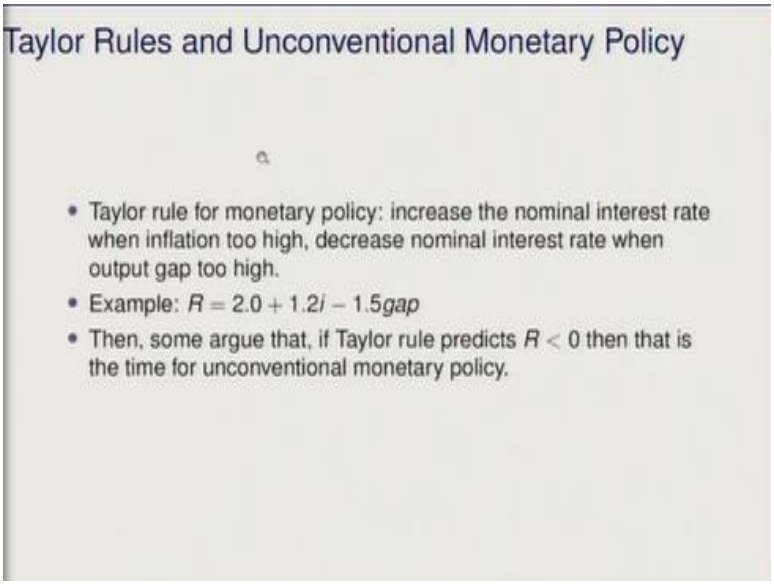

So, here we are talking about the Taylor rule. So, John Taylor developed this idea that what will be the appropriate monetary policy rule through which central bank will decide about the appropriate rate about the policy rate. So, Taylor rule for monetary policy increase in nominal interest rate when inflation too high. Normally, one of the main objectives of the central bank is that it has to go for price stability.

So, when I say about price stability then it implies that the rate of inflation has to be lower. Most of the countries have gone for inflation targeting mechanism under that they have certain rule of

thumb or certain I would say targets fixed for the central bank. So, in case of India as per the monetary policy committee they have decided about 4 plus minus 2. So, 4 plus minus 2 that the upper range will be 6% and lower range will be 2 %.

Below this if it will go the central bank has to react. If inflation touches 6% or beyond then central bank will react. Normally, we find that there is direct relationship between the policy rate and inflation. So, if inflation is going up policy rate will go up. If inflation is coming down policy rate will come down. So, that is the understanding. And here we find that here we have the inflation. So, what it means that here if I am talking about R which is the real rate of interest.

So, here we say that here it is R = 2.0 + 1.2i - 1.5 gap. So, this output gaps, this I will be discussing in the subsequent slides in detail. But let us understand what is the value of this 1.2 and 1.5. If you have a 1% increase in inflation which is i is the inflation here and a gap is the output gap. If you have 1% increase in inflation then rate of interest increase by the central bank will be around 1.2%. If you have the output gap here, we are mentioning about gap this shows about the output gap.

If output gap which shows the relationship between the unemployment rate at the equilibrium and how much unemployment rate you have actual. So, deviation from that or you can say that the actual and potential output with the full capacity, how much output an economy can produce and how much it is producing right now? So, if it is lower then of course it means that you have the slowdown.

If you are potential higher than the potential then it means that you are utilizing all of the resources. Your employment and everything will be better. So, unemployment will reduce so that kind of dimension I am talking about. So, let us first think about the nominal interest rate. If you have an inflation increasing by 1% your nominal interest rate will increase by 1.2. If the output gap increases by 1% your nominal interest rate will have the inverse relationship.

That it will decrease by 1.5. And these relationships are having very important role in the economy. If you have I inflation 0 if you have no output gap your nominal rate of interest will be equivalent to what you have the 2% which is the natural rate of interest. So, this can be called as the natural

rate of interest. Natural rate of interest the rate at which you have the full employment in the economy or equilibrium output in the economy.

So, you do not see any deviation. So, these two variables play very important role. One is the inflation and one is the output gap. And if you have an output gap as 0 so 0 multiplied by 1.2 it becomes 0 and 0 multiplied 1.5 it becomes 0. So, these two will be 0 which means that your nominal interest rate is equivalent to the natural rate of interest. And this is the ideal scenario. But in real life it may not be the same.

