

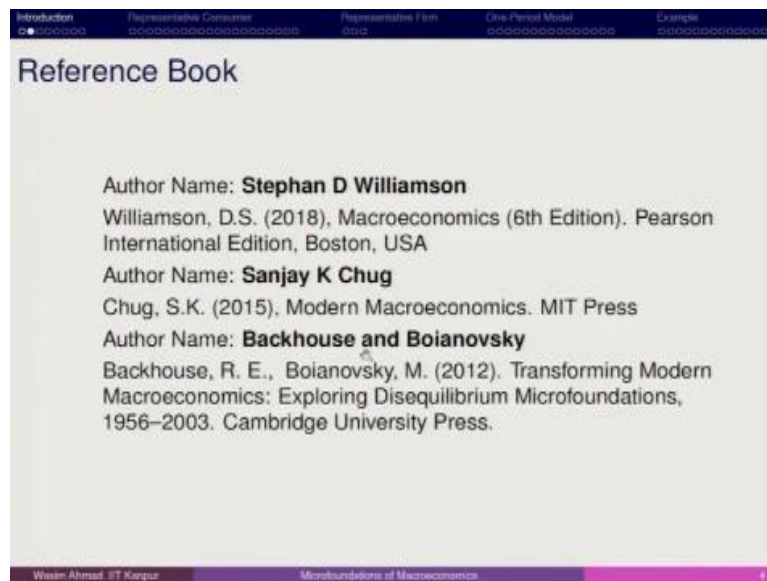
Microfoundations of Macroeconomics
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Lecture – 03
One Period Model III

Hi everyone, we are going to start again, and we are talking about the consumption and leisure model. In this particular model, we have talked about the basic microeconomic foundations of macroeconomics. We have already defined the representative consumer, representative agent, and different characteristics.

While characterising the representative consumer; we defined the budget constraint; we also looked at the consumer optimization, the optimal level of consumption and leisure. Now, we will be looking from the labour supply side. Broadly, how the labour supply function of the representative consumers looks like? So, the references remain the same, even for this session.

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You can choose any of these books and go through but I would recommend that you should read Stephen D Williamson, this is going to be the major reference for this lecture.

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Consumer Optimization: Comparative statics

Figure: An Increase in $\pi - T$ for the Consumer
 Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition, Chapter 4

Considering consumption and leisure as normal goods, what happens when there is an increase in the market real wage rate

An increase in the real wage rate – Income and substitution effects

Remember:

- Real wage (w) is increasing and π and T are constant.
- Initial budget line is ABD , increase in w shifts out the budget constraint to EBD . EB is steeper than AB now.
- Consumer's initial preference is at F . After w increase, he/she moves to point H . The situation creates certainty about consumption but not about leisure?
- F to O and O to H are substitution effect and income effect, respectively.

Conclusion: Consumption must rise, and leisure may rise or fall!

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So, we had seen about this part that what happens when we have the increase in wage rate, then we saw that the increase in wage rate has a direct impact on the consumption but for leisure, it is not very certain whether it will rise or fall so.

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Labour Supply Curve

- We can define the labour supply curve to measure the supply of labour by the representative consumer at the given wage rate.
- The labour supply specification can be specified as:

$$N^s(w) = h - l(w) \quad (4)$$

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Now, we will talk about the labour supply. Labour supply is the amount of labour that the representative agent supplies at the given wage rate. The wage rate is decided by the factor market and is also decided by the marginal productivity of labour. So, if the marginal productivity of labour is higher, the wage rate is expected to go up because there will be a lot of demand for labour.

