Engineering Econometrics
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Lecture – 02
Introduction to Engineering Econometrics (Contd.)

Hello everybody. This is Rudra Pradhan here. Welcome to Engineering Econometrics and that too welcome to second lecture of this series. And we are still in Introduction to Engineering Econometrics.

In the first lectures, we have already highlighted what is all about econometrics and what are the kind of you know requirements, what is the kind of you know structure of this particular subject and the kind of you know engineering problems which you like to target for you know discussing in the concept engineering econometrics.

So, in this lectures, specifically we will go the econometrics trade mark to solve some of the engineering problems.

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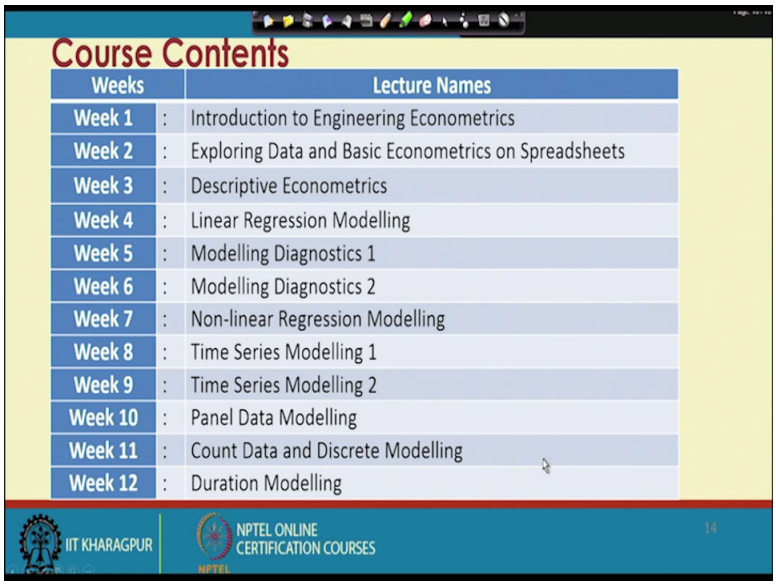

So, as usual so, this is how you know the complete course contents.

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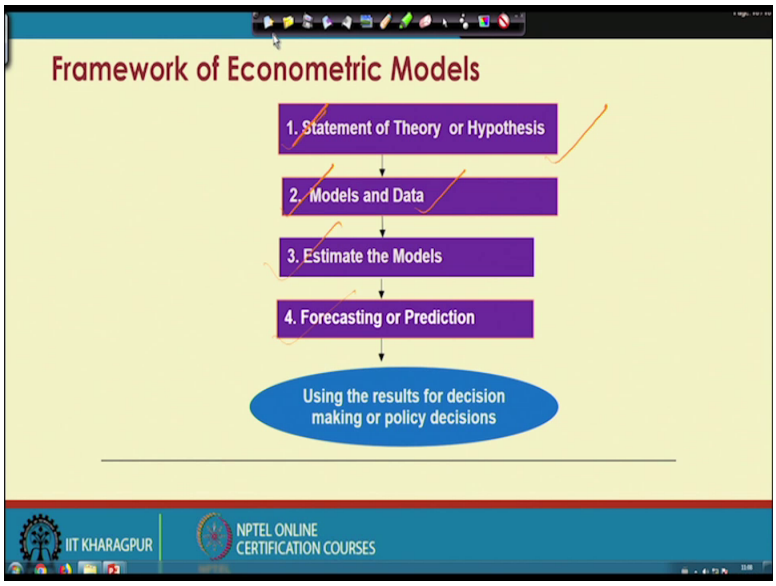

And we are in unit 1, and that too introduction to you know engineering econometrics. All togethers, we have already discussed econometrics is the use of theory, data and techniques. And in the techniques, we have some kind of you know mathematical techniques and statistical techniques and then we connect which data to examine the existing theory and expecting some kind of you know new insights to address the engineering problem more effectively and as per the particular requirement or maybe organizational requirement or sectoral requirement or something like that.

So, now in this lectures, we like to know what are the steps through which you can you know start the process and then we come with kind of you know inside surface through which you can you know address the engineering problem in a more attractive way and as per the particular, you know requirement. So, technically, you know so far as a framework frame work is concerned that too for any kind of you know econometric modeling, you know we have the you know structure called like you know step by step you know structure and a that to stepwise process.