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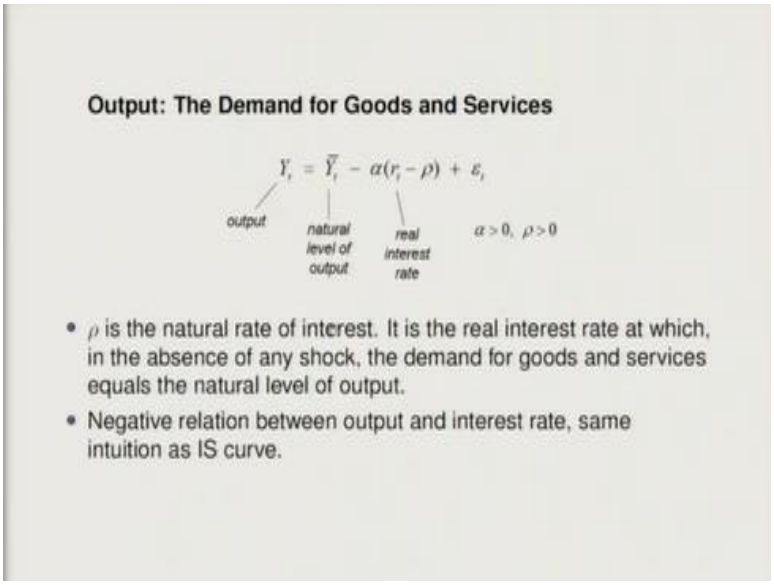

Let us talk about how we can understand this. So, this particular part we are discussing from Mankiw. So, there we have first start with the basic premise of the Taylor rule derivation. So, this equation is widely popular and being used by the fed reserve for this policy stand on the monetary policy. So, here we have a Y_t which is the output and here you have the natural rate of output. And natural rate of output is the rate at which if everything goes well ceteris paribus.

Then this is the output that the economy will achieve. So, if everything equals then and if the economy utilizes the resources available in the economy optimally then this is the output that the economy is going to get. Then here you have the real rate of interest. This is what we have the r_t. And ρ here is the natural rate of interest. So, the real rate of interest is this and, here you have the ϵ_t. And this ϵ_t is having some kind of shock. So, this is from demand side.

So, demand side in the sense that you have a sudden change in some macroeconomic scenario in flow of capital or something that has created some shock or maybe an unwanted shock has happened in the economy. So, because of that the decrease in demand. So, this random variable will have both upside and down side capturing in the economy from demand side. So, and mean of this is 0 and variance is 1. So, this is how we go about it.

The α is greater than 0 and ρ is also greater than 0. The ρ is important ρ is the natural rate of interest. It is the real interest rate at which in the absence of any shock the demand for goods and services equals the natural level of output. So, this is what I mentioned at the full employment equilibrium level. So, this is the ideal situation. This should be the rate of interest actually in the economy.

But due to deviations either because of this ϵ or because of this α you have some parameters not coming exactly to the natural rate of interest. So, real rate of interest is not equal. If real rate of interest is equal to natural interest rate this becomes 0 which means that your Y_t is equal to Y_t bar. And if you are just taking the expectation then this is also 0. So, this is the ideal situation that if you have a real rate of interest equivalent to ρ which is the natural rate of interest.

Then you do not have to worry about the moment you have a deviation then it matters a lot. So, if r_t is greater than ρ then what will be the scenario? If r_t is less than ρ then what will be the scenario? But overall since it is having the; inverse relationship between the output and real interest rate. So, this is directly linked with what we call it the IS LM scenario. I think those who have done the macroeconomics one that you must be knowing about IS LM framework this gives an idea.

So, there it is linked with this. So, $Y_t = Y_t$bar the full employment potential output – $\alpha\ (r_t\ -\ \rho)\ +\ \epsilon_t$ is nothing but the equation of IS curve IS line which is downward sloping inverse relationship between output and interest rate. So, here we will be talking about this. α value will matter a lot.

