Health Economics

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Week – 10

Lecture 52- Application of DEA in Healthcare Using DEAP

Welcome friends once again to our NPTEL MOOC module on health economics. As I have already mentioned to you, this course is also counted as a faculty development program type of course. Once you enroll and are certified after the examination, you will also receive a certificate and equivalent to the faculty development program. More interestingly, this course gives different units that are highly applied yet provide a backup of its theoretical base, clarifying each of the directions. In this particular week, we already explained the discussion on, or we discussed, efficiency. So, precisely on health efficiency, and we have in the previous lecture in particular, we started explaining the software, the application that is DEAP software, data envelopment, and programming.

So, let us further apply it and clarify each of the tools in the discussions. So that is why this lecture is called Practical on Data Envelopment Analysis. So, the learning goals in this case will be on CCR input, CCR output, BCC input, and BCC output, and we will directly derive from the package from the software so that the findings and to what extent can be useful. You can write your papers directly after listening to this video.

This will be precisely 20 to 30 minutes and will be very useful to you. So, in the previous lecture, if you remember, I introduced DEAP software. We have also provided you with the instruction files. We also discussed the output files; we specified in the instructions how to set the commands, and simply, in the DEAP software, we derived the results. Today, in this lecture, we will be discussing CCR input-based models.

There are four main results in the output file. So, we will be emphasizing mostly efficiency scores, then a summary of slacks, then a summary of peers, peer weights, and peer count, then a summary of input-output targets, and other is by the firm results. So, we will discuss each of them, how results are derived, and how they are interpreted in our example dataset, where if you remember, we discussed two inputs and two output cases, which were the example of nursing hours and medical supplies and their impact on inpatient admissions and outpatient visits of the 10 hospitals or 10 firms. So, this is where we stand, and there are 10 H or the DMUs or the firms or the hospitals are here, and the inputs are two inputs, these two are the inputs, and these two are the outputs.

Table: Hospital inputs and outputs				
Provider	Inputs		Outputs	
	Nursing hours	Medical supplies ($)	Inpatients admissions	Outpatients' visits
H1	567	2678	409	211
H2	350	1200	90	85
H3	445	1616	295	186
H4	2200	1450	560	71
H5	450	890	195	94
H6	399	1660	209	100
H7	156	3102	108	57
H8	2314	3456	877	252
H9	560	4000	189	310
H10	1669	4500	530	390

And we are now going to use further and to interpret the results. Now, just see one thing: the fundamental result we derived is the efficiency summary. And if you remember, we made the file called CCR1-instruction.txt, and the data file is CCR1.txt from the data file we derived and an input-oriented DEA model that is CCRIN I mentioned, the scale assumption is, of course, CRS, Constant Returns to Scale and slacks are calculated using multistage method.

Slacks, as we already explained earlier in these basics. I am just going to show you the basic result in the next screen. So, if you remember, I will just show you the file that I opened. The file is my CCR1-ins. Instruction is the text; this is the file name if you can read it.

But within that, if you remember, we mentioned the data stored in CCR1.txt. That means it is a notepad file; we have to specify the extension as well. Then, the output is specified as CCR1-out. Another important instruction we mentioned is we need to specify the number of firms.

In our case, it is if you remember, just now I mentioned that there are 10 firms and a number of time periods. It is only the cross-sectional we are explaining only one time period since one is mentioned, the number of outputs are 2, and the number of inputs are 2, and so far as input and output-oriented models are concerned, had it been in output-oriented, we could have mentioned 1, but since it is input oriented, the code is actually 0. So, we have mentioned 0. CRS-based; hence it is 0, and since it is a basic DEA model multistage, we call it multistage because we are capturing the slacks, which I have just mentioned. So, why slacks? Because of that, we optimized, and accordingly, we defined Pareto optimality against the general efficiency scores. So, we will also clarify the result once again, and hence it is 0 since it is a basic DEA, but later on, if it is in an output-oriented model, we also require two-stage frameworks; we will be taking the help of 4 as the core.