But if it is lower, then the wage rate comes down, so, that framework will be applied. When we set up the microeconomic model and define our agent, in our setup, it may look straightforward, but in real life, if we work with your own model, it's not that straightforward

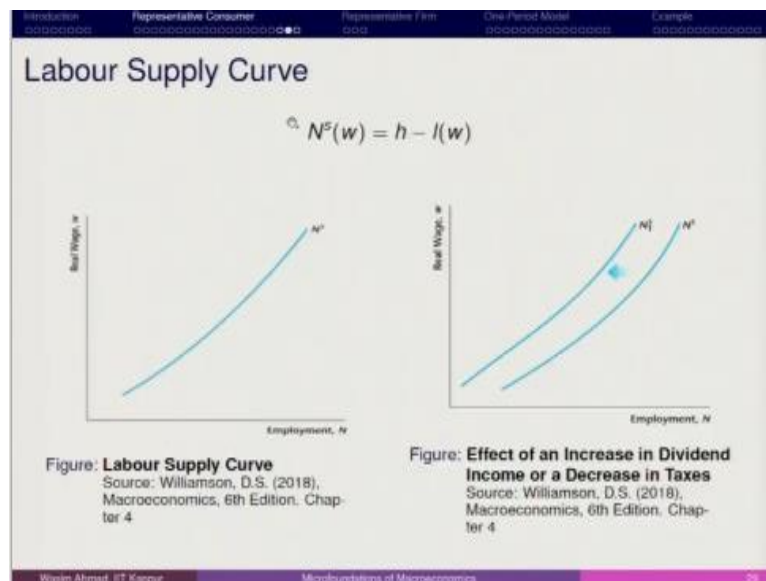
Then we have to think about the modelling framework, the basic model that you are assuming that whether this particular guy is going to have the Cobb Douglas base kind of utility function or any CRR kind of utility function. So, those things you must keep in mind, when you are having interaction between the consumer and the firm, then you have to bring the labour supply idea into account.

Here we have 2 labour supply specifications.

$$N^S(w) = h - l(w)$$

N^S is the labour supply and w is the real wage rate. Labour supply is equal to the number of hours available minus the leisure component that we have which is also linked to the wage rate.

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The labour supply has an upward slope because as the real wage increases, the employment will increase because it is expected that it should have a substitution effect but after a certain point of time, it will also have the backward bending kind of scenario and backward bending typically happens when you have the income effect playing a very important role.

Now, if you think about the comparative statics then in what scenarios does this moves leftward? What are the components that can affect the labour supply - a sudden increase in income of the representative consumer or tax decline.

If the government is saying that because of some reasons, it will not be charging tax. It means that this amount of extra money, the consumer is going to have so, this will also have an interfering effect on the labour supply. Those dimensions we have to take into account. So, when you have the increase in profit or the dividend or decrease in taxes, then you have the leftward shift.

And rightward shift, when it is just working against.

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The backward-bending labour supply curve

$$N^s(w) = h - l(w)$$

Real Wage - Number of Hours Worked

The labor supply curve is backward-bending because at high wage levels, the amount of hours worked declines.

Reasons for backward-bending curve:

- When (w) is low, the Substitution Effect (SE) outweighs the Income Effect (IE) and thus the labour supply curve has a positive slope.
- At very high levels of the nominal after-tax wage, the IE outweighs the SE and thus the labour supply curve has a negative (backward bending) slope.
- At intermediate levels of the nominal after-tax wage, the SE roughly cancels out the IE, giving the labour supply curve its vertical origin.

Now, here we have the $h - l(w)$, which is the total number of hours worked. So, as I told that, this may look very straightforward case that it is in a positive trend, the same way that we have in economics with the supply curve, but after a certain point of time as I mentioned that you may have the backward bending curve.

So, in which all conditions this happen? The labour supply curve is backward bending, because at high wage levels the amounts of hours work declines. In many of the countries, you have the situations where the number of working days in a week is getting down, it is getting lowered and now, you have to work only for 4 days, 5 days. So, those aspects you can link here.

When the wage is low, the substitution effect outweighs the income effect. At low wage any increase in the wage rate will result in an increase in labour supply and reduce leisure. This also affects consumption.

At very high level of wage, the income effect outweighs the substitution effect and as a result, the supply curve will show negative relation. This means that it will start bending back. Now, at the intermediate levels of the nominal wage, the substitution effect roughly cancels out the income effect which means that there will be some kind of mitigation here; giving the labour supply curves a vertical shape.