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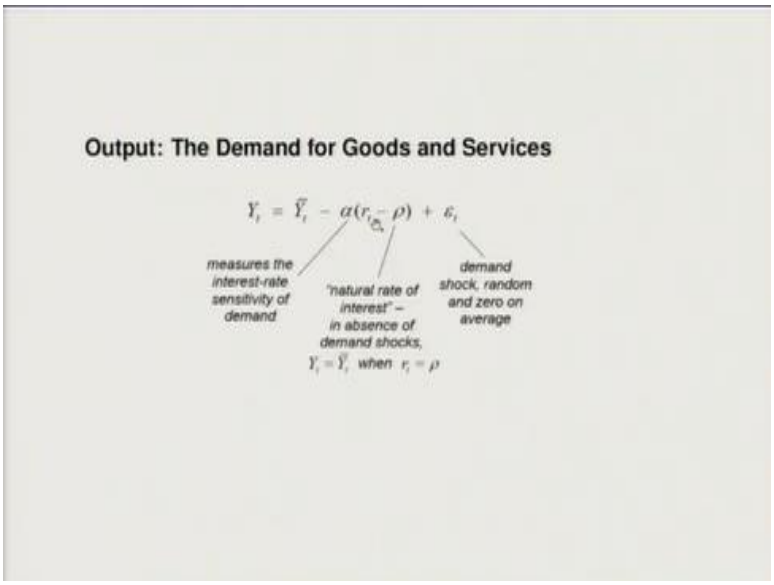

That what is the α value here we have. So, this is what we measure the interest sensitivity of demand. If it is higher then it means that you are having a more sensitive the rate of interest with output. If it is lower, then it is less sensitive. So, this is what natural rate of interest. If you have r_t is equal to ρ so, this will become 0. And then you have Y_t= $Y_t$bar. So, this is the ideal situation for most of the economy. This is the demand shock that I have already mentioned.

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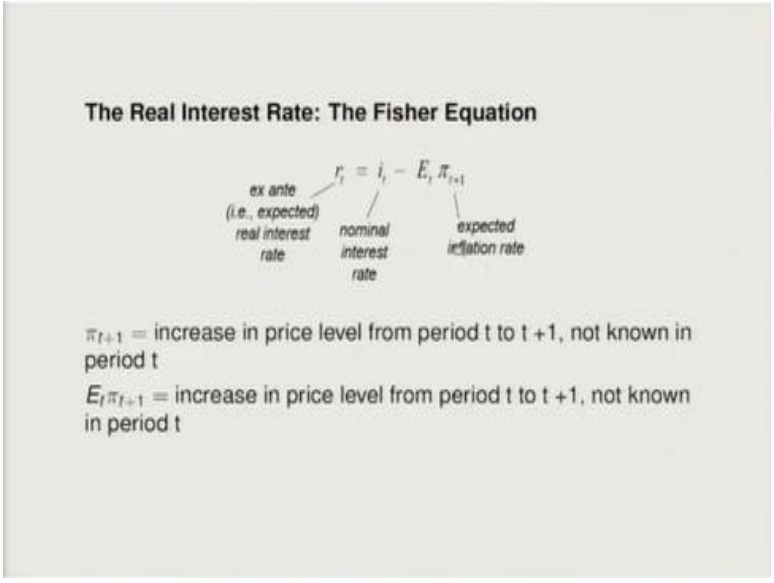

Let us talk about the rate of interest. And here rate of interest will have lot of importance. So, Fisherian idea works here. So, Fisher equation we know that here you have the real rate of interest. Real rate of interest is nothing but you have the normal rate of interest minus here you have the

expected inflation rate. So, if you have the expected inflation rate expected real interest rate playing role. So, you have $r_t = i_t - E_t\pi_{t+1}$.

So, here what is more important is that here we are putting an expectation operator with π_{t+1}which means that it is talking about you are expecting in current period about future inflation. So, $E_t\pi_{t+1}$ which means that you are expecting in the current period about future inflation. So, once you have future inflation then that matters a lot. So, it can be also like here you have $E_{t-1}\pi_t$ so $r_t = i_t - E_{t-1}\pi_t$ can also be linked.

Which means that if you are going to think about the real interest rate then the subtraction of the normal interest rate with inflation it is the expected not the actual. So, that means that there is some kind of stochastic element attached. Increase in price period from t to t + 1, not known in period t this is what we have. Increase in price level from t to not known for period t. and it is about the expectation. So, expectation is happening in period t about the π_{t+1}.