So, this is done, and if you want to see it once for your dataset, this is what we entered already. This is the dataset directly. The data is to be entered in this file and saved as with the file name; this file name should be specified. I am going to close these files as a basic instruction for closing and operating them. The output file is also already mentioned. So, we have to simply specify the instruction file name, and we need to enter it.

We know that this is our instruction file, and the name is CCR1-ins. This is what we need to just enter. So, we know that we get our output, and the output is already saved in our file output file we already saved it. So, you just see what it looks like. This is our first table to explain the total efficiency, overall efficiency, or efficiency summary to you.

You start with the efficiency summary. So, for the first table we are explaining, I am just using the main window to explain you. Here is my main window, which I just derived, and here it is. So, let us see that the efficiency scores of all 10 hospitals are obtained in the first case; in the first section, you just see till the 10, and their efficiency mean score is also mentioned. 6 of the 10 we have just highlighted those 6 that is H1, H3, H4, H5, H8 and H9.

These 6 are technically efficient since their score is perfect and they are called efficient firms. Also, Farrell efficient firms need to account for the slacks. At this moment, it is not accounting for the slacks. After accounting for the slacks, we will decide whether they are actually Pareto efficient or not. For hospitals 2 and 6, here is actually for 2, 6, 7, and 10.

The technical efficiency scores are actually less than 1, but positive. Hence, they are called inefficient hospitals or firms. So, we need to have a scope for utilizing its slacks if you remember. Hence, we will try to differentiate Farel efficient from Pareto efficient firms. So, these have scope for improvement.

So, improve their efficiency or reduce their inefficiencies proportionately by reducing their inputs through the input-oriented models. So, let us see what is there. So, for example, H6 can improve its efficiency by reducing certain inputs to by 24.2 percent. So, what do you mean by this? So, you can just see it at the back.

So, we have already mentioned that H2 is 0.615, and that means efficient. What is the difference against 1? So, it is still cutting short of 1 for firm 2 and firm 6. Let us stick to the fact that we are expanding 6 at this moment. So, for the 6 case, so that means the difference is actually 1 is the optimum score minus 0.758. So, this is precisely 24.2 percent. So, we can improve its efficiency by reducing certain inputs up to that is 24.2 percent. Whereas in the case of H2, 1 is minus since it is 0.615, so it will be 1 minus 0.615, which is precisely 38.5 percent. And can actually if you reduce the inputs by this percentage, this can improve its efficiency. And similarly, you can also explain for H10 since they are inefficient firms.

Here, the mean total efficiency score, the mean score is actually 0.909. This is also called the whole industry overall 10 industries efficiency, which means they are 90 percent efficient. So, 10 percent of inefficiencies are still there that can also be improved by individual level improvement. Hence, the question is which inputs need to be reduced by calculated proportions, these input reductions or output augmentations, the total inefficiencies that are comprised of the number of proportional reductions as well as in slacks for those hospitals that cannot reach their efficiency targets or frontiers despite the proportional reductions.

We are supposed to utilize the possible slacks, which we already explained the meaning of slacks in our earlier lectures. So, what are those slacks? We will clarify once again. Basically, if you remember, in the input-output model or in the output-oriented model, we target the frontiers. So, slacks represent only the leftover proportions of inefficiencies. So, that is, after a proportional reduction in inputs or increase in outputs, if a DMU cannot reach the efficiency frontier, slacks are needed to push the DMUs to the frontier that is still the target.

Through the slacks, you can reach the DMU frontiers. Here, none of the efficient hospitals have any slacks, and only for inefficient hospitals, if there are any slacks, so inefficient hospitals cases are to be discussed. No efficient hospitals have any slacks. So, as I already mentioned, even if it is an output-oriented or input-oriented case, So, Farrell efficient firms are, in that case, all are actually Pareto efficient since there is no scope for slacks to be utilized.

