Microfoundations of Macroeconomics
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Lecture – 22
Sticky Prices II

Let us start. So we were talking about the intertemporal model in the monetary I would say context. So, we were trying to understand that how we can derive the monetary intertemporal model and in the last session we also discussed with the rational expectation. So, here we will be talking, we will be trying to derive the similar kind of picture that we have covered for intertemporal consumption model.

So, it will look similar to that, but here we will be trying to add some more dimension about the demand for money, supply of money, the neutrality of money that is the concept we have. I would say we will also talk about the classical dichotomy of the controversy and towards the end we will be going and examining the conventional and unconventional monetary policy.

Under that we will be having the understanding about the quantitative easing and then we will have the negative interest rate. So, with this background let us start with the session where we were discussing about or formulating the monetary intertemporal model, the ingredients of the monetary intertemporal model.

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Reference Book

Author Name: **Stephan D. Williamson**

Williamson, D.S. (2014), Macroeconomics (5th Edition). Pearson International Edition, Boston, USA

Williamson, D.S. (2018), Macroeconomics (6th Edition). Pearson International Edition, Boston, USA

So, here it looks like. So, here you have the reference book remain same Stephen D. Williamson and I am referring the same book.

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Here the objective remain same so we will be trying to arrive at the monetary intertemporal model we will be super imposing the fisherian idea and trying to understand that how the real context can play a very important role then we will be trying to derive the competitive equilibrium from there we will initiate the debate of neutrality. So, neutrality will be introduced here.

And then the effectiveness of conventional, unconventional monetary policy. These things we have already covered so let us not waste time.

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Here we are talking about the different alternatives of making payments. So, money has of course facilitated the transaction now it is much easier to purchase or sell a particular asset, but at the same time the evolution of technology and further developments in the financial sector especially in the domain of banking it has facilitated the transaction in a much bigger way.

So, conventionally if you have a cash you can buy certain goods, but you have some provisions through which even if you do not have cash you will be given the interest free period even if you do not have money right now in the current period you can still facilitate your transaction and whatever is the interest period given within that period of time you are supposed to clear the dues.

So, that kind of alternative arrangement that we have in the monetary market it is called the credit card. So, we will be introducing the credit card into our model to understand the monetary intertemporal framework. So, here what we say that the idea is that how credit card can be used as an alternative to currency or the transaction. What we are trying to say that if an individual is having credit card and cash both.

How this individual will be deciding about when to use credit card and when to use cash. So, if the person is using cash or currency then what will be the situations in what all situation if I am trying to put a scenario wherein I am trying to give some incentive to the consumer that even if I have a cash and credit card you can still if you have the nominal interest rate given a scenario very high.

So, if the nominal interest rate high in that scenario how this representative consumer or the consumer is going to react. So, whether when the interest rate is high he will be using more of credit card or cash or currency so that is the underlying idea. So, here you will have the two period in one period everyone transact so one period does not matter. In future period you have the settlement taking place so that is the understanding here.
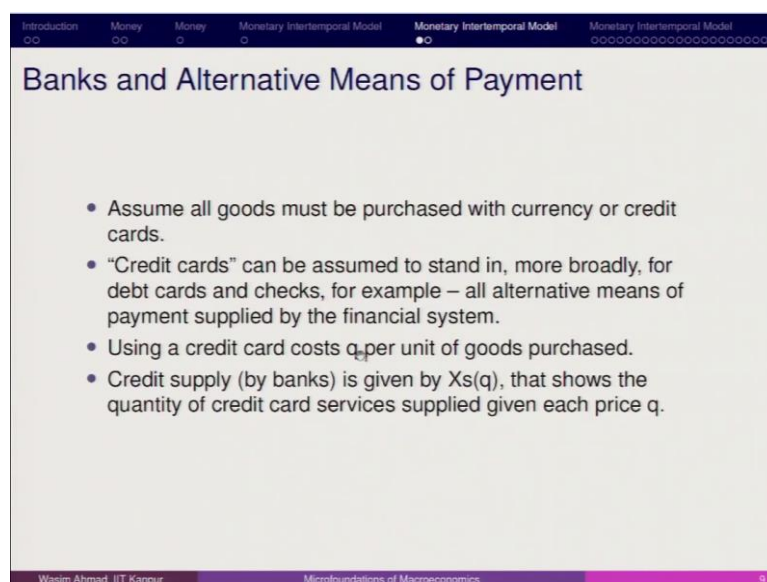
We are also introducing the consumer firm, government, the role of the government will be more prominent when we will be driving the demand for money and beyond when we are trying to see the intersection of equilibrium price means demand and supply of money. So, there the role of the government will be more visible with the given set of debt or the bond market function it has.