So, this stepwise process, we have some kind of you know theory that is the background of this you know engineering problems. So, the theory may be dealing with you know, you know may be something like you know space engineering problem or something like you know chemical engineering problem. So, this will give you some kind of you know background what to study, what to examine, then there is a question of you know how to

examines and what are the needs, all these things will be coming in the later stage but ultimately, what is the you know core concept or you know core requirement or you know core theory through which you can you know start the process.

So, that is why the step 1, you know process of the econometric framework is a very very crucial. So, once you understand the theory very effectively, then the rest of the process will be very you know easy to follow up. But if you are you know particular engineering problem or the theory behind this particular you know engineering problem is not clear and a you cannot understand, then ultimately you cannot actually do the modeling or you cannot get the kind of you know insights or the kind of you know press more effectively as per the particular you know requirement.

So, that is why understanding of you know theory for you know irrespective of any kind of you know engineering problems, we have no issue, but whatever you know engineering problems you like to pick up it is may be for aerospace, may be from mechanical engineering, may be from mining engineering, it is not at all you know issue.

But ultimately this is what the problem, this is what the kind of you know requirement and then how to get these requirements, econometrics will help you. So, we are here to use the econometrics on the basis of the understanding of the engineering problem and then we will move to second step where there is a structure of called as you know models and data. So, in the models and data typically, so what we will do, we like to transfer the engineering theory into model.

And then, the model will be you know further transfer in to some kind of you know statistical form and then we can connect with data and the process of this connections, you know model to data is called as a empirical process, where we have to estimate the model and that too with the help of you know data and techniques then, that will give you some kind of you know new insight or some kind of you know effects or comments or you know the kind of you know outputs to you know address the engineering problem.

So, ultimately, so the requirement is the you know econometric output that is a empirical output. So, that is how you will go for you know estimations and that is how the third step of this process that is the framework is the estimation of the identify model and in the estimation process, we will get some kind of you know output and that output is

actually a you know meaningful kind of you know requirements through which you can actually take the decision.

So, in the next step, you will move for you know forecasting or predictions and that is actually the main you know motto behind this econometrics problem. Any kind of you know econometrics use is you know, forecasting and prediction of the decision variables. So, how to forecast and how to predict, what are the you know prediction behind the decision variables. So, that we like to learn in the in this process.

Then ultimately, after you know getting all these you know structure or some you know the steps, so ultimately, we will come with some kind of you know results for the decision making process and the kind of you know policy decisions.

In you know technically, so that means, you know we have first steps here, step 1, statement of the theory, step 2, step 2 models and data and step theory, step 3 estimate the model and step 4, forecasting and prediction and finally, it is the decision, decision making process. So, what is the background of the problem, the kind of you know requirement and econometrics will give you some kind of you know insights. So, through which you can you know come with a kind of you know comments or the kind of you know decision to address this you know issues and you know problems.

So, we can actually you know address the steps in a more effective way. So, in the second slide, so, I will let you know the kind of you know structuring a.

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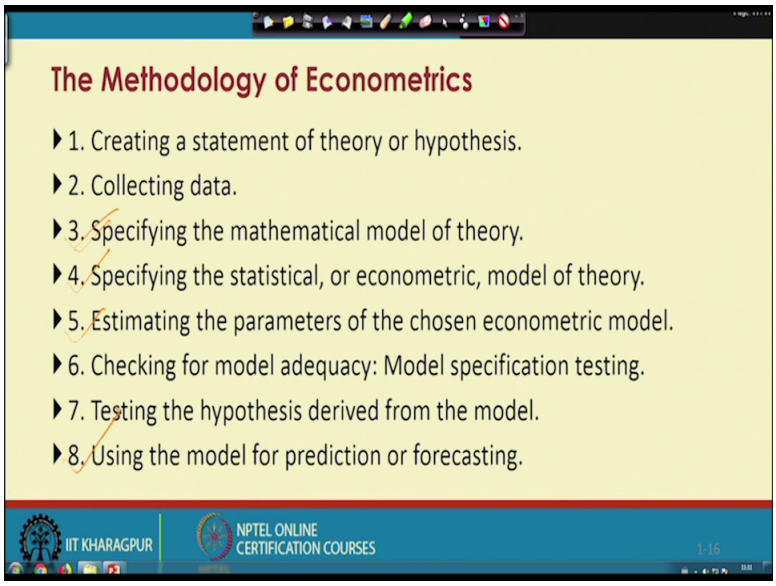

Where you know the you know, methodological framework is more clear in fact, ok. So, ultimately, in a broader sense, so we have all together you know 8 steps. So, in the first step; that means, methodologically we have to follow a different steps. So, the first step is a creating a statement from the theory, that statement may be put in a kind of you know objective structures and then through the objective we can build the hypothesis.

