

Microfoundations of Macroeconomics
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Lecture – 18
Search and Unemployment III

Welcome back. we were talking about the search and unemployment model and under this model we discuss the one-sided model and in one-sided model we were talking about the supply side of the labour market. Now when I talk about the supply side of the labour market then we have to think about in what context the labour will be participating in the labour market.

We had derived some ideas about how we can measure the participation of labour in the labour force market and if the labour is participating then what are the factors that determine the participation of the labour force. One basic aspect that we always look at what are the safety needs of the labour? One we discussed is that the government introduces the unemployment insurance benefit.

And this unemployment insurance benefit provides an opportunity for the labour to bargain with the firm. That at least there will be some kind of threshold for the labour to ask for a better wage from the firm. We analyze these aspects. We were talking about the two-sided parts. We had introduced both the firm and the labour.

And we wanted to see from the demand side and supply side. Labour is also looking for work. Firm is also posting the vacancies so if we are seeing from both dimensions then how the interaction between the firm and the consumer or labour can play important role in determining the overall unemployment of the economy. We would be getting back and deriving those macro indicators that we had mentioned the unemployment rate, the participation rate, the vacancy rate, and the Beveridge curve.

So, all these concepts will again be coming back, but at this moment let us get back to what we were talking about and then we will move and finally we will conclude this particular topic.

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opportunities or the number of firms posting vacancies and the number of individuals looking for opportunities so it is a ratio of that.

We have also used the reciprocal, but labour market tightness basically decides about this. So, if you have more of A's, individuals are having more opportunities to look for. So as a result you find that the unemployment reduces, but here we are talking only about those firms which are posting the vacancies. These things we have derived already. We had also derived about the N.

If N is the number of individuals looking for opportunity and Q is the number of consumers who are looking for work then we are talking about $N - Q$, not the N entire. we are talking about only those individuals who have interested in working and they are looking for opportunities.

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You have the expected payoff of searching for work. So, if it is going up then it is of course bound to have a positive relationship so this we have shown, but this is the labour supply curve of the representative labour or the consumer that he or she is looking at here.

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The One-Sided Search Model
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Firms

- A firm must post a vacancy in order to have a chance of matching with a worker.
- k = cost of posting a vacancy, in units of consumption goods
- A = number of active firms (firms posting vacancies)

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It was interesting that we introduce for the first time the firm in our model and we mentioned that the firm will be posting vacancies which means that this firm is looking for more people to be hired, but one aspect that we touched upon in the last session also was the cost of posting vacancies that how the companies hire consultancy firms and the recruitment agencies to hire some amount of labour.

And A is we are denoting at A number of firms which are actively looking for individuals. this is what we are mentioning.

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The slide is titled "Matching" and is part of a presentation on "A Two-Sided Search Model of Unemployment". It contains the following content:

- A successful match in the model is between one worker and one firm.
- M = aggregate number of matches
- e = matching efficiency
- Matching function:

$$M = em(Q, A) \quad (2)$$

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We have already introduced the labour, we introduced the firm. Now we will be seeing how these two are interacting with each other. Here you have to note down that a successful match in the model is between one worker and one firm which means that an individual is looking for a job and the firm is looking for an individual so both are matching each other.

M is equal to the aggregate number of matches and e is equal to matching efficiency and here we have the matching function. The matching function that we are mentioning $M = em(Q, A)$ so this is what we are mentioning about. e represents the efficiency so that we normally say if you are having the Cobb–Douglas production function. The A parameter that we have or A constant that we used represents the productivity.

In the same way, e also represents the efficiency of Q and A . Q represents the number of individuals looking for jobs, A represents the number of firms looking for individuals.

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Progress indicators: Introduction (5/5), One-Sided (5/5), Two-Sided (1/10)

Properties of the Matching Function

- The matching function has properties like a production function.
- The “inputs,” Q and A , produce the “output” M , and e plays the same role as total factor productivity in the production function.
- The matching function has constant returns to scale, positive marginal products, and diminishing marginal products.

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So here it decides about and it has certain characteristics that I have already mentioned so it mentions constant return to scale, positive marginal product, and diminishing marginal products. These are all associated common terms. So linearly specified you can say and even if you have an increment in the function by one then it also leads to the matching increase by one.