So, labour supply is increasing at a lower wage, then it is constant at an intermediate level and it is a downward sloping at high wages.

When the income effect reinforces at a very high level, you have the income effect outweighing it means that this particular guy would like to spend some more time in leisure and do less of work.

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Representative Firm

- The production function.
- Profit maximization and labor demand.

$$Y = zF(K, N) \quad (5)$$

Properties

- Constant returns to scale.
- Output increases with increases in either the labor input or the capital input.
- The marginal product of labor decreases as the labor input increases.
- The marginal product of capital decreases as the capital input increases.
- The marginal product of labor increases as the quantity of the capital input increases.

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This was from the representative consumer side. For this particular part, you can refer any textbook of micro that will be sufficient.

So, I think even the Hal Varian intermediate microeconomics will be more than sufficient. Now, coming to production function: once I go for the production function, the firm has a profit maximisation objective. What is that objective? So, when I say that we have profit maximisation and then we talk about $Y = zF(K, N)$.

z is a constant term, that talks about the level of productivity. How these two particular factors are going to contribute to the output. So, this is an important factor. Now, if you have done the basic economics, then you must be knowing that a constant returns to scale, where you have the increase in input resulting in an increase in output at the same rate.

The output increases with increasing either the labour input or capital.

The marginal product of labour decreases as the labour input increases. Marginal product is nothing but an additional increase in output due to increase in one unit of labour. If you continuously increase the labour then the rate at which output increases, decrease.

So, in the beginning when you increased from 1 unit to 2 unit, then it helped you to augment the output, but when you go for continuously adding, then after some time, the change in output will decline. So, you will not have the same growth. So, maybe earlier you hired only one person, to this one person you added one more. So, earlier this person was producing 4. So, now, you started producing 8.

You again had one more and they started producing 12 but again you had one more, then it may not be leading to 16; it may come down to 15 or 13. So, that is the case that if you go on increasing the labour input then that becomes a burden. In case of India, the typical exercise that we always say in the case of agriculture sector that you have more labour and this leads to a problem and productivity of the agriculture sector is always questioned.

Now, marginal product of capital decreases as the capital input increases, when I say marginal product of capital decreases as the capital increase in the sense that if you are having one machine and you are producing some output and you go on adding the same way as I mentioned about the labour, it will also have the similar reactions. Marginal production of labour increases as the quantity of capital increases.

This is a good exercise. Earlier you are using less machinery and more of labour. So, labour used to take more time to produce one output. The moment you increase capital, you bring machinery, you have a certain level of automation at the very basic level. So, this labour finds it very useful and then this augments the production process.

So, better technology, better I would say production system. It increases the efficiency or enhancing the efficiency in the production process. And single labour earlier he used to produce only 10 units but because of machinery, he is producing 500 units of output. So, that is the underlying idea. So, if you have better machinery, better tools, then this helps the marginal product of labour to increase.

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Representative Firm

- Profit function of firm is written as

$$\pi = zF(K, N^d) - wN^d \quad (6)$$
 where wN^d is the total cost of the labour input.
- When the firm maximizes profits, the marginal product of labor equals the real wage.

Source: Williamson, D.S. (2018), Macroeconomics, 6th Edition. Chapter 4

Now, here we define the profit function which is π . It is nothing but

$$\pi = zF(K, N^d) - wN^d$$

So, $zF(K, N^d)$ is the amount of income and wN^d is the labour share. So, this is the amount that the labour is receiving. z is the productivity factor and N^d is the demand for labour and K is the capital that this representative agent is having.

When the firm maximises profits, marginal product of labour equals wage rate and this is what it tells about. So, here (refer figure) you have the MPN is equal to w and this MPN is having a lot of meaning here and this is what it looks like. So, this is the production process. Here you have the labour demand. On top of this whatever line you superimposed at point A, this particular representative agent will be just thinking about how much costs it incurs and how much labour he has to ask so, this will be the labour input or labour demand coming from the firm. So, this is what we try to cover in this.