So, technical hypothesis is a kind of you know observations which is not tested and we like to test and that is how econometrics will be or economics is needed to you know test these hypothesis. So, now, then to test this hypothesis we need actually some kind of you know information, that is what is the question of you know data so; that means, you together the data to verify the theory and again the verification of theory and the verification of hypothesis, it is not the only data requirement. So, we need actually model and geometrical outputs.

So, that is why in the step 3, so, we have a model here and in the model, you know we have to we have to find out a structures which can you know better fit corresponding to a particular you know engineering problem and a in the first step is the mathematical transformation, then we you know again we can transfer into statistical angles or in a kind of you know econometric framework. So, to verify the particular you know theory or to examine the particular theory. And then in the step 5, we will go for estimation of

these you know model parameters and that will be possible only through some techniques and the kind of you know a availability of you know data.

Then finally, after getting the empirical outputs, so, you will go for you know model reliability for checking the model accuracy and a model accuracy specifically that is called as an model specification testing. And the steps 7, so, test of hypothesis derived from the model and then finally, use the model for predictions and forecasting which is the last step and that itself will give you some kind of you know decision making a process ok. So, this is what the you know, you know process through which you can initiate the you know kind of you know enquiry.

And then ultimately, you will be and the enquiry with you know new insights or you know comments against the existing you know theory. So, this is how the particular you know structure. So, accordingly, so, we will actually move to the following discussion.

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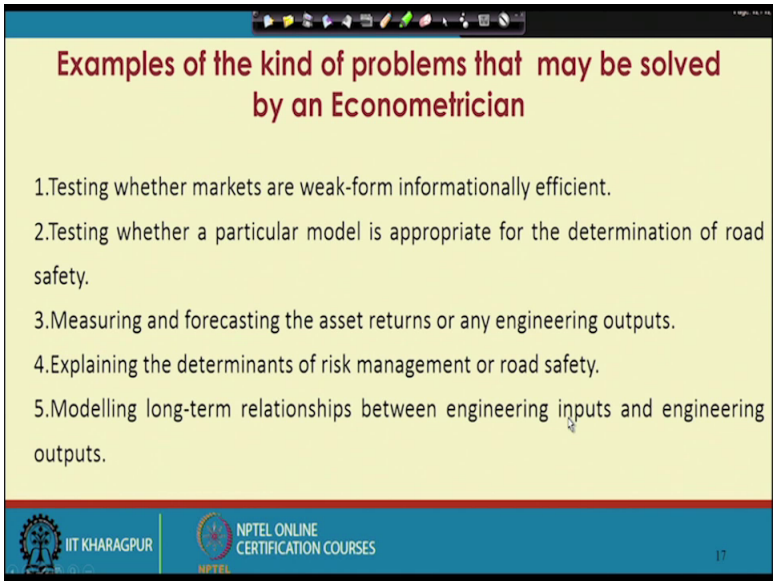

So, that is you know, what you can do whatever steps or methodological framework we have been highlighteds.

So, now what are the problem areas or the kind of you know engineering areas where you can actually a apply this technique and the kind of you know steps as per the particular requirement. So, some sample examples, I will I will provide here. So, like you know, means a the sample example is here like this you know, what is the specific

objectives or remarks or the kind of you know hypothesis that need to be verified through the help of you know data techniques and the kind of you know the steps or the methodology which we have already highlighted.

So, so, the examples may be like that you know testing or examining whether the markets are weak for internationally efficient right. So, it is a kind of you know observations, so that means, the market may be efficient, may be in efficient.

So, there is a procedural and the you know in that procedures, econometrics definitely will give you a some kind of you know hint or some kind of you know structures so that, we can come with a kind of you know observations and you know insights. And similarly, the other examples maybe testing whether a particular model is a appropriate for the determination of you know road safety; that means, a for a particular you know a problem requirement, we may have a different models all together.