This is what so if one firm is increasing one individual is increasing it is also leading to increasing by the same amount in M so this is what it mentions about. It can be interpreted in that way and that if you have a constant increase then we call it the constant return to scale so this is what you mentioned. Positive marginal product in the sense that further additions is having a positive effect so output also will increase.

If we are hiring one more person then the output is going to increase, but it will also have a diminishing scenario, but after some point of time, you cannot go for infinite hiring because you have to look for productivity also. From the productivity point of view we are assuming that it is about the diminishing marginal products.

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Supply Side of the Labor Market: Optimization by Consumers

- Each consumer chooses between home production and searching for work.
- If the consumer chooses to search for work, then he or she finds a match with a firm with probability

$$p_c = \frac{em(Q, A)}{Q} = em\left(1, \frac{A}{Q}\right) = em(1, j) \quad (3)$$
- If the consumer searches for work and is matched he/she receives wage w .
- If the consumer searches and is not matched, then he/she is unemployed and receives the UI benefit b .

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We are now looking at the optimization by consumers and how consumers are optimizing. Now here you have to note down that each consumer chooses between home production and searching for work. Home production in the sense that they are not going to look for a job.

They are sitting at home doing some work that they enjoy so maybe the leisure that we have discussed in the one-period model will come into play here. You can say that those activities do not pay you any or that are not having an immediate economic benefit. We are mentioning those and searching for work means that if you work for a certain number of hours with a fixed duration then you are going to get some reward or the wage.

So we are not counting for non-wage activities we are counting those activities which are linked with the wage. If you work for a certain number of hours we are supposed to get. Now if the consumer chooses to search for work, then he or she finds a match with a firm and with certain probabilities. If the consumer is looking for work then there are chances that he may be employed and there are chances that he may not be employed.

We are mentioning about that so here we have the probability of matching which means the chance that a consumer skill set or the required skill of the firm matches with the particular consumer so here it is p_c .

$$p_c = \frac{em(Q, A)}{Q} = em\left(1, \frac{A}{Q}\right) = em(1, j)$$

If the consumer searches for work he or she will receive the wage rate if the consumer searches and is not matched then he or she will have to depend upon the unemployment insurance benefits which is b , so which means that if the individual is able to match with the required skills of the firm he gets employment.

He gets the wage rate if he is able to match and if matching does not take place, then he has to satisfy with the unemployment insurance benefits so that is the underlying idea. So, this also we had covered.

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The slide is titled "Marginal Consumer" and is part of a presentation on search models. It contains the following content:

- The probability of being unemployed if a consumer chooses to search for market is then $1 - p_c = 1 - em(1, j)$
- For the consumer who is indifferent between home production and searching for work,

$$P(Q) = p_c w + (1 - p_c) b = b + em(1, j)(w - b) \quad (4)$$

- Here, j is labor market tightness,

$$j = \frac{A}{Q} \quad (5)$$

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Then we mentioned the consumer probability of being unemployed,

$$1 - p_c = 1 - em(1, j)$$

So if the consumer matches the requirement of the firm, if the skill match the firm's requirements and the individual, we have p_c and if it is not matching then it is $1 - p_c$.

Here it is if he is matched then it is p_c multiplied by the wage rate plus if he is not matched then he has to satisfy with the unemployment insurance benefit. How we can mention it so here we can simply derive. If you go for writing it further just for the p_c then ultimately what we have is

$$P(Q) = p_c w + (1 - p_c) b = b + em(1, j)(w - b)$$

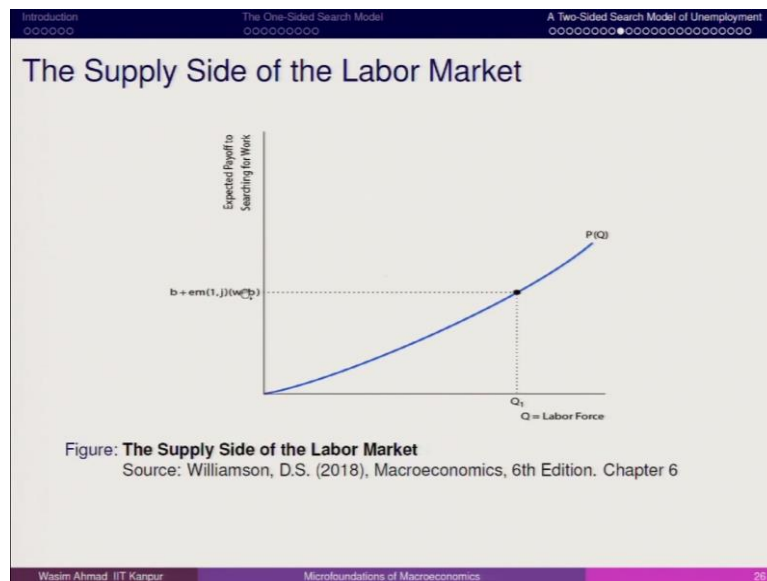
This we can introduce it here and then finally we can arrive at this figure. Now here you have to note is that $w - b$ what is $w - b$? $w - b$ is the difference between how much the firm is