However, if Farrell efficient firms or hospitals have any slacks, that means the Farrell efficient score is actually less than that of the Pareto efficient. Hence, their Farrell efficiency or efficiency is not Pareto efficient. So, I think I have already mentioned it in the result window, but I am not discussing it. Our next table is on this. If you look at this carefully, I am just going to show it once, and I will explain it from the slide.

So, this is the one that we are actually explaining, and I will also be utilizing this for calculation. After that, we will also be discussing a summary of peers. Let us come back to the main window and explain once again. So, the first clarification is that where the firms with an efficiency score of 1 or are the efficient ones do not have any slacks; hence, Farrell efficient is also called Pareto efficient. So, we will start by explaining this from the, as I already mentioned from firm two, and now we are actually explaining slacks cases.

So, firm 2 is required to reduce its nursing hours by approximately 12 hours. Despite the reduction, you can see that the top table is for output slacks, and the bottom one is for input slacks. So, through the inputs, we can able to optimize the outputs. So hence, through the inputs, you can see the changes 12, which we have already mentioned. So, approximately 12 hours is required to reach at the efficiency level for the firm 2.

Despite the reduction in this input, it would not achieve efficiency. To achieve this, H2 should also augment its inpatient admission by 44.8 percent. So, its output also has to be augmented.

Just input reduction cannot be reached. Similarly, we can also explain a similar situation for H. A similar situation with a different magnitude is given in H10, and we can also explain a similar situation with a different magnitude given in H10. H7 in the case of H7, you can just see 0, input reduction is not required, H7 should spend, you can see it is the second one that is clearly mentioned, H7 should spend 2309.19 less per medical supplies. The first case is 0, so the second one is important, so we have emphasized the second one. The third table, which you see, is called peer analysis; I have just shown from the output table a summary of peers, which the basic DEA model gives.

So, a peer explanation is given. Now, peer is very important because we need to stick to the main window once again through the slides. Peers are important not just because of the individual firm but also because of who else is competing with me and how they are competing. So, it gives me who my peers are; if I am not efficient, then who are my peers? If I am efficient, I am the one, and there are no peers required to be efficient. If I am not efficient, we have already mentioned that firm 2, that is, the DMU-2, is not that efficient; even 6, 7, and even 10 are not efficient.

So, in that case, others are with their efficient score if you remember that those are 1, so hence 1's peer is 1, 2, 3's peer is 3, 4's peer is 3, 4, 5's peer is 5, and so on. However, inefficient firms have different peers; they are trying to compete with the best competitors. Firm 2 if competing with 3 can be more efficient. This means that peer is the benchmark for the best practice. In this case, they have to be defined as their benchmark because they are the top one if they are efficient. However, in the case of efficient hospitals, they compete with themselves, whereas in the case of inefficient ones, they have to be benchmarked with the better firms.

So, especially here, 2, 6, 7, and 10 need to benchmark the efficient firms. So, here is what I have already mentioned. For inefficient hospitals, their benchmarks are one or many, especially in 6 and 7; you just see it is not just one firm; there are actually two firms together, and they are competing. And yes, weights are different. Now, you need to compare with weights, whose weight is higher.

So, benchmark with 1 or benchmark with 2 or even 3, a benchmark for H2 and H10 are firm number 3. For 6 and 7, there are two hospitals, H1 and H3; you can find them here. Now, since, as I already said, peer weights are important, it is not just one that is being competed or confronted with since there are multiple competitions. So, weights need to be taken carefully. So, we will explain those weights; I think you have already seen them in our table, and you will also find out the same result and check it.

So, you just see, to become efficient, H6 and H7 must use a combination of both H1 and H3. So, because we have already seen that 6 and 7 are having with the peer as H3 and 1, they are combining H6 and H7 weights. H6 and H7 are a combination of H1 and H3. How much of H1 and how much of H3 as a combination is required requires little calculation, and this calculation must be taken very seriously, which is precisely called lambda, and as weights, only efficiency can be achieved.