So, we have a theory. So, sometimes we like to check whether the particular theories is still valid or something in, there is a need of you know modification or you know restructuring. And sometimes, some theory already actually applied where you know huge in the form of a kind of a, in the form of a model and the econometric process is to check whether the particular model is still valid to operate the process, like you know you know the second case where you know it is a kind of you know road safety it determination model and we like to check whether this model is still valid or not right. And in the third type of you know examples, will be measuring and forecasting the asset returns or any engineering outputs.

So, that means, it may be you know product output or it may be financial output. So, you know sometimes you know econometrics will help you lot to gets some kind of you know insights as per the particular you know requirement and there are examples like you know explaining the determinants of risk management or you know road safety. So, corresponding to the second one, so here it is already you know model is there to examine the determinants or not road safety but against corresponding you know different you know different road structure or something kind of you know transportation infrastructure.

So, you may in a position to know or we are interest is to know, what are the factors through which that road safety can be controlled or can be maintained. So, econometrics

again help you lot to address such kind of you know problem ok. So, then ultimately, there are also examples.

So, where modeling long term relations in between engineering inputs and engineering outputs; so, we have a couple of inputs and outputs. So, econometrics can help to integrate all these inputs and to get some kind of you know outputs. So, as per the particular you know engineering requirement ok.

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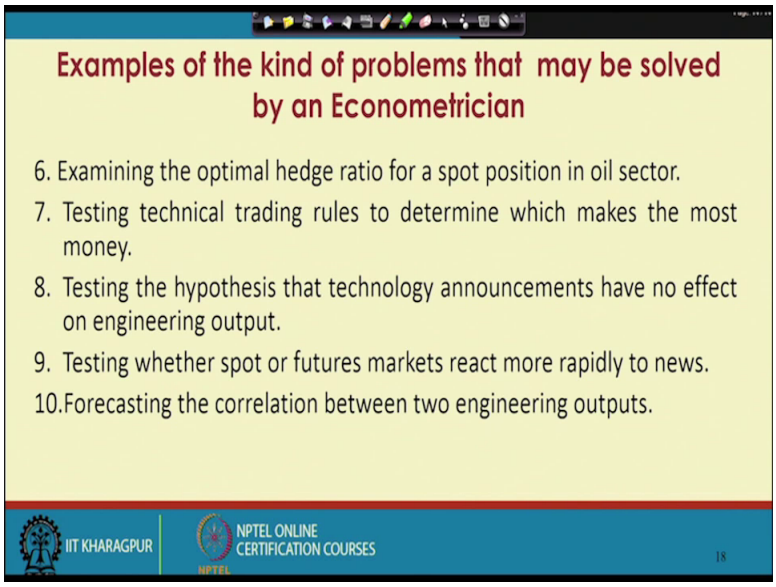

So, similarly, there are also examples like you know examining the optimal hedge ratio for a you know spot position in oil sector. So, this is typically actually financial issues in the oil sector and testing a technical trading rules to determine which makes the most money. So, these are the kind of you know observations actually.

So, when you have some kind of you know observations or the kind of you know you know issues, so, econometrics can be applied to address these issues and you know effects right. Then, testing the hypothesis that technology announcement have no effect on engineering output.

So, like this, there are couple of you know problems which can be analyze or you can a address through this you know econometrics issues and similarly, testing whethers spot or future markets react more rapidly to you know news and a similarly forecasting the correlation between two engineering outputs.

So, likewise we, we have actually plenty of examples where means technically, we can bring plenty of such you know scenarios or you know issues or the problems through which we a we can apply the engineering means a engineering econometrics to solve these problems and to get some kind of you know insights to address the business problem you know more effectively ok.

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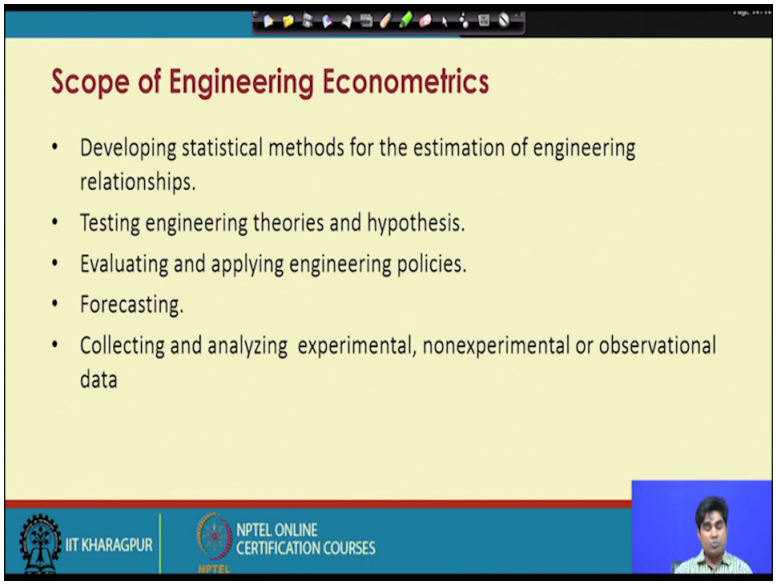