So, goods purchased at price P no matter what means of payment whether credit card or currency. So, whatever you have the nominal price expressed it is in the form of the price. So, whatever goods are transacted whether it is consumer or whether it is the firm, whether it is government the numeraire is the price of the goods which is being transacted. Here when we mentioned about credit card so we have to also mention that bank will not offer the credit card at free of cost because bank also incur some cost additional cost.

So, what are those cost so that could be in the form of either the saving the history of the consumer or keeping the record of all the transactions whether the representative consumer is using the card for transaction or making payment. The banks have to maintain the record so if banks are making the record then they will incur the cost, there will be employees hired to look after those record.

And because of that each and every bank charges the credit card service. So, if you are choosing the credit card if you are opting the credit card you will have to incur some amount of cost that is what the model assumes.

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So, here you have the credit card can be assumed; so if you are going to use the credit card so this is the cost that you are incurring. So, the cost of credit card usage is nothing, but q per unit of goods purchase. So, whatever amount of goods you are purchasing you are incurring some amount of cost so which means that if the individual is using the credit card. So, whatever is

the credit limit of the credit card so that credit card will be equivalent to the x is the output that the consumer is going to buy.
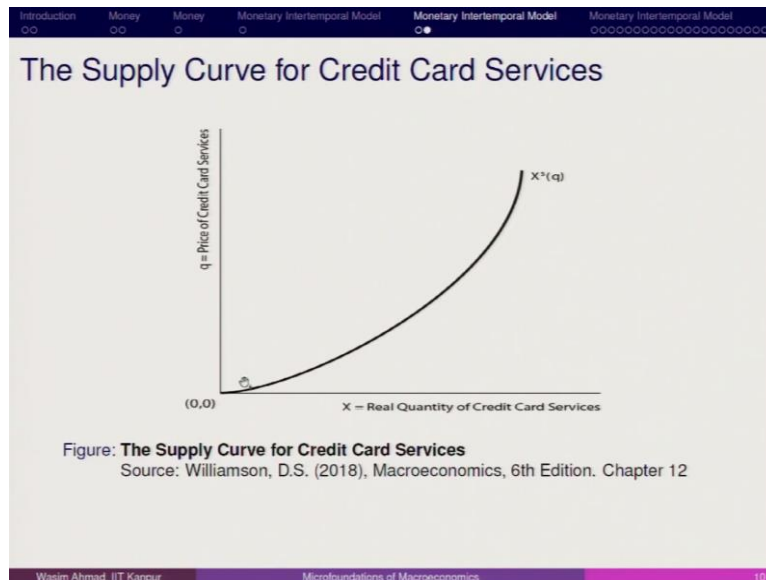
And Xs is the supply and q is the unit of the cost that the bank is charging for using. So, typically if you want to understand the credit card how it works those of who are still students you may not have idea. So, credit card normally functions that you have the card provided by the bank, bank will issue a card so and they will be charging the membership fee that will be the cost.

So, annual cost the bank charges so bank maybe charging you Rs. 5,000, 10,000 with the credit limit of suppose 2 lakh, 3 lakh depending upon your monthly income. So, they will be deciding about or the annual income. Once they go for giving you some kind of credit limit so you have the option that once you purchase the credit card then you will be allowed to make transaction up to the credit limit of the card based on your purchasing power.