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One-Period Model

Assumptions

- A closed economy set-up with only three agents in the economy
 - Representative consumer
 - Representative firm
 - Government

Closed economy:

$$Y = C + G, \text{ where } Y = zF(K, N) \quad (7)$$

- To provide a perspective of distribution and welfare, we introduce the concepts of economic efficiency and Pareto optimality.
- Three relevant questions
 - What happens when there is increase in government spending or total productivity?
 - Can we measure the impact of tax distortion on wage income?
 - What should be the size of the government?

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Now, once I have defined this particular part, so, what is critical in the case of a representative firm is that he has a well-defined production function and it has profit-making objectives. So, π is taking into account both the production side of the firm and also the representative consumer side because wN^d is going to the representative consumer.

So, in the case of a firm, from the representative consumer side, this is the labour supply. From firm side, this is the labour demand. So, this we are mentioning here, N^d . Now, we will be working with the macro setup. Now, we will be trying to include these 2 micro agents in the macroeconomic setups and try to derive the macroeconomic inference.

So, this is the ultimate objective of this course that we are trying to understand; apart from IS-LM framework that we always follow and certain production systems or the economic growth theories that we have, to understand the macro setup. Now, we have a closed economy set up with only 3 agents in the economy. Here we have the representative consumer, representative firm and the government.

Now, government, we have not defined yet but we can easily assume that this particular government collects lump sum tax T from the representative agent. So, some amount of consumption goods is being taken by the which will be used as expenditures.

We are talking about consumption and the government. So, whatever amount that the government is collecting from the representative consumer, it is also used for expenditure. So,

here we have Y equal to $C + G$ that we have mentioned. So, C is the consumption and G is the government expenditure. Here Y that we are mentioning it is nothing but $zF(K, N)$.

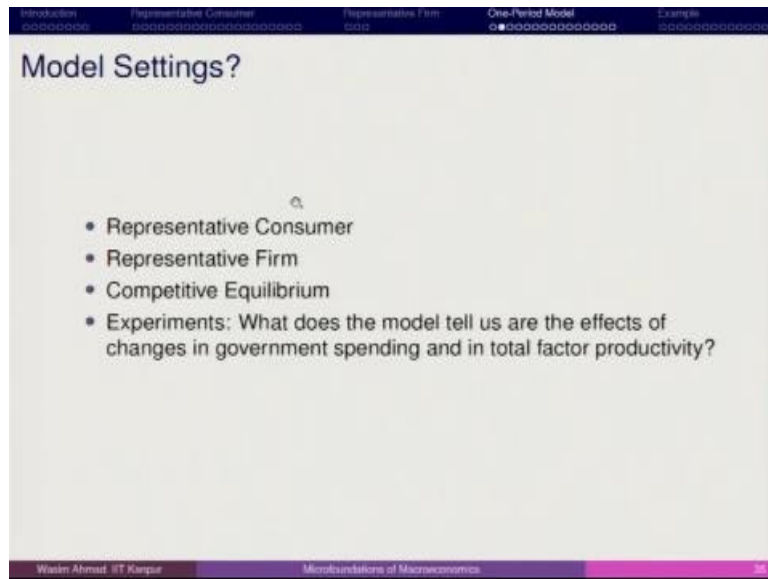
So, here it is $zF(K, N)$ is equal to $C + G$ that we are mentioning. So, here you have to think from the point of view of closed economy that how closed economy functions. So, in closed economy setup we are not at all interested. in trying to add the I component which is the investment. We are more interested in understanding Y is equal to $C + G$ and this is how it looks like. So, here we are talking about the distribution and welfare.

Once I have the role of the government, so, government role, we have not defined so, the role of the government would be that it will make sure that since the representative firm is hiring the representative consumer. So, we have to make sure that whatever equilibrium that we achieve with the help of both representative consumer and the firm, whether the competitive claim that we have achieved, whether it is appropriate or not. Can we also measure the efficiency whether this is efficient or not?