So, this is how the kind of you know structure and this scope of engineering econometrics is like this ah; means ultimately, it is not that you know knowing the steps or the kind of you know requirements but we have lots of you know scopes to know this you know engineering econometrics. So, first of all, developing statistical methods for the estimation of engineering relationships in the in the particular engineering problem, we have sometimes problems to establish the relationship you know input to output or input to input or output to output.

So, there are lots of you know complexity and econometrics will help you to solve this complexity and come with a kind of you know new insights to address the problems more effectively. And then, testing engineering theories and build you know hypothesis, evaluating and applying engineering policies, then we can go for you know engineering forecasting with respect to inputs and outputs of a particular you know engineering area and collecting analyzing experimental non-experimental or observational data. And

mostly, engineer you know the kind of you know econometrics, a we use actually non-experimental data and observational data.

So, sometimes when you go for you know experimental data, the accuracy is sometimes you know very high but when it is non-experimental data and observational data. Then the accuracy may not so high. So, in that context, the use of econometrics is at the highest, you know is at the highest level where, the you know the kind of you know non-experimental issues, a case or you know observational data it can you know reduce such kind of you know complexity and then address the problem as per the particular you know requirement.

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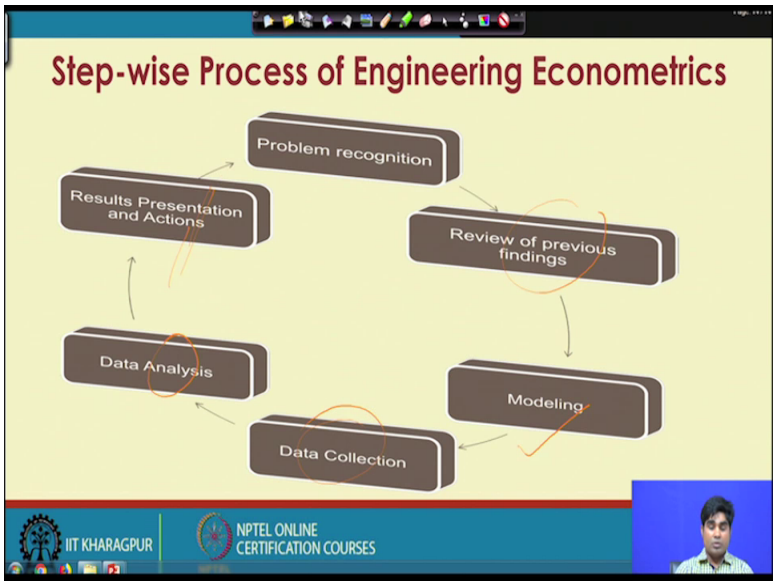

And then, the particular stepwise process may be like this. So, this is a kind of you know a flowchart and whatever steps which have already discussed in the in the previously. So, we have the structure here called as you know problem reorganization, that this step 1 of the process and then and then will ultimately, ultimately we will go for some kind of you know existing structure.

That means, once you identify the problems, so you will like we like to actually go for some kind of you know home work or some kind of you know enquiry whether there are you know some availability of you know studies or you know analysis like that you know to the corresponding you know requirement problem, requirement. And that will give you some kind of you know insights or some kind of you know structuring which

can help you again to revisit the particular problem and looking for you know some kind of you know new insights again. Then the third process is nothing but called as you know modeling.

And where we first convert the theory into mathematical model, then statistical model and then, the job is to estimate the statistical model and for that there is need of you know data and that is why the next step is the data gathering. And once you have the data and you have the model, so, just you have to connect the data with a model to get the estimated you know output and that is what is called as you know data analysis. For that, you know model and data we have to apply some kind of you know techniques to estimate the process and that is what is called as you know data analysis.