So, if we are using that card for transaction then you do not have to pay immediately to the bank. You can pay that after one or two day, but you will be given 20 days or 18 days or more than 20 days interest free period. So, it means that whatever purchase outstanding amount that you have on your card you can settle within 20 days and then there will be last date of payment if you are not making the payment then bank will charge the rate of interest on the outstanding.

So, the efficient use of card is that you can use the card and then you can make the payment immediately after or before the last date of making payment then bank will not charge anything except that the annual fees that banks charge. So, this is how it works so Xs(q) represent that.

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Figure: **The Supply Curve for Credit Card Services**
Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 12

So, here you have the y axis which shows about the price of credit card services and here you have the x axis that shows the real quantity of credit card services. Now if you are seeing the line it shows the upward trend. So as you have the credit card services increasing price will also increase so this is how you have. So, q will also increase and q is directly related to the quantity of credit card services so this is how we try and understand.

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So, let us start with the monetary intertemporal model how it works. So, here suppose a consumer uses the credit card for transaction so if the consumer is going to use the credit card it means that this representative consumer is going to have debt from the bank. So, whatever amount that you will have if he settles the amount in the current period itself then it is fine. So, this is the case that when the consumer uses the credit card for transaction he is seeking credit from the bank and settling the outstanding in the current period only.

So, in the current period itself he is settling the contract. The rate charge on this so in the market in the free market where you have the borrowing and lending taking place the rate of interest offered in that market is supposedly denoted by R. So, if R is the nominal interest rate at which borrowing and lending is taking place then how we can decide about.

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So, suppose all agents consumer firms and the government purchase y units of good. So, if you are using the credit card it means that you are demanding this much amount of good $X^d(q)$. So, Y is the total amount so if you subtract $Y - X^d(q)$ so it means that rest of the amount what is the difference between $Y - X^d(q)$. Currency is being used so cash is being used for that.

So, here if the representative consumer is making $X^d(q)$ by using the credit card Y - $X^d(q)$ goes as cash payment.

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Introduction
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Monetary Intertemporal Model
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Demand for Credit Card Services

- Suppose that an economic agent considers buying one more unit of goods with credit, and one less unit of goods with currency.
- The most likely scenario is P fewer units of currency to make transactions during the current period and lent it, yielding $P(1 + R)$ at the beginning of future period.
- The consumer pays $P(1 + q)$ units of money to settle the credit card debt with bank at the end of the period.
  - If $P(1 + R) > P(1 + q)$, then all goods are purchased with credit cards.
  - If $P(1 + R) < P(1 + q)$, then all goods are purchased with currency.
  - $R = q$ will imply that the agent is indifferent between using currency and a credit card.

So, here you have one more scenario like for example suppose an economic agent considers buying one more unit of good with credit card and one less unit of good with currency. Now here you have the scenario. This particular representative consumer suppose he wants to buy a particular good then he makes the transaction using the credit card and then the amount he has both credit card and cash.

But he is making the card he is using the card for transaction keeping the cash with himself or herself. Now what is the opportunity cost of holding the cash now this is linked with the nominal interest rate if the nominal interest rate is high then this consumer will be using the credit card and he will not be paying using currency because this currency he can keep it in the bank or lend it to somebody.

At the rate of interest R whatever amount that this representative consumer or the consumer is going to get if this R return is higher than what he is making as an cost of using the credit card then he would always like to which also means that if the return generated from this lending it is higher than the usage of credit card cost then of course this representative consumer would always like to use the credit card.

So, it is linked with the interest rate scenario so how we can understand in a more formal way. The most likely scenario is P fewer units of currency to make transactions so whatever amount of money or currency that he is not using by using credit card he is lending in the market and which in turn he is earning P into $1 + R$ at the beginning of the future period. So, this is what he is going to get.

Now once the representative consumer arrives in the final period we are talking about intertemporal so first period we do not have to worry about in second period now we are seeing the main role. So, this is the return by not using the cash. So, you are lending and you are getting P into 1 + R if we are using the credit card then this is what you have so P into 1 + q is the unit of money to settle the credit.