offering the wage rate and how much is the unemployment insurance benefit. Wider is the gap between these two there are high chances that labour will be willing to supply his or her labour.

But from the firm side, we are not sure what will happen to the firm side because the firm may not like to hire because when the wage rate is high the firm may have to incur the extra cost. Those things we will be dealing with later. One thing that I mentioned is that θ the labour market tightness it is the ratio of A upon Q , the number of actively looking firm and people who are searching for jobs. If A increases there are high chances that the labour market tightness is going to be higher.

If A decreases the labour market tightness is going to be lower. This is how we interpret this.

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Now once I mentioned about so this is the supply side so expected payoff that the labour is willing to supply this much. This is what we mentioned the given the difference between $w - b$ that the labour expects the matching function and the unemployment benefit and this is the labour force. If you are going to increase this there will be increase in the labour force because more people will be interested because $w - b$ is going to be higher. This is what we are mentioning about.

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Demand Side of the Labor Market

- A firm entering the labor market bears the cost k to post a vacancy.
- The probability that a firm with a vacancy finds a worker to fill the job is

$$p_f = \frac{em(Q, A)}{A} = em\left(\frac{Q}{A}, 1\right) = em\left(\frac{1}{j}, 1\right) \quad (6)$$
- When matched, a worker and firm produce z , so the payoff to the firm is profit = $z - w$.

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Demand-side of the labour market when the firm enters in the market it bears the cost k to post a vacancy which means that as I said that firm is hiring a consultancy firm and this particular firm is helping the firms to recruit so which means that if firms are posting vacancies it goes to some consultancy firms, consultancy firms charge to the posting firms.

And then the firm settles or pays the amount. There is a cost involved in hiring. The probability that a firm with a vacancy finds a worker to fill the job is

$$p_f = \frac{em(Q, A)}{A} = em\left(\frac{Q}{A}, 1\right) = em\left(\frac{1}{j}, 1\right)$$

Firm produce z so the payoff to the firm is profit $z - w$ so this is what we are mentioning that if the firm is producing z amount of output this is output when firm is hiring a worker.

If worker and a firm produces amount z then the payoff of the profit would be how much you are producing, how much is your output produced by hiring the labour and how much you are paying to the labour. So $z - w$ represents that.

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Expected Net Payoff for a Firm Posting a Vacancy is Zero in Equilibrium

- Firm will enter the labor market, posting vacancies, until the expected net payoff from doing so is zero

$$p_f(z - w) - k = 0$$

- In equilibrium, k must be equal to the expected payoff for the firm from posting the vacancy, which implies:

$$em\left(\frac{1}{j}, 1\right) = \frac{k}{z - w} \quad (7)$$

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Now expected net payoff for a firm posting a vacancy is zero in equilibrium how it is zero. The firm will enter the labour market it will post the vacancies until the expected net payoff doing so is 0. Here it is

$$p_f(z - w) - k = 0$$

This is what we are mentioning that when the firm is entering into the market and so we assume that whatever the recruitment or likelihood the recruitment that the firm is having and whatever is the profit that firm makes it is equivalent to the cost.

This is what the equilibrium mentions. In equilibrium, k must be equal to the expected payoff. So this is what we have for the firm for posting the vacancy so here if I am writing

$$em\left(\frac{1}{j}, 1\right) = \frac{k}{z - w}$$

This is what we mentioned that in equilibrium whatever the firm is having profit.

The cost of posting vacancies relative to the profit if it is lower than the firm is going to post more vacancies otherwise not which means that if $z - w$ is higher firm will not mind posting vacancy because even if k is increasing, but the rate of increase in profit is much higher than k then firm does not bother about, but if it is lower than the firm will not post vacancy which means that labour market tightness will have some impact of this. This is what we are going to examine.