And the data analysis will give you some kind of you know empirical output and that is what is called as you know results sides results means derive the derived empirical results and look for the kind of you know actions and that may be the kind of you know predictions and forecasting's and then we will use this prediction forecasting for policy decision or management decision or a particular you know engineering a sector or engineering program, you know problem.

So now, on the basis of this discussions, so we can get to know, what are the ways you have to start the process to get some kind of you know new insights.

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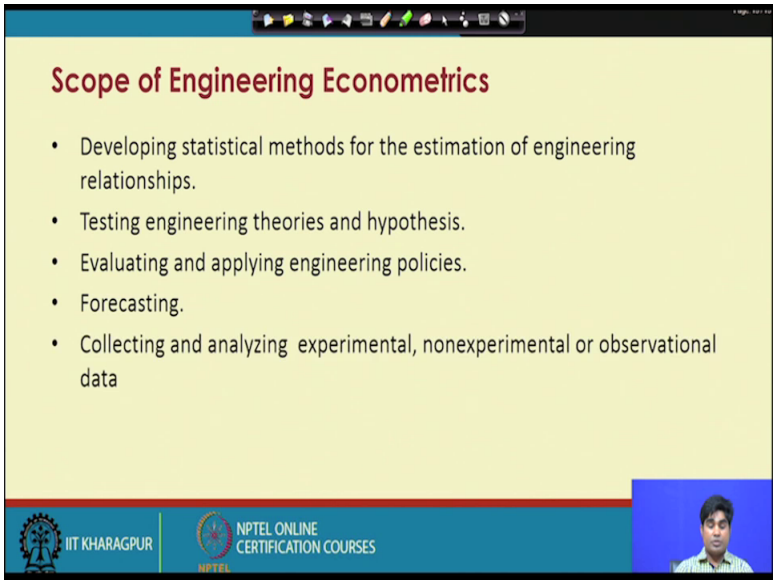

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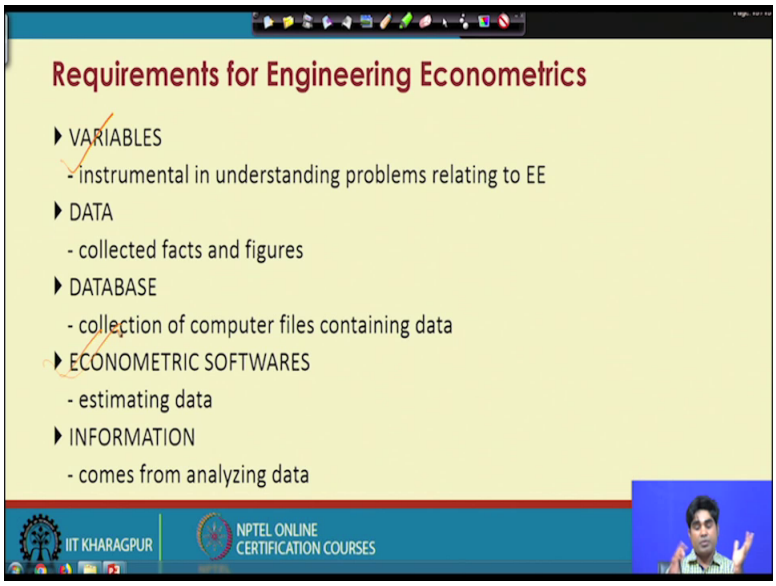

And against the thing is that you know what are the typical requirements for you know engineering econometrics. So, the typical requirement is like this. So, we start with you know theory and ultimately, the step by step process is like that you know theory, model, data, then empirical output and then the inspection to build it the empirical output to look for the new insight and use this insights for prediction, forecasting and policy requirements.

So, ultimately, the most important thing is that, the decision variables. So, in a particular problem, our job is to transfer the problem into mathematical model or you know statistical model and you cannot build mathematical model or statistical model until unless you can technically quantify or transfer the existing theoretical framework into mathematical frame work. That is a possible in the form of you know identifying the a variables right, identifying the variables right.

So, that is how understanding the variables and fixing a as per problem you know requirement is very important. So, so first requirement is the a variables and the variables requirement is a it is a kind of you know you know means, it is instrumental you know understanding problems relating to engineering econometrics. So, variables can be dependent, can be independent, then you know what is the more important or what is the kind of you know requirements.