So, whatever is the value of the product you have good you have to settle the value. So, at the end of the future period this is what this representative consumer has to do. So, he has to settle this amount and with this return. As long as P into 1 + R is greater than P into 1 + q he would like to go for using the credit card he will not use the cash because this is giving more return than using the cash.

So, if this particular representative consumer is experiencing a higher interest rate environment then he would like to go for lending the money whatever he or she has then going for a simply using the credit card. So, this is the marginal benefit and this is the marginal cost so as long as these two are or in this case if P into 1 + R is less than P into 1 + q then he would like to go for using the currency.

He will not use the credit card because even though he is going to lend the cash in the money market or anywhere he is not going to get return more than R so return is going to be lower, but if you have a R = q then this will imply that the agent will be indifferent between using the credit card or the currency. So, this is the underlying idea that if you have in the market if the consumer is given the opportunity that he or she has the credit card.

And he or she also has some amount of currency. Now given the interest rate environment that we have if the payoff from lending of the cash is higher than using the credit card the consumer will be attempted to use more of a credit card, but if it reverses then we would go back to cash. So, in most of the economies we often find that you have lot of goods attach with the credit card for usage.

And this is one of the reasons that in the intertemporal context if we put the credit card then it is easier to understand the money market system how it works and where the rate of interest, the nominal rate of interest is the nodal parameter to deal with. So, from here we can think
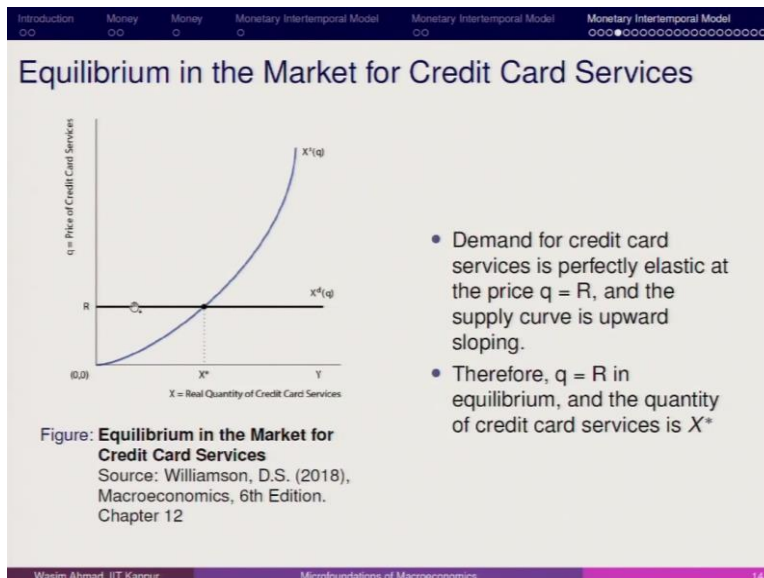
about how much I should hold the cash. So, holding the cash if you are holding your money for certain period and given the interest rate environment then this is directly linked to the demand for money.

So, now we will be talking in the context of demand for money. Supply of money is of course in most of the models in macroeconomic model it is considered as indigenous variable so we do not have, but the demand for money becomes the indigenous part of the system and that is why demand for money understanding is crucial. Supply of money it works on the time pattern that whether the individuals; the way we have dealt with the rational expectation in that we have already understood the idea if you have the rational expectation playing a role in terms of higher money supply which means that people will expect that there will be higher rise in inflation.

If we have higher rise in inflation then we would supply more amount of labour and work because they expect that the prices are going to be higher, but this you have to also understand that in which all directions the money supply will increase whether this will directly increase by having the pumping of the money or cheaper loan or it will be through different channel.

So, maybe the government is using the seigniorage to pump up the money. So that may also be possible, the helicopter effect and then you also have the holding of bond. So, you go for quantitative easing. So, those kind of methodology can be applied, but demand for money understanding become crucial. So, demand for money it talks about whatever is the interest rate environment that you have when the individuals are tempted to hold more of cash.