So, Fisher equation what happened that? Because of this expectation it also becomes the expected real interest rate. So, your expected real interest rate is nothing but the nominal interest rate minus the expected inflation that the consumer is expecting in current period about the future inflation. So, maybe you can think about the current inflation based on the expectation from the past.

So, maybe this can be linked with the adopting expectation scenario. So, adoptive expectation will be coming after this. So, this is how it works.

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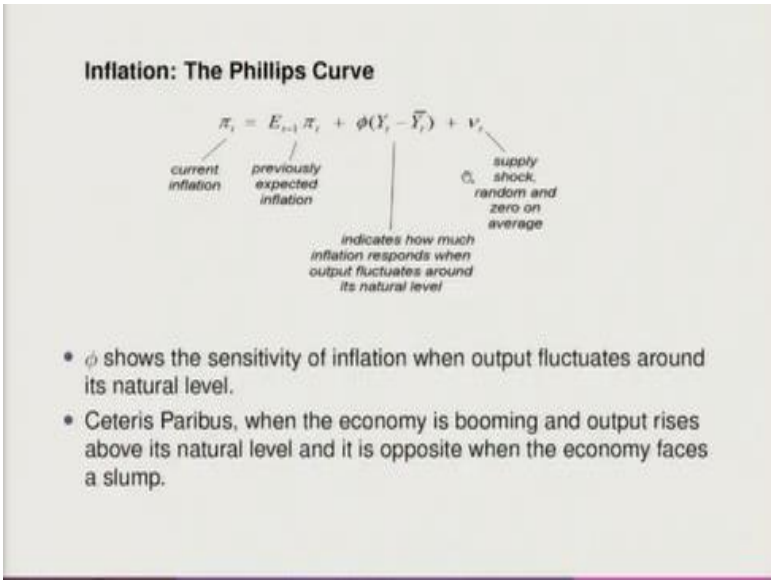

The second is about the Phillips curve. So, Phillips curve is coming from the supply side. So, Phillips curve how it works? So, here you have the current inflation and here as I told that this is coming from here $E_t\pi_{t+1}$. So, here you have $E_{t-1}\pi_t$, here which is nothing but the previously expected inflation. Here we have a ϕ (Y_t- Y bar). And this is nothing but your output gap.

How much is inflation responds when output fluctuates around its natural level. So, this is the natural level of output and this is the actual output. How much is the deviation? Natural level output means the output achieved at the full employment equilibrium. And there is no deviation happening. So, this is the most ideal scenario you can see. So, $Y_t bar$ represents the most ideal output.

But in reality, actuality depending upon the rate of interest and certain parameters it may not be the same to achieve the same level of output. So, deviation will attract some change in the policy rate and inflation and this is what we are trying to understand here. And V_t is nothing but here you have the supply shock random or so it is having the same like aggregate demand the ϵ that we had assumed. So, it is having the same.

The phi shows the sensitivity of inflation with respect to output around the natural level which means that when economy is booming your Y_t will be greater than $Y_t bar$ which means that here you will have the output rises above the natural level which means that this is the natural level

output. Your economy is booming if it is doing good then it will be $Y_t - Y_t bar$ and if the economy is not going up.

If it is not moving up and if it is in recession then it will be just opposite to this. So $Y_t - Y_t bar$ that we have this will be Y_t greater than $Y_t bar$ boom scenario. You will have the higher inflation scenario. The central bank will also react in the same way. If a Y_t less than Y_t bar you have this slowdown in the economy. So, this will create a very favourable scenario for the lowering the interest rate then the central bank will think about reducing the interest.

So, output gap has lot of importance. Second thing about the output gap it also talks about the unemployment scenarios. So, unemployment scenario can be linked with your output gap if it is higher. If your Y_t is greater than $Y_t bar$ then it means that you are creating more output. Demand of goods and services are higher and then it will also bring more favourable scenario for the economy.

So, we can think from the perspective of unemployment increasing and decreasing. So, there is a very famous law.