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As you can see if k increases you can see that the labour market tightness decreases, and this leads to more unemployment which means that less of posting of vacancies and once you have the less posting of vacancies the matching will be very difficult and this will further reduce the labour market tightness.

And as a result, the outcome at a macro level will be that your unemployment will increase. Let us get back to it, I think we had sufficient background about this in the last session so we will be now going forward. Now the idea is that once I am mentioning the expected net payoff which is the here. Now we have also derived the demand side of the labour market now we are seeing how we can bring to an equilibrium of firm or how we can derive the equilibrium between firm and the labour because both are participating.

The objective of the labour is to maximize the wage rate, the objective of the firm is to maximize the profit. So how much bargaining is possible between firm and the labour. This we try to understand with the alternative strategies that these two individuals have under the Nash bargaining problem.

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So here we mentioned a equals to worker share in total surplus so this is the bargaining power they have. If I go for the substitution so how much do I have so if $w - b$ so this is the worker surplus equals to a is the workers share of total surplus. This is the total surplus we have. This is the labour share so labour shares can be written as,

$$w - b = a(z - b)$$

$$w = az + (1 - a)b$$

This means that a is linked with the profit or I would say output produced by the firms and $1 - a$ goes to the unemployment insurance benefit. Both are counted here.

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Equilibrium

- Two equations determining Q and j (from supply side, demand side, and Nash bargaining):
Substitute of value of w (8) in (4) and (7)

$$P(Q) = b + em(1, j)a(z - b) \quad (9)$$

$$em\left(\frac{1}{j}, 1\right) = \frac{k}{(1 - a)(z - b)} \quad (10)$$

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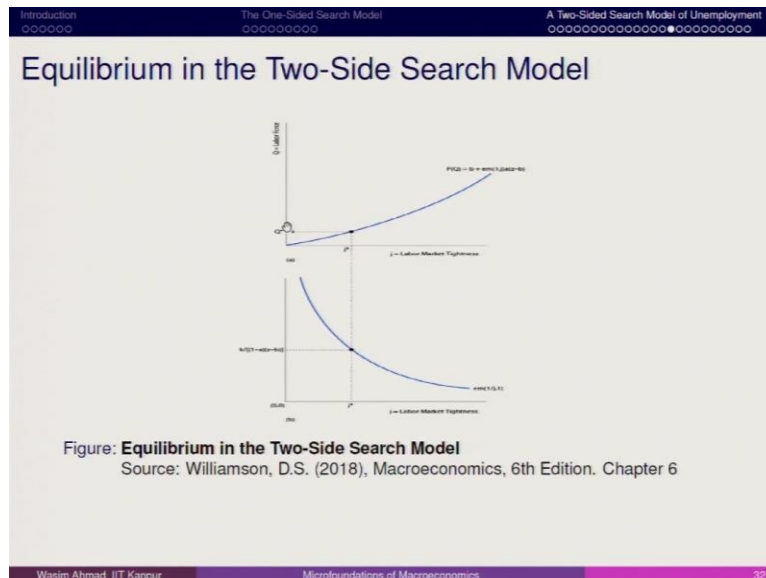
Now once we have these two equations so two equations determining Q and j from supply side, demand side and Nash bargaining can be written.

$$P(Q) = b + em(1, j)a(z - b)$$

$$em\left(\frac{1}{j}, 1\right) = \frac{k}{(1 - a)(z - b)}$$

If k is increasing it will bother much to the firm for posting a vacancy so this is the underlying idea.

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We will also have the further understanding of this. Suppose, we have this particular line and we can see that the labour market tightness that we have decide we mentioned about labour market tightness is z the corresponding labour force participation is Q this is what. We will have the comparative statics also what happens if k increases, what happens if b increases because now we have explicit understanding that b is also playing a role how much we have the product produced which means that productivity will matter now.

So we will also see that what will happen if there is a productivity increase and if we are going to see increase in k so that matters now.