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Figure: **Equilibrium in the Market for Credit Card Services**
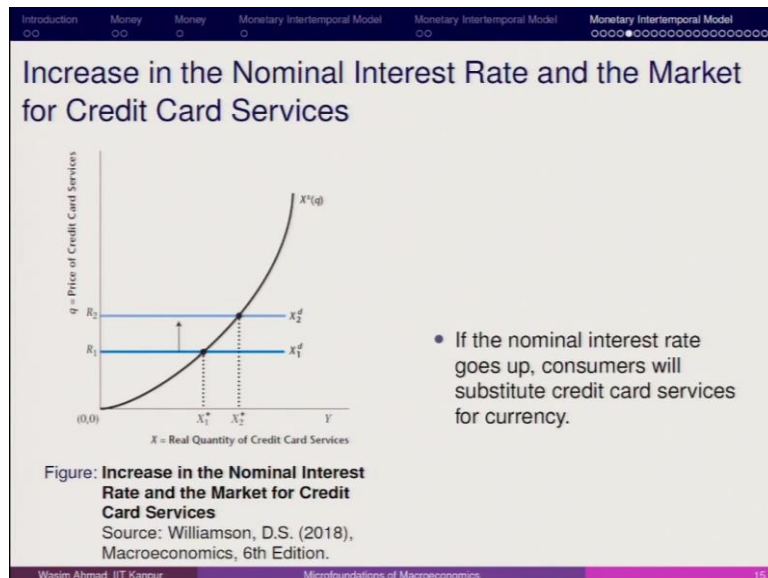Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 12

So here this is the supply of credit card and this is the demand of credit card; so demand of credit card more or less it is horizontal. So, here at this so this is the demand that we have for the credit card. So, real quantity this is the price and so you can say that at equilibrium where you have the intersection of or the equilibrium point where you have the supply and demand crossing each other so here it is X^*.

So here you can see the demand for credit card services it is q = R is here. So, here he will be indifferent the moment it goes up you will have more of a credit card leading. The moment you have a down you have more of a demand for credit card. So, you can think with respect to the nominal interest rate how it is working. Now what happens when we have the nominal interest rate higher.

If the nominal interest rate higher and this demand for credit card is linked with the nominal rate of interest so here we have the R.

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Increase in the Nominal Interest Rate and the Market for Credit Card Services

Figure: **Increase in the Nominal Interest Rate and the Market for Credit Card Services**
Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition.

- If the nominal interest rate goes up, consumers will substitute credit card services for currency.

If R is increasing it is bound to happen that your demand for credit card service will increase and this will further will have the usage of more of credit card less of cash. The consumer will substitute credit card services for currency they will not be using cash. So, if you have a nominal interest rate higher it means that people will be saving or lending money in the money market or to somebody and in the future period whatever return they get if it is higher than after settling the debt then they are more than happy to use the credit card. So, this is how it works.
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Demand for money

$$M^d = P[Y - X * (R)]$$

Here, X*(R) is the equilibrium quantity of credit card services (decreasing function of R). Therefore, more simply:

$$M^d = PL(\underset{+}{Y}, R)$$

Now if you think about as I mentioned that understanding the credit card and interest rate environment especially with regard to putting cash in middle. We are able to understand that there is a some amount of cash holding taking place because of the interest rate scenario that the economy is facing so here we have the demand for money and here demand for money you

can see it is determined by a price this is the I would say most of the goods and services are expressed in this price.

Here we have the output or you can say real income – X transpose R. So, here you have the rate of interest decided so rate of interest it is nothing, but the nominal. Here you can see that demand for money is directly linked with the real income which means that if you have income increasing the demand for money will also increase, but with interest rate it is having inverse relationship, the interest rate is increasing people would like to hold more of cash.

If interest rate is decreasing people would like to release the cash so this is how it works. So, negative interest rate scenarios are linked with this also. So, here $X^*(R)$ is the equilibrium quantity. So, in a simple language we can write it in this way that money demand it depends upon the PL is represented for the function. So here you have L(Y, R). So, real income and the rate of interest plays very important role in deciding about the demand for money. So, this is how it matters.