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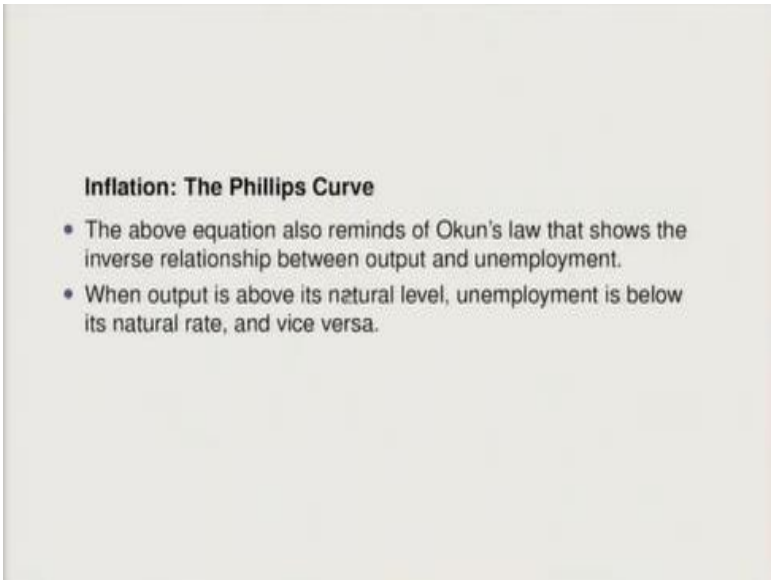

So, the above equation can be linked with the Okun's law that shows the inverse relationship between output and employment. So, if Y_t is greater than Y bar unemployment will be lower. If

Y_t is less than Y bar unemployment will be higher which means that it is having some kind of inverse relationship with a π_t. So, here Y_t - $Y_t bar$ is linked with the Okun's law which means that it is also talking about the inverse relationship between output and unemployment.

Output unemployment will be linked with this. When the economy is booming output rises above its natural level which means that here you have more implement of labour. Everyone will be getting wages everyone will be happy. Unemployment will be lower. So, from such theory perspective also we discuss that if the economy is booming everyone is having good scenario. There is not so much increase in the social welfare cost.

And the social welfare amount is not increasing which means that unemployment insurance benefit if it is not increasing. Then this creates more matching scenarios which means their firm will be posting vacancies and the individuals will be also getting job. So, if your Y_t greater than $Y_t$bar than this creates that kind of scenario. So, ultimately, we will be having a less of unemployment. But if you have output gap increasing which means that Y_t is less than $Y_t$bar.

Then this is creating us more unemployment less matching happening the economy companies are posting jobs individuals are not applying. And at that time if the central bank or if the government has gone for increasing the unemployment insurance, then there will be again matching efficiency decreasing and labour market tightness that we discuss in that way. So, this will further decrease the output and increase unemployment.

So, it is also linked with this. When the output unemployment is below natural rate and vice versa. So, this is how we mention about.

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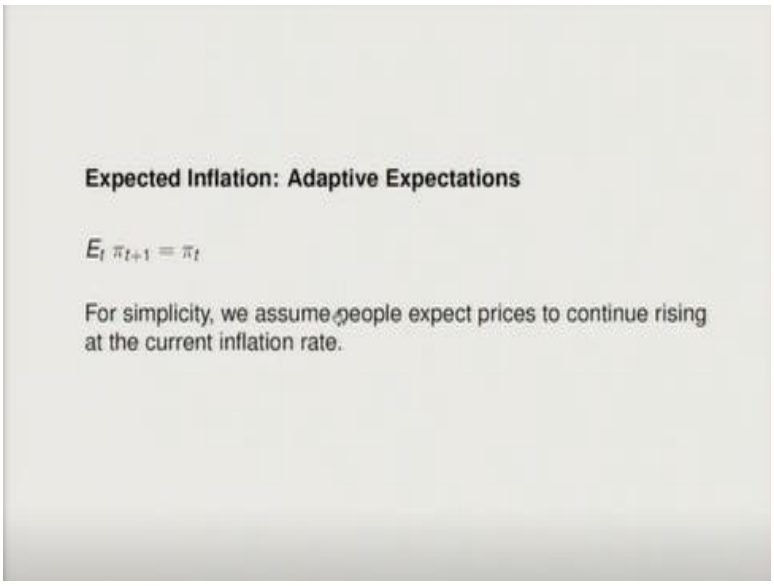

Adaptive expectation, this is coming directly from the Fisherian equation. So, here we had the Fisher equation $E_t\pi_{t+1}$. So, here what we say that $E_t\pi_{t+1}$ is nothing but π_t which means that the individual's future expectation depends upon the immediate past or the current period. So, this is the underlying idea behind this adaptive expectation that you are just assimilating the previous period information to predict about the current period or using current information for prediction about the future. So, this is how it link with this.