So, these are called lambda or weights obtained from the dual version of the linear program solved to estimate these values. For example, H7, in our case, will attempt to become like H1 more than H3, as observed from the respective weights of H1 and H3. So, this is precisely with a value called lambda of 0.237 versus lambda of 0.38; it is already mentioned very clearly so far as H7 is concerned.

Another one is called peer count summary. So, I am not going through that software once again; I have already shown it. This is how it is displayed. So, peer count means one is basically just the reverses against the peer, which I have already said; it is basically how many are being referred. Number of times each firm is a peer of another one. It represents the number of times efficient firms, that is, hospitals are peer to the inefficient units one or two times, respectively.

One is the efficient firm, as I already told you; it is counted two times by another firm, or two firms are counted, and one is their peer. Similarly, firm 3 is considered 4 times. So, 4 firms actually considered 3 as their peer, whereas others are considered 0 because they do not have any competition or they do not have a peer count. An efficient firm may also peer count as 0 if it is not peer to others, an efficient firm always peers to itself.

So, on counting as a peer, it is excluded. So, for example, for H1 count peer of 2, that is, H6 and H7, you can just cross-check from the data as it is already given from the first result, not data from the result, peer result, and H3 count of a peer of 4 firms that is H2, H6, H7, H10. Another result is given is called efficiency targets for inputs and outputs. If you remember, when we say targets, that means we are sticking to target analysis, which is already mentioned in this type of mapping we mentioned. Here is a summary of output targets. Slacks are also important. So, for each hospital, target input and output levels are given in the figure as a result of the DEAP.

These targets are the result of respective slack values added to proportional reduction amounts. So, to calculate the target values for input, the input value is multiplied with an optimal efficiency score, and then slack amounts are subtracted as per the formula already given to you. If you remember that the formula optimal score is determined, then from the optimal score, we apply it through the slack method and can be calculated. For efficient firms, target values are equivalent to their original input and output values.

So, no need to calculate further. Here, we are sticking to 2 once again, starting from their input to their output. So, for the DMUs inefficient 1, that is, 2 in this case, the target for input variables in the CCR input-oriented DEA model will comprise a proportional reduction in the input variables by their efficiency score of the DMUs minus the slack value. Slack value is important, as I already told you, so far as the target is concerned. The efficiency score is also multiplied to reach the target. So, in this case, we are sticking to the result in our case nursing hours as the inputs and medical supply are another input for hospital number 2.

So, our target is this is what is mentioned. So, here is our input in that case is: H2, NH is our nursing hours, and the slack is of that nursing hours, and for the unit, that is DMUs 2. So, in this one, we are using, if you remember, our efficiency score for that 2 is 0.615. I am just going to show you.

So, it is here I am just using another window simultaneously. It could have also been put in the next slide, but you can just check the efficiency score we calculated from the beginning, which is the efficiency summary. It is here that 0.615. I am going back to this again, and we will be using it further. So, if you remember, we are using the inputs and the output as we already discussed in the slacks case, which is in terms of inputs and in terms of also outputs.

So, if you remember, I will just go back slightly and or in the same window, I will just tell you. So, here it is. So, 12.034 is the case for inputs as 350. So, input table, if you remember, go back to the table and check the input respective to that DMU; it is 350.

So, by calculation, we find that the target value is 203.360. This is what is derived. You need not be confused what is all about what the DP is providing you. This is actually very systematic, and you will be convinced. Similarly, the target calculation of medical supply is the first one we derived.

This is for X_{NH}. So, we can also calculate for the MS. So, for the medical supply, you just apply the values. We have already mentioned that this has happened 0.615 times. In this case, it will be 1200 because that medical supply input was 1200, and in that case, the slack was 0. If you check it from the table in another window, I can just highlight it for you if you are a bit confused. So, this is 0, isn't it? So, slack is subtracted as 0 in this case, 0.615 already we mentioned.