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So, here we have two interesting cases based on this Y and R it says that increasing in real income more currency required as volume of transaction increases. So, this is what we call it as m v = p t. So, once I have m v = p t then if transaction is increasing or then it can be linked with the demand for money also. So, how can we link it if we have the real income increasing for the individual.

So, everyone is seeing the rise in income then it is bound to happen that there will be more transaction taking place and more transaction the volume of transaction will decide about the further usage of whether the alternative payment system will exist or how it will be decided, but here this is having the direct link. This shows about the expansion scenarios in the economy.

If you have the intervention coming from the nominal interest rate then here you have to understand in a more clear way. The nominal interest rate is the opportunity cost of using currency in transaction and higher are employees that there will be more usage of credit card in transactions and less use of currencies then here also you have the demand for money impacted.

So, here increase in real income this is what we are trying to understand the increase in real income it has direct impact on the volume, but here we have the direct relationship between the; when you have the higher R when the nominal rate of interest is higher than it is bound to happen that the people will use more of credit card less of cash so holding of cash will increase.

But if it is going to be lent in the market then this earning whatever increase you have earning this will further induce the consumers to save or lend more of a cash. So, holding of cash is increasing with the rise of the rate of interest. So, this is how we often mention about the transaction in demand for money so this is what it shows about.

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Now if I work out with the Fisher equation that we have mentioned that your real rate of interest is nothing, but the nominal rate of interest minus inflation. So, if I am going to work out with

this then how it looks like. Suppose for example we assume that the inflation rate is 0. So, once I am assuming that the inflation rate is zero then we can say that the demand for money is nothing, but your PL(Y, r).

And it is all since it is zero so you can think about it is r, r is positive. So, in this setup this is how it looks like that if you are going to deal with R so far we have been able to derive the demand for money scenario the nominal demand for money scenario. Now we will be seeing that can we also understand and bring out the dimensions of the supply side that how supply side is decided which all factors play very important role. So, we can spend some time.

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So here what we are saying that we are introducing government here so there is a government and this government is having the responsibility of dealing with both monetary policy and the fiscal policy. Monetary policy you must be knowing that it works on the rate of interest scenario. So, one of the objectives of the monetary policy is to control the inflation how inflation is going to be decided.

Fiscal side comes from the taxation if taxation is going to be here then the government is going to get more income and this will further increase the expenditure so those dimensions are analyzed. So, let us work out the budget constraint of the government. In the current period the government purchases G units of good and pays the nominal interest rate and principal to the government debt outstanding from the last period.

So here if I am using B^- in the sense that here you have this – as a superscript. So, here if I am going to have these superscript here then this shows that this is the outstanding amount B^- which is carrying forward from the previous period. So, this particular amount is being sold by the government in the previous period. Once you must be knowing that once you are selling the bond whatever coupon outstanding that you have attach with the bond you will be paying in future.
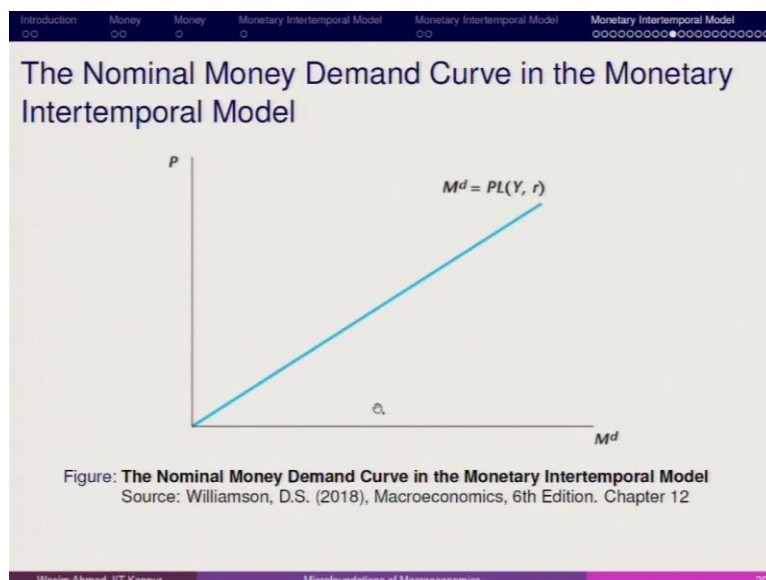
So, this is the carry forward from previous period, maturity is happening in the current period. So 1 + R will be attached so this is how it works out. So, here you have the expenditure side so this is the expenditure side of the government and this is the income of the government. Here you have the price into the government expenditure so this is the nominal government expenditure we have $(1 + R^-) B^-$.