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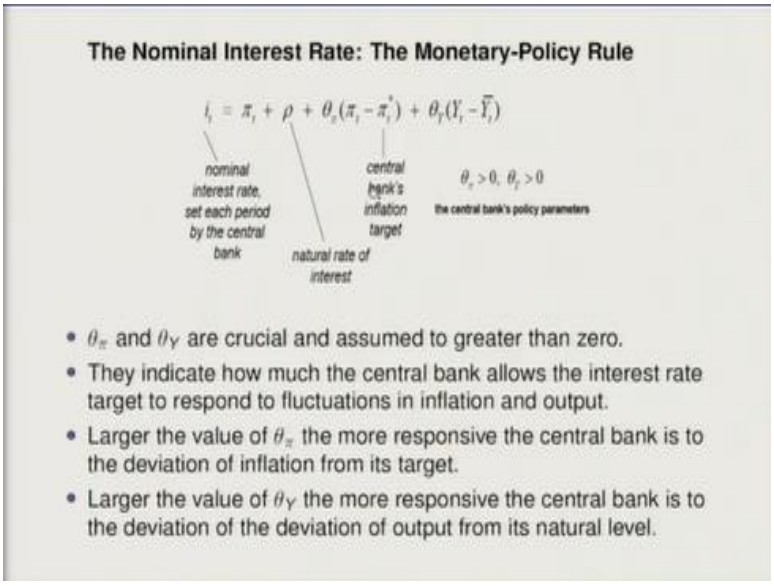

Then here we have finally the monetary policy rule that we discuss about. So, let us combine everything all the equations. If you go for solutions substituting one to another then we finally arrive at this particular equation. So, which is the nominal interest rate it is equivalent to π_t which

is inflation + ρ which is the natural rate of interest + $\theta_\pi\ \pi_t\ - \pi_t^*\ + \theta_Y\ Y_t - \ Y_t bar$. And this particular equation is coming by combining all demand.

Then we had Fisher equation demand for goods and services. Then we had fisher equation then we had the Phillips curve then we had the adapted expectation. So, combining all those we are getting this particular equation. And this particular equation talks about the dynamic adjustment because here you have the t + 1 and t. So, here you have the one period ahead we are talking about when we are expecting in the current period about future.

So, it involves some dynamic or inter temporal scenario. So, this also speaks about the dynamic systems here we have $i_t\ = \pi_t\ +\ \rho\ + \theta_\pi$. Here you have a $\pi_t\ - \pi_t^*\ + \theta_Y\ Y_t - \ Y_t bar$. So, this is how we say. So, normal interest rate set each period by the central bank and here you have π_t. Here we have the ρ which is nothing but the natural rate of interest. Now, this π_t^* is nothing but the central bank inflation target.

So, π_t^* here central bank inflation target as I mentioned about that in case of most of the countries about inflation targeting mechanism countries have gone for deciding about the normal rate of inflation. So, in case of India as I mentioned as per MPC it is 4 + minus 2. So, 4% you can understand. So, this is about 4%. So, this is decided by the RBI, the central bank. Here you have a θ_Y which is linked with the coefficient attached with the output gap.

θ_π is the coefficient attached with the inflation gap. So, this is what we have the inflation gap. So, how much inflation is deviating from the central bank target plus how sensitive is the nominal interest rate with the output gap? So, these two parameters θ_π and θ_Y play very important role. They indicate how much central bank allows the interest rate target to respond to fluctuations in inflation and output.

So, here which means that with the; nominal interest rate which is nothing but the policy rate how this policy rate is sensitive to the inflation gap and the output gap. So, this is how, how much it is deviating. If we have a π_t equivalent to the policy target rate of the central bank then this will be

0. This π_t will be 0. So, this means that it is 0 almost. Now here if you do not have any output gap then this will also be 0. So, if this is 0 then this will also be 0.