So, all these things will be coming into the picture but ultimately, you have to see that you know the entire theory will transfer into form a variables and ultimately, we look for the relationship you know measurements among these you know variable to address the particular you know engineering theory.

Then, we need data. So, this is facts and figures corresponding to the variables, decision variables and database. So, sometimes you know, you can you know have this data directly from a organization and for a from a particular you know plant or something you know laboratory etcetera. And by the way for you know hacker problem or some kind of you know complex kind of you know problems, so we have lots of you know database where you know we can get the data and you know verify the theory that too with the help of using actually econometrics right.

So, the ultimately, so, we should know the variables, data and where the data can be collected. So, the kind of you know base will be, will a help you to proceed you know very quickly and to the payments as per the particular requirement. So technically, data maybe primary one and maybe secondary one; primary one means actually, you can you know go to the particular you know field or you know area then you would take the data, you know directly.

But you know in the case of you know secondary data, it is not a one to one. So, it is a indirect process. Somebody has collected for some requirement and you like to use this data to verify a particular you know theories. So, that is how you must know the kind of you know primary structure and secondary structure; then, then we have actually econometric softwares. Lots of you know softwares, we need actually to estimate this data through a particular you know technique. Of course, there is the estimation process is very mathematical and you can do it in manually.

But when your data set is very high and the problem is very bigger, that too with respect to more number of variable with you know different kind of you know relationships, so, in that case doing manually is not actually so effective or you know you cannot actually get the results as per the particular requirements. Sometimes, the some problem is such a complex to in to workout manually is very difficult.

So, our job is not to you know highlight whether it is a manual process or the kind of you know mechanical process like the use of software but the thing is that you know

ultimately it is our need. So, how to bring these empirical output that is how the issue all about right. After that, then the process will again continue to validate the theory to look to check whether there is a kind of you know new insights and what kind of decision you have to take from this these insights to address the particular engineering problem something like that. And then, informations and the information usually comes from this you know data analysis.

So, once you analyze the data, so the data itself will give you some kind of you know prediction observations. And this prediction observations will address the engineering problem more effectively. So, by the way, so this is what the kind of you know requirement ultimately; so, we will like know what are this particular you know structuring.

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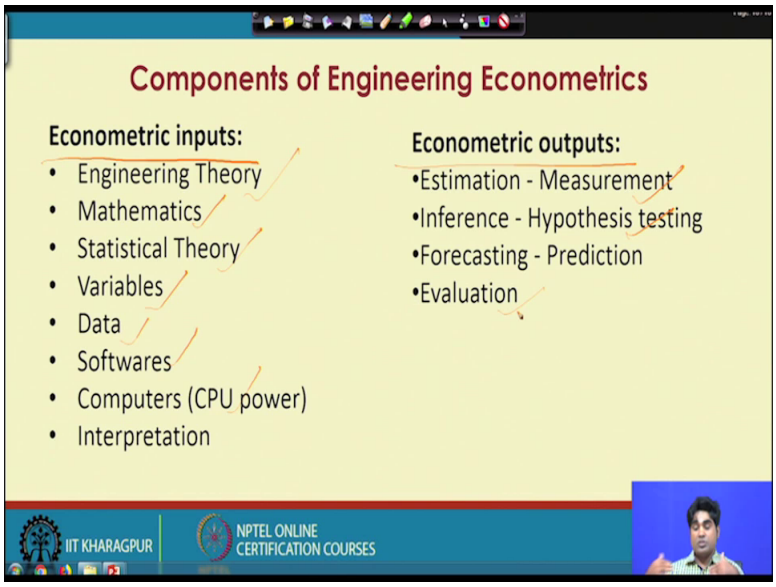

So, the so, far as you know components of engineering econometrics a are concerned. I have already highlighted that you know, there are actually to a process and that is first that is actually econometric inputs; that is the first one and then econometric outputs, the second one.

So that means, technically we have a econometric out inputs and we have a econometric outputs. So, econometrics inputs basically deals with you know various, you know engineering theory and of course, we cannot actually target all the engineering theory at

a time. We have to focus a particular engineering theory and again in a particular engineering theory, there are several problems.

We have to specifically focus a particular engineering problem to highlights you know technique ultimately, ultimately the all structure is a you know, problem to you know insights. So, we must have a problem corresponding to this problems, once you understand properly then you think about the kind of you know econometric use or the kind of you know application through which you can you know group for the some kind of you know new insight.