For that purpose, we will also try to introduce the concepts like welfare economics concept, and the distribution concept. We introduced the concept of economic efficiency, which is also directly linked with the Pareto optimality. So, the Pareto optimality condition will be used. So, what happens when there is an increase in government spending or total productivity? Can we measure the impact of tax distortion on wage income?

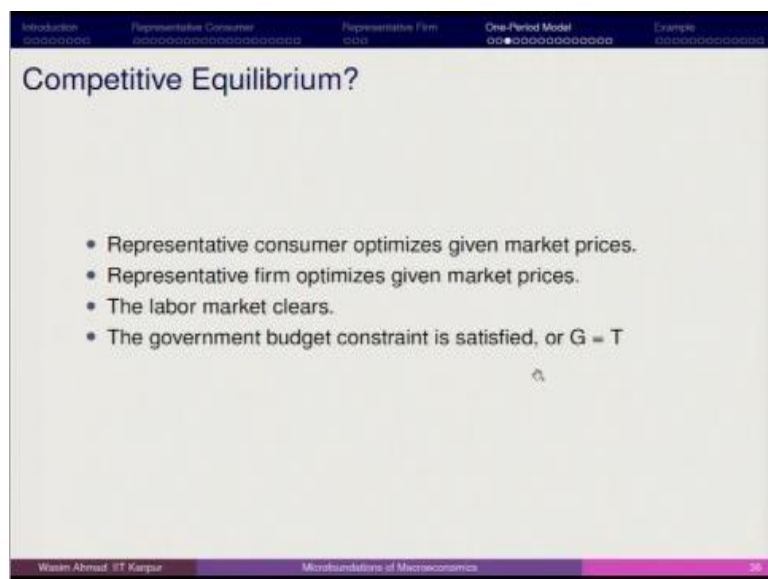
What should be the size of the government? So, this is what we are also trying to understand. So, whatever we have assumed so far, how it is going to be used? We will be seeing that.

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So, what is the modelling setup? Representative consumer, representative firm and the competitive equilibrium. And how does the model reacts? And what are the effects of changes in government spending on total factor productivity?

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So, those things we will be mentioning about and then also we will be trying to see that when we are saying that there is a tax imposed by the government then how G is equal to T is looking like?

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Competitive Equilibrium: A simple exposition

- We have assumed a closed economy

$$Y = C + G, \text{ where } Y = zF(K, N) \quad (8)$$

- To exhibit how $Y=C+G$ (Income-expenditure identity) holds in equilibrium, we begin by substituting budget constraint of the representative consumer (Eq. (2)).

$$C = wN + \pi - T$$

- Substitute Eqs. (2-6) into Eq. (7)

$$C = wN + Y - wN^d - G$$

- Imposing the conditions of equilibrium when $N^d = N$ and T (tax revenue) = G (Govt. exp.)

$$C = Y - G$$

$$Y = C + G$$

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So, what are labour market clearing conditions? we will be looking at those things. So, we have now assumed that Y is equal to $C + G$, where Y is equal to $zF(K, N)$ and here we have a closed economy. So, Y is equal to $C + G$. So, income expenditure identity that we have, so, we now start substituting of the representative consumer.

So, how many consumers are there? So, suppose 50,000 consumers are there in the economy. So, C represents the budget constraint of all the representative consumers that we have assumed. So, this could be $C = wN + \pi - T$ and this we have assumed in the; you can pick it up when we had defined the representative consumer. So, C is equal to $C = wN + \pi - T$. So, this is coming from here we had assumed; yes here.

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Representative Consumer: Budget constraint

- If we simplify the budget constraint as:

$$C = -wl + wh + \pi - T$$

- The budget constraint of the representative consumer looks alike

Figure: **Representative Consumer's Budget Constraint when $T > \pi$**
 Source: Williamson, D.S. (2018), *Macroeconomics*, 6th Edition, Chapter 4

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Introduction **Representative Consumer** Representative Firm One Period Model Example