So, in most of the cases what you will have is that your natural rate of interest is nothing but $i_t - \pi_t$ which means that the equilibrium rate of inflation and the number interest rate. Whatever is the difference that will be your natural rate of interest that we always mention. They indicate how much the central bank allows the interest rate target to respond larger the value of θ_π . If θ_π is greater which means the deviation is happening it is much larger.

The more responsive the central bank is to the deviation and inflation from target. So, if it is higher, then the central bank will also react by the same way. It is having direct relationship. If it is higher, then the central bank will also increase by the same amount. So, if the θ_π appears to be 1.2 then 1% increase in inflation beyond the inflation target will increase by the size of the θ_π so, 1.2.

The larger the value of θ_Y the more responsive the central bank is to the deviation of the output from its natural level. So, this is how it and it is also linked with the Okun's law that I mentioned that at equilibrium how much you have the employment taking place and how much it plays very important role. So, this is how we talk about. So, for the central bank whether it is federal fund reserve or the reserve bank of India θ_π and θ_Y play very important role and these two concepts are really important.

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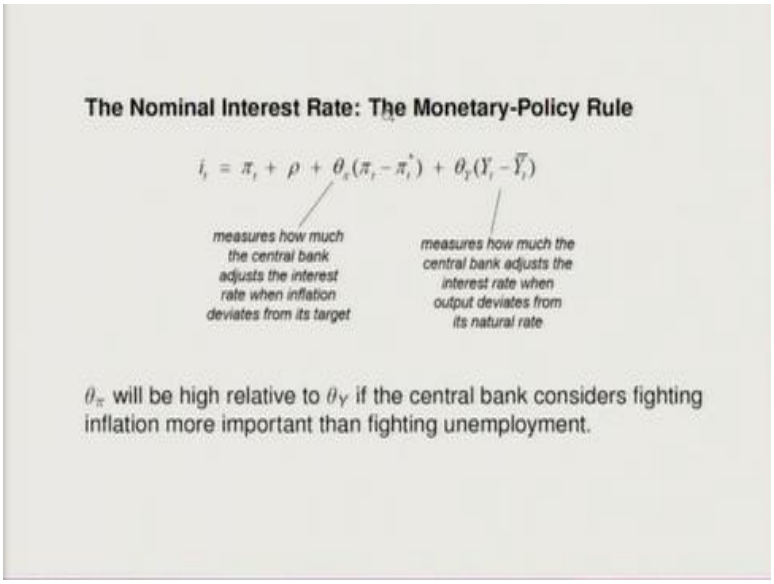

So, if you are thinking about $i_t = \pi_t + \rho$. So, here what it mentions if you just try to understand measure how much the central bank adjusts the interest rate when inflation deviates from its target. This output gap you have how much the central bank adjusts the interest rate when output deviates from its natural rate. So, this is how we try and understand. So, θ_π will be high relative to θ_Y if the central bank considers.

Fighting inflation more important than fighting unemployment. So, this is how we can interpret the coefficient in the real life.

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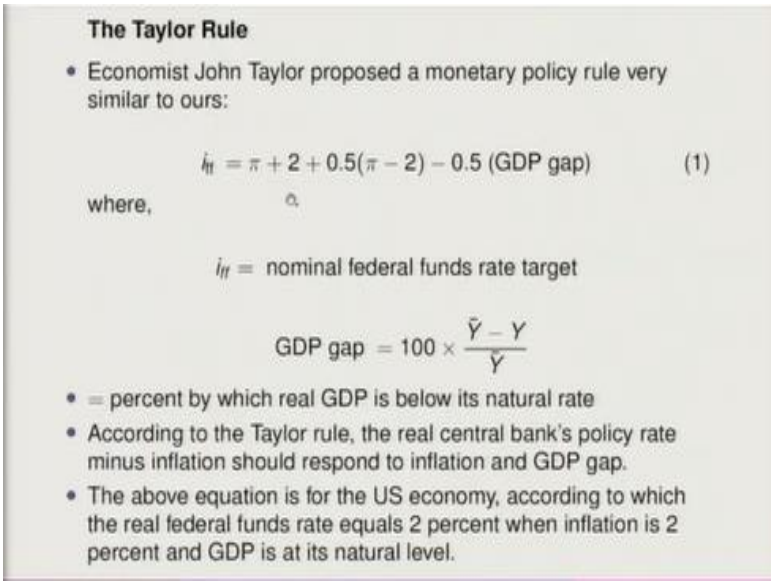