Hence, the calculation of the target boils down to 738.495. Similarly, you can also calculate the output targets, and the formula will be different for input targets, and output targets are different. In that case, when it is output-oriented output target based, though it is an input-oriented model, but output target, our slacks will be positive, won't it? As I told you in our theoretical explanation. So, it is positive, so the slack is actually added. The output slacks have to be added, not the input slacks, for, again, for the medical supply MS.

We are trying to find this result, and this is for MS, for NH, and MS. We are referring to 134; this one is for NH. Just make a check: the first one is NH, and the second one is called MS, but this table is for MS. We started the first part where you can just check this is for NH, this is MS, and this is NH.

I will just cross-check. I probably made a mistake here; I am just clarifying. When we say output-oriented, we mention NH and MS in the input case. But in the two outputs targeted, if you remember from my starting picture, I have to show it to you quickly, and I will come back. So, this is what we have shown it.

This is what I forgot. This is our first output; this is our second output. Inpatient admissions and outpatient visits. So, I will just go back to that page and explain it to you, and I will be taking less time here. So, input we have already explained.

The first output is output 1, Q1, and Q2. So, I have already shown it to you. The Slacks are different from the Slacks we have mentioned. So, we have just added the slack with that output value. So, the output value was 90 plus the slack. Hence, it is 134.812. In the second case, that is the second output that I have just mentioned, so this is basically Q1, and this is basically the Q2 that I have just shown you.

In that case, in the second output, its slack was 0; hence, it is the same. So, that is the target-based efficiency scores we explained. So, four items are there. The last one is the result, which also gives a firm explanation. It gives four items: the original value, the radial movement, the slack moment, and the projected value. Also, you can use 4, 1, 2, 3, and 4. I am not explaining much since we have already consumed more time and may be taken off in detail later.

If you go through it on your own, you can probably find out. So, each of the directions is for firm 1, then the next one, firm 2, and so on. So, from firm 2, for example, firm 2, the efficiency, total technical efficiency score was 0.615, and we mentioned it as an inefficient firm. Radial contraction in inputs needs to be defined as efficient.

- Similarly, target calculation of Medical S

$$\hat{x}_{MS,H2} = \theta^{*} x_{MS,H2} - s_{MS}^{-*}$$

$$\hat{x}_{MS,H2} = 0.615*1200 - 0$$

$$\hat{x}_{MS,H2} \approx 738.495$$

Efficient output targets are calculated as (for H_2)

$$\hat{y}_{ro} = y_{ro} + s_i^{+*} \quad r = 1, \ldots . s$$

$$\hat{y}_{IA,H2} = y_{IA,H2} + s_{IA}^{+*}$$

$$\hat{y}_{IA,H2} = 90+44.812$$

$$\hat{y}_{IA,H2} = 134.812$$

$$\hat{y}_{OV,H2} = y_{OV,H2} + s_{OV}^{+*}$$

$$\hat{y}_{OV,H2} = 85 + 0$$

$$\hat{y}_{OV,H2} = 85.00$$

Rest explanations are explained as above already. We already explained, but the radial moment is actually more important, and inputs-based Slack adjustments are especially required. So, we will be explaining this BCC input model. Then, we will use a separate file accordingly. We will be using the BCC dot text accordingly, and I will show you in detail. I have made everything here, but there are simple differences. Just a clarification in this case: the rest are the same.

So, the data we have taken and the output file we can mention, we used to follow these actually earlier, and we take 0. Here, the rest are the same except this, just see, since it is the BCC model. The rest are identical; I need not mention more time at this moment; whenever time and performance, we may give more emphasis on this; rest are more or less the same. What is this BCC? As I already told you, it is based on variable returns to scale assumption. Hence, there are differences between peer efficiency, overall efficiency, and scale efficiency.