Representative Consumer: Budget constraint

- The representative consumer disposable income is:

$$wN^S + \pi - T$$
- The consumer's budget constraint is:

$$C = wN^S + \pi - T$$

If we substitute (1) into (2), we have,

$$C = w(h - \hat{n}) + \pi - T$$

If we simplify it further as:

$$C = -wl + wh + \pi - T$$

$$C + wl = +wh + \pi - T$$

Implicit Expenditure on Goods = Implicit Real Disposable Income

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So, here we had assumed right. So, here we had $C = wN^S + \pi - T$. So, this is how the budget constraint is. So, here we are talking about the same part. Now, if you just superimpose substitute equation 2 to 6 into 7, then here it looks like this. So,

$$C = wN + Y - wN^d - G$$

So, here we substituted π and then T the tax that this representative consumer is paying, it is nothing but it is equivalent to G because government is not saving anything whatever it gets from the representative consumer, it uses for expenditure, so, that we are putting it here. So, imposing the conditions of equilibrium when $N^d = N$, so, when we are mentioning about equilibrium so, here we have labour market clear, demand for labour and supply for labour will be getting cleared here.

wN and wN^d is getting cancelled nothing but

$$C = Y - G,$$

which can be written as

$$Y = C + G.$$

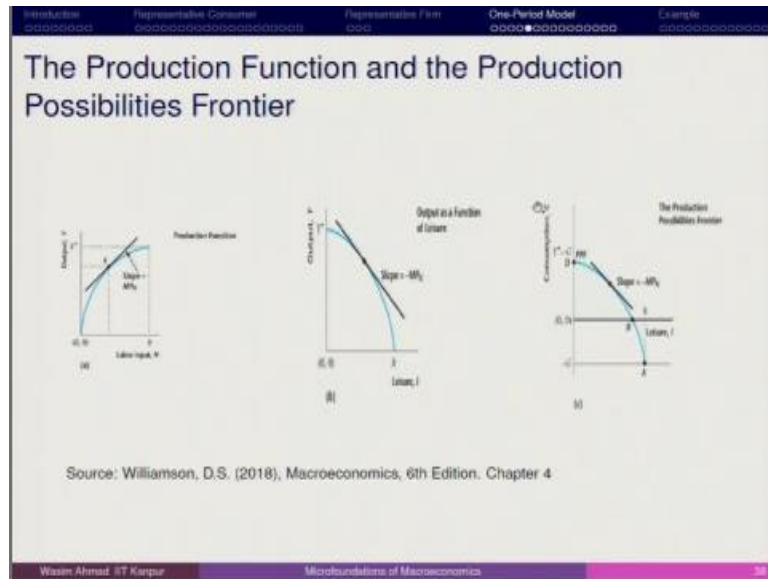
So, I think the simple exposition that I had shown you, gives you a lot of idea about the macroeconomic picture. So, I hope from this slide, it is clear that how are we trying to understand the macroeconomic picture with the foundations of microeconomics.

So, here, once we have Y is equal to $C + G$, so, we are able to arrive at the closed economy model. What we did in this we assume 2 representative agents, one was the consumer and another was the firm and these 2 representative agents when we incorporated it here, so, this π

that represented the consumer had a dividend. We included as the production function and then we add equilibrium.

We know that when labour market clears, demand supply will be equal. So, here we are just cancelling both wN and wN^d . So, these clears and finally, we are having C is equal to $Y - G$ and Y is equal to $C + G$.

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(Refer figures in slide) These charts are important and these charts are important for 3 reasons. One is that it helps you understand that there are some new dimensions in the economy that we should be understanding. Second thing is that now, there will be explicit relationship between consumption and leisure that we have seen in the case of consumer, and the firm idea is also superimposed here.

Those superimpositions are playing a very important role. Here we have a production function. So, this is the output that this economy is having. This is the production function; given the labour input, this is the output that this production function is producing. Now, here we have the leisure. So, output as a function of leisure when we are mentioning, then this is how it looks like and both have the same slope like marginal productivity of labour, but here it is downward sloping. So, here it is minus right.