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Equilibrium Unemployment Rate, Vacancy Rate, and Aggregate Output

- In equilibrium, as functions of j and Q , the unemployment rate, vacancy rate, and level of aggregate output, respectively, are:
 - Unemployment rate is $u = \frac{Q(1-\beta\epsilon)}{Q} = 1 - em(1, j)$
 - Vacancy rate: $v = \frac{A(1-\beta\epsilon)}{A} = 1 - em(\frac{1}{j}, 1)$
 - Aggregate output as $Y = Mz = Qem(1, j)z$

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Now as we have already mentioned about these two things, we have to go back and derive the macroeconomic variables which all were the macro-economic variables? The very first variable

was the unemployment rate, unemployment rate is what? This is what we mentioned about here it is nothing but

$$U = \frac{Q(1-p_c)}{Q} = 1 - em(1, j)$$

Your unemployment rate is nothing, but 1 minus how much we have the efficiency of matching so this is what it becomes. Vacancy rate is

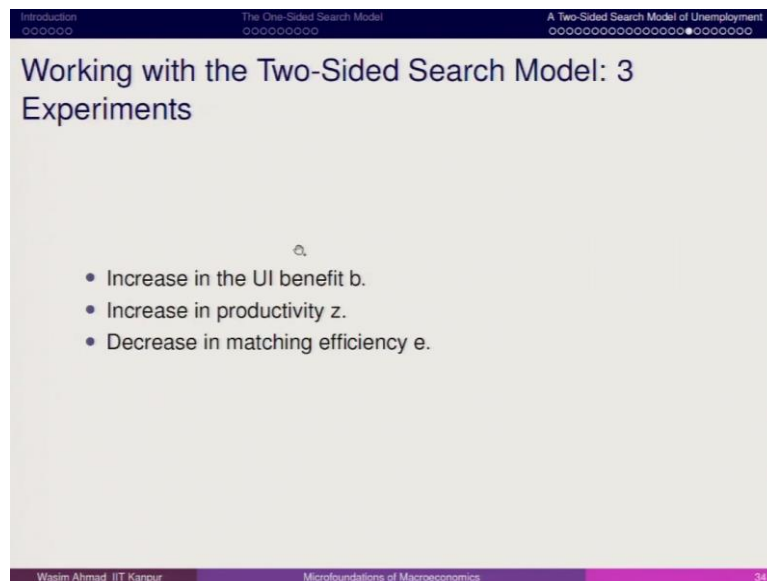
$$V = \frac{A(1-p_f)}{A} = 1 - em\left(\frac{1}{j}, 1\right)$$

The aggregate output in the economy is

$$Y = Mz = Qem(1, j)z$$

This is the aggregate output this is the vacancy rate and this is the unemployment rate.

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Now we will be working with the comparative statics so increase in the UI benefit b increase in productivity z, and decrease in matching efficiency e. It means that once you have the increase in unemployment benefit so what we see is that so here this is the first equilibrium that we have so this is what we have $\frac{k}{(1-a)(z-b_1)}$. This is the original equilibrium.

We see that once we have the unemployment insurance increasing then this leads to leftward shift of the labour supply curve and as a result you will find that the unemployment will increase because there is decrease in the labour supply why because once we have the unemployment benefit increasing more number of people will be asking for higher job, higher wages and that will be difficult for the firm to meet. So, this is what we have.

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Increase in the UI Benefit, b

- Reduces total surplus from a match, $z - b$.
- Increases the wage, w , as the alternative to working becomes more tempting for a searching consumer.
- Posting vacancies becomes less attractive for firms, so labor market tightness, j , falls.
- For consumers, searching for work becomes more attractive, as the wage is higher. But searching for work is also less attractive, as the chances of finding a job are lower (j is lower).
- Q may rise or fall given these two opposing effects.
- u rises and v falls.

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Increasing the wage rate as alternative to working becomes more attempting for searching consumer. This is what so as a result labour market tightness j falls. For consumer searching for work becomes more attractive and they will not be accepting which means that your unemployment will rise and vacancy will fall. This will have impact on your Beveridge curve so this is what we are trying to understand.

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An Increase in Productivity

- Increases the total surplus from a match, $z - b$.
- Increases the wage, w , as the worker gets the same share of a larger pie.
- As profit is higher, posting vacancies becomes more attractive for firms, so labor market tightness, j , rises.
- For consumers, searching for work becomes more attractive, as the wage is higher, and the chances of finding work are better.
- Q rises, u falls, v rises, Y rises.

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Second is the increase in productivity what happens if the firm is hiring a labour and this labour help produce a more output. It means the increase in z so once I have increase in z so this will help a lot so $z - b$ this is what we are mentioning about. If the total surplus is increasing then this will have the positive effect.

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