So, another interesting aspect is that we used to get 0 value for the multistage simple DA result, but in this case, since we are using the VRS model, we need a two-stage explanation. Hence, we have taken four as the code, and the rest are the same, and accordingly, we can follow. So, in our case, in our practical example, we will be providing this document to you for your exercise as well whenever you register for it, and you will have access to all these practical handouts. So, we are using the CCR3 instruction file, but earlier, we mentioned it here on our DEAP page. So, we need to just open that DEAP file, and CCR3 output is created by DEAP, and the rest of the results can be interpreted very clearly.

So, we have been discussing the application of DEAP software. We have already calculated the input-based models. Now, as I already told you just a couple of minutes back the , CRS-based input model and its interpretations as derivations, etcetera, how the result is shown. Now, we are discussing the BCC input model. So, I will just show you how we did it, and then you can recall it very quickly.

So, the data that we have already shown you are two inputs and two outputs. And at this moment, since we are changing to BCC, do you remember the theory that is related to your assumption? The assumption here is it is related to variable returns to scale. We used to have the CCR model, which is all about the constant returns to scale. So, we used to get the technical efficiency or the overall technical efficiency results, and so we derived the overall summary results. But here we are going to discuss peer technical efficiency and scale efficiency.

So, how did we enter? I will not operate further because I have already shown you here, and you can cross-check with my previous slide through my laptop. So, the text data I feed it is again the same as the CCR1 dot text it is here. And my output now I actually changing because I wanted to show you a different result based on BCC. Hence, it is CCR3 hyphen output dot txt.

This is the new file I created, and I am mentioning it in my instruction file. Another change is that we are supposed to specify it is a VRS model; rest are the same VRS model. VRS means it is over here it has to be mentioned in one. The second important, interesting aspect is that we have to discuss either one stage or two stages. Since we are addressing the targets through the Slacks, a two-stage calculation is required.

Hence, we are mentioning four as the code. The rest are the same since it is input-based. So, our model is actually input-based. For your memory, once again, for your clarification, we have discussed two outputs and two inputs as per our data. So, this is what we have discussed. So, we need to carry it out again. The similar approach I will follow again, and I will simply write down my instruction file here, which is CCR3, and make sure that you are operating on the same folder. Also, it is suggested not to open any of this txt file.

Make it closed and keep all those instruction files. Takes the data file and then outputs the file on the same folder. It has to be the same name that has to be mentioned here as CCR3-INS instruction.txt, and this result has to be entered. This is the first result, which is called efficiency summary. One interesting part of this is that we used to get the CRS-based estimation with the first firm, the 10 DMU of the firms, along with their CRS value, but now we are, in addition, getting VRS and the scale results.

In addition to that, the third column also identifies whether it is following which kind of returns to scale: increasing, constant, or decreasing. IRS stands for increasing, DASH stands for constant, and DRS stands for decreasing. So, dash means constant. The firm is considered to be the efficient one in this VRS model. They are considered to be optimizing their level and used to be constant. Another interesting aspect is that changes in the DMUs are very and we are following the VRS based. So, the production function hardly gets any options to find out the major changes through the VRS framework.

More DMUs are required to be effective enough to identify inefficiencies. Hence, this setup derived almost all the firms that are efficient except one, which is 6. Hence, our concern here is to emphasize how 6 is made and what the interpretation is all about. The full form of everything is mentioned for your clarity I am not mentioning much time. So, we are referring to H6 at this moment.

So, BCC and VRS efficiency scores are generally higher than the CCR and efficiency scores for input-oriented models. More hospitals are considered to be efficient using this particular approach whenever we have more hospitals or more DMUs to be there. How to scale efficiency is the third column that we have mentioned. How is it mentioned as scale? It is basically the efficiency score based on the CCR model divided by the efficiencies called the BCC model. That means the technical efficiency divided by the peer efficiency is nothing but scale efficiency.