In real life scenario this is how it looks like that your inflation the federal fund rate of the US economy it will be around $\pi + 2$. So, this is the Taylor rule of the federal fund rate that the federal reserve bank of US always considers. So, they consider θ_π and θ_Y at 0.5 both same GDP gap 2% is the send federal bank target. So, they consider 2 % which is also the natural rate of interest. So, nominal federal funded target is this.

Now, GDP gap that they consider by this. You can also kind of calculate GDP gap by as I told I think in some sessions that you can go by filtering mechanism. You can take the deviation from the actual. So, any data will have the cyclical and trend. If you subtract trend from actual data whatever is residual amount that you are going to get that acts as a GDP gap. So, according to Taylor rule the real central bank's policy rate minus inflation.

This is what should respond to inflation and gap. So, in case of US economy sensitive 2% if you have the scenario where pi is also 2 then this becomes 0. We have to only deal with GDP gap. So, if $\pi = 2$ then this will also disappear which means that the central bank will be hovering about the real interest rate around 2%. So, this is how. The real federal rate equals 2% when inflation is 2% and GDP is at its natural level.

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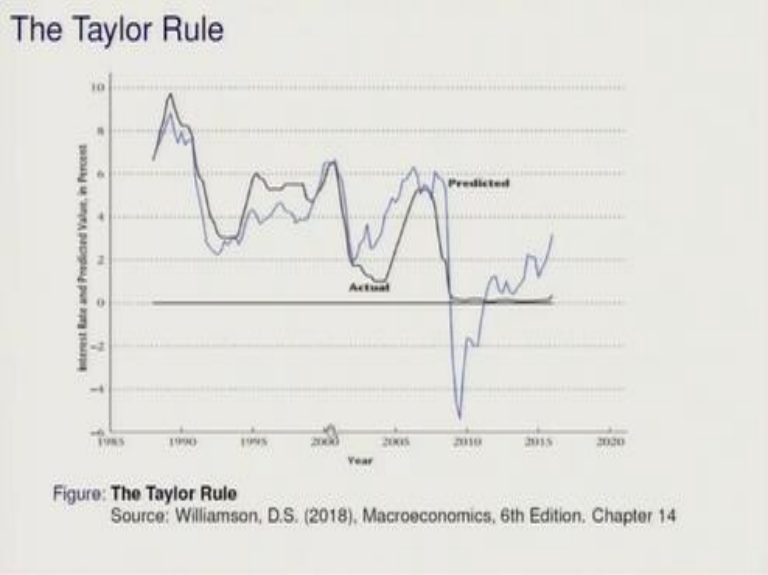

Figure: **The Taylor Rule**
Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 14

In most of the scenario in Williamson book what they mention about this is the actual and this is the predicted with the Taylor rule and they see a marginal deviation not much. But yes, in certain

situation they do not go for they do not have the similar kind of trend that we often find. So, this is how it looks like. So, overall, I hope it is clear that when we are talking about the decision about the policy rate then what all factors are important.

First is the demand supply scenario which means that we are talking about the inversions between output and rate of interest. Then we superimpose the condition of the Fisher equation the real rate of interest will matter. Why real rate of interest will matter? Because individuals who are living in the economy, they will be thinking about how much they gain really from saving in the bank. So, if they are getting above the inflation, it is all good for the central bank.

If they are getting less than the inflation then that is not good. And individuals will have doubt about the central banks credibility about the inflation targeting. So, all the central banks they always think about moving around the Taylor rule or they apply the Taylor idea from this perspective. And that is why it is very important to understand the John Taylor idea to at least come out with the appropriate policy rate.

So, if you want you can refer the manque book and also the Taylor. And I will be continuing further with recent developments non-conventional in next session. So, I am stopping it here. I hope it has helped you understand the monetary policy context in a much better way. We will be having further discussion in the next session and I am stopping it now. Thank you so much for your attention.