So, this bond has been issued in the past and this is the return that the bond is offering. So, this is the future of value of the bond issued or I would say current value of the bond issued in the previous period. So, maturity is taking place in the current period so we are understanding that way. This is also the nominal tax that the government is charging from individual. This is the bond issued in the current period.

So there is no minus attached here plus here you have the growth or the rate of change in the money supply. So, all these factors are important so here you have the income and here you have the expenditure. Now once I am saying about the income and expenditure so this money supply which is exogenous this will be decided by the Central Bank, these two will come from the government sources and B may also be linked with the money supply because if you are thinking about buying and selling of bond then this also matters in the open market operations.
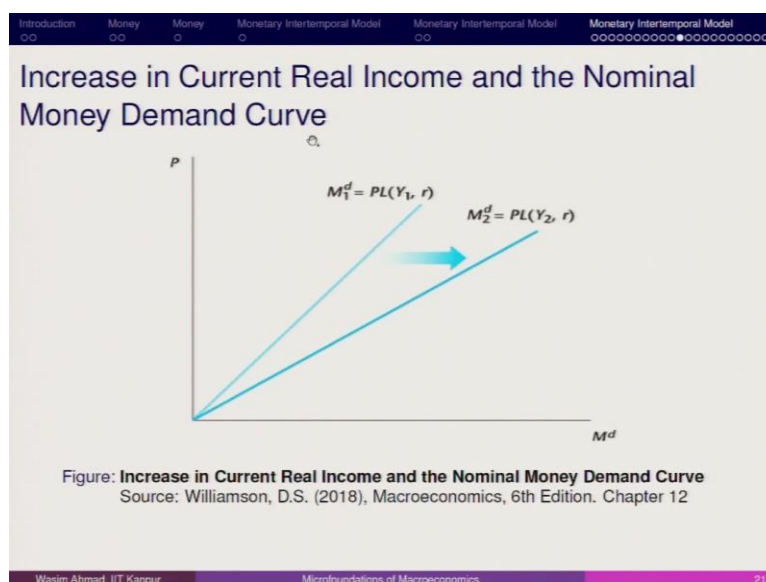
So, there we will again be taking into account especially with regard to the liquidity trap. So, to understand if this is the equation that we can derive based on the intertemporal scenario that we have so PT denotes the nominal taxes so this is what we are getting.

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Figure: **The Nominal Money Demand Curve in the Monetary Intertemporal Model**
Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 12

And once we get this then here we have the demand for money. So, demand for money it looks like whenever you have demand for money price will shoot up and this we have the direct relationship with regard to the nominal money supply.

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Figure: **Increase in Current Real Income and the Nominal Money Demand Curve**
Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 12

But more or less if you have the real income increasing then this is what happens that if you have price is here if the rightward shift in the line then here price is going to be lower and then here you have the money demand increasing. So, these two factors I hope you are able to understand that I am saying about the money demand increasing which means that holding of the cash.

But the moment you see decline in prices people tend to use more of cash and they will be again using for transaction so which means that demand for money will also increase. So, here

you have this much demand if you have rightward shift the price will be lower and then here we will have the demand for money coming like this. So, here you have the rightward shift.

I will again be focusing on here. So, I will be now completing this session here and I will stop here and I hope you have able to understand the monetary intertemporal model. I will continue from here in the next session. Thank you so much for your attention.