So, this is how the third column is derived. You can just see the values are nothing but the ratio. This is divided by nothing but the scale. You can just cross-check on your own, and hence, we derive the values, which is how they are highlighted in this slide. So, the BCC efficiency score that is mentioned as theta star is considered as a peer technical efficiency, whereas CCR is called technical efficiency or overall technical efficiency. That is also represented by theta CCR. Returns to scale, the last column, as I already clarified, I think I need not emphasize much. However, one interesting aspect here of calculating and assessing the RTS returns to scale is that increasing the constant or decreasing the sum of lambda weights values is important.

So, lambda value where to get it? If you remember, I discussed the CCR-based model, and again, this model also assumes the basic assumption of CCR. Hence, the peer weights are important. Peer weights were already mentioned and explained in the last lecture. However, for you, if the summation of lambda weights finally is less than 1, then that is called increasing rates of return; if the sum of lambda is greater than 1, then those particular DMUs are considered to be decreasing returns to scale or decreasing rates of return.

However, the dash is called where the sum of lambda is equal to 1, and they are considered to be the efficient DMUs. So, again, you just check the CCR input result. We discussed those lambdas and their summations. So, how did we do it? We actually cross-checked with their summation of those peer weights with their respective peers. So, especially for H6 and H7, some of the lambda are in addition to their respective lambda weights.

The sum of the lambda value of H7, particularly in this case, is 0.237 and 0.238. So, boils down to 0.275. So, then, since it is less than 1, it is interpreted as increasing returns to scale. However, in 10, it is more than 1, which is 2.097, so it is following a DRS function. These calculations are behind DEAP; they only give the result. So, in the BCC peer analysis, we can have the peer weights for the different peers, and peer counts are also mentioned here.

So, you can see how it is interpreted. I have already given detailed clarity; I think there is no need to emphasize further. The lambda weights corresponding to these reference hospitals are mentioned where inefficiencies are noted. So, lambda weights really matter. One is that the peer is actually loading how much of weight. And here final words with the slacks and efficient targets because we already clarified in our CCR model. For the sixth case, the output slacks, the value to be noted in input slacks, there are no slacks, and we are not discussing in one case only.

In the case of output slacks noted for the sixth firm, that is a matter of interest to us. In order to reach the BCC frontier, output augmentation is approximately 16; in that case, 16 outpatient visits are needed to augment the output, which is the interpretation. Target formulation for inputs using the formula that we used to give it; you can just apply the same way that we discussed the CCR case. And here, for the sixth, you can just see by substituting the efficiency score, actual inputs, and optimal slack values in the above formula, that is, for 6, we get these labels for output, and by substituting the value, we get the exact values in the outputs. So, you just cross-check if you have any doubts, and we will be happy to address them.

So, for the CCR output model, we will create a new instruction file. Since the input we discussed, similarly, for output, we have to define it, but you just mark that since output takes 1 as the value as output-oriented, we have changed it to 1. So, this is CCR base CCR. So, this has to be 0 then; the rest are CCR-based, so 0 is mentioned here. So it does not create any problems.

For the rest, we have to create this instruction file as well, and we can operate and get the result accordingly. The technical efficiency scores remain the same as those of the CCR input-oriented. The results in the summary of the slacks change a bit since our approach is for the outputs. So, the explanations are the same, so I am not emphasizing further. If you have any questions, we will answer them. Similarly, in BCC output, we are only supposed to change this VRS to 1 and the output to 1 since it is highlighted on the instruction page.

So, we discussed that a couple of minutes back. And similarly, our instruction file has to be specifically mentioned for this particular operation. The technical efficiency score remains the same as the input-oriented BCC model, but Slacks changed a bit. So, you can explain the Slacks carefully by applying the appropriate formula. So, that is all I think. I have clarified everything about operating the DEAP, including the efficiency scores and interpretations, etc.

I am quite sure that you will be happy to apply it to your paper. So, in the next unit, we will be discussing micro and macro indicators of healthcare, health data handling packages that are open source, and licensed data. We will explain some of these and give you a holding of those data. To follow the lecture very clearly, we are referring to this author's chapters

2 and 3 for better reading. I think with this I must close. Here, I am expecting your feedback. Thank you.