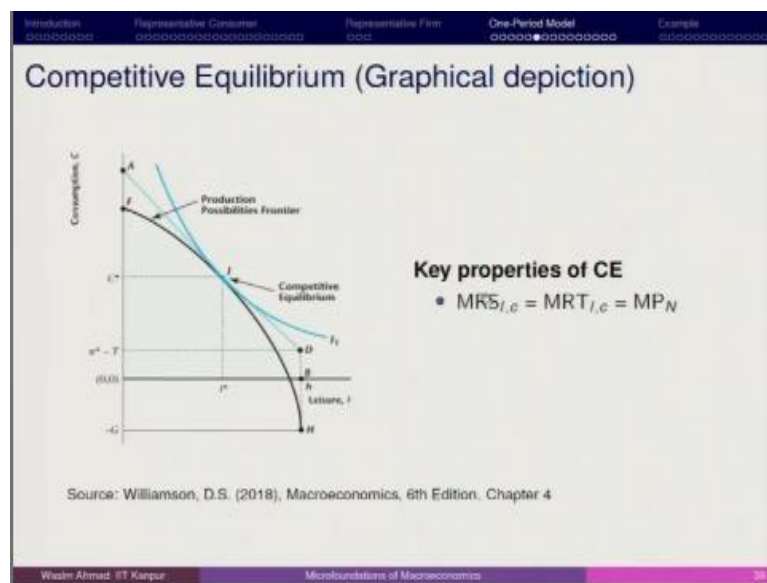
Now, think about here. So, here what is this $-G$? Why are we assuming $-G$? Because some amount of consumption has gone as a tax. Government is taking away some amount of

consumption. Now, you are starting from (0,0) here, this particular amount has gone as a tax. So, we are now more bothered about D to B. So, this is the leisure l that you have.

Now, given the scenario from D to B, this will be the area where this economy will be producing. This is represented by the production possibility frontier, so, $Y - G$, why this G is subtracted from this. This line that you have is nothing but it shows about the production possibility that how much the economy with the help of these agents in the economy with the help of the representative consumer can produce and how much firm can utilise these 2.

So, these things are important to note. Third panel talks about the production possibilities. The slope of this is nothing but marginal rate of transformation that we mentioned that how much there is a possibility of transforming one output or input into another, so, that we mentioned about here.

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It talks about how much you can convert labour into consumption, leisure into consumption and how much you have the transformation possibility of consumption into leisure.

The competitive equilibrium is the point where you have the equilibrium from all 3 sides. The marginal rate of substitution between leisure and consumption is equal to marginal rate of transformation between leisure and consumption, is equal to marginal product of labour. The moment I say marginal product of labour, it is coming from the firm side.

This is the marginal rate of transformation which is coming from the production side that how much is the possibility that the representative agent will be deciding about and how much the economy is having the ability to convert the consumption into leisure; marginal rate of substitution of leisure for consumption is this point J. So, production possibility frontier is this; J is the competitive equilibrium.

So, at the competitive equilibrium level, C^* is the consumption and I^* is the leisure and the J point also shows the competitive equilibrium. So, at this point, all these 3 are equivalent. So, this is how we try to arrive here. I will be stopping it here. In the next session, we will be talking about the inference.

But for you the most critical part should be to understand this that when we assume the closed economy Y is equal to $C + G$. We introduce the representative consumer, whatever we had assumed and then we have now introduced the production, which means the firm, the representative firm. With these 2 playing a role, how are we directing it and deriving the closed economy setup Y is equal to $C + G$. The rest of the things are the static phenomena.

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The relationship between Competitive Equilibrium (CE) and Economic Efficiency (EE)

- The connection between CE and EE are crucial for two reasons:
 - First, how social optimal outcomes can be achieved under perfect competition
 - Second, it helps understand the social optimum better than the CE.
- The measure economic efficiency the most relevant concept that comes is "Pareto Optimality".

"A CE is Pareto optimal if there is no way to rearrange production or to reallocate goods so that no one is better off without making anyone worse off"

So, I will be taking up further from here. And I will be mentioning it again these cases and then we will be going to the role of social planner and further. I will be stopping it here. Thank you. Thank you so much for your attention.