So then, the a again the inputs are you know mathematics which you have already highlighted, statistical theory and variables which have a again highlighted, data, softwares and then computers because of softwares when you use softwares to get the empirical outputs; so, we are you means a you are supposed to know the use of you know computer, otherwise you cannot operate the softwares you know by end ok. So, understanding data, variables, theory, mathematics, statistical is not enough until unless you are you know acquainted with the softwares and the kind of you know computer system.

Because some of the problems you know, very complex and you cannot get the empirical output or insights very easily or in a kind of you know a simple step by step process because we just you know explain what are the steps you have suppose to follow but in some point of time, the steps are so complex that you know you may not ultimately go to the next steps; so, until, unless you are clear in that particular steps.

So, for that, you know computers you know softwares and the use of computer you know really I means very need. So, then, once you are you know accounted with the system. So, you must be in a position to interpret. So, that means, must have a understanding ability and you must have some kind of innovative thought process though which you can you know you can you know interpret the particular model in a more effective way. And then in the output sides, we have estimation that is the measurement output.

And then, we will go for, we will go for inference and hypothesis testings and then finally, forecasting predictions and the kind of you know evaluation that is the kind of you know management decision or policy decision.

So, ultimately, so estimation-measurement, inference-hypothesis testing, forecasting-predictions, evaluation, these are all you know econometrics you know step by step outcomes. So, all these outcomes are completely connected with a the input sights and on the basis of you know inputs, you get these outputs and that too address the particular engineering problem more effectively. So, you must be very carefuls to know these inputs ; these are the inputs and against you must be you know very much aquatinted with these you know econometric output.

So ultimately, how they are connected and how it will be actually address in a effective way to get the new insights. So, over the time you can learn because it is not you know means, say one day or in you know one lecture, you cannot just understand. So, you just know that these are the items in the basket that to with respect to econometric inputs and these are the items where the basket of you know econometrics output. Ultimately, that will be you know kind of you know structure which you can have it.

So, now ultimately, so these are the components of you know engineering econometrics and engineering output.

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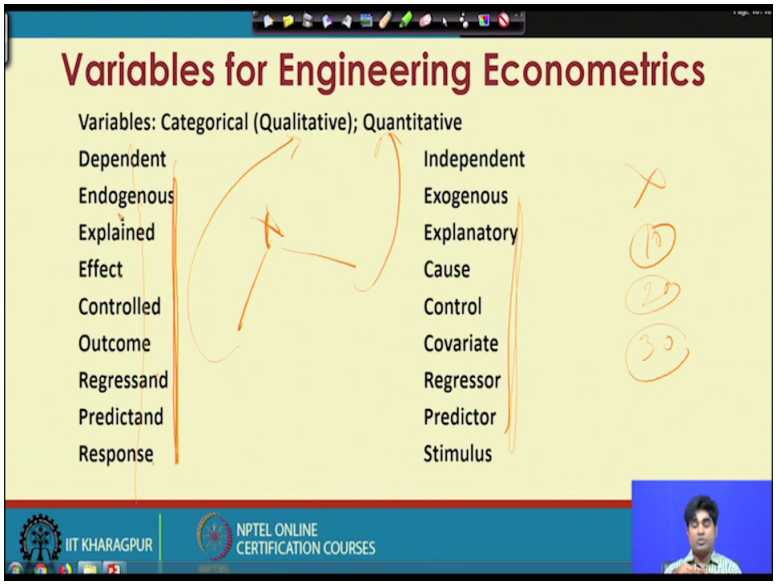

Then, then we have a actually a you know one of the requirement is actually variables. Ultimately, in a kind of you know what I have already mentioned that you know in the econometric process all altogether, from step 1 to you know last step; so, it is the game of you know variables measurement, establishment of you know variables is less than c.

So, so ultimately, the requirement is to understand the variables fast perfectly. So, technically, variables can be classified into two types; qualitative variable and quantitative variable. A particular for instance, let us x is a x is a variable, let us say x is a variables; so, which can be called as you know quantitatives means; that means, can be qualitative or you know quantitatives ultimately it depends upon the you know kind of you know informations.

So, that is what is called as you know data. So, how these data can be represented to the x. So, that is you know actually key understanding or you know key requirement again. So, ultimately for, for instance let me see right X e x, then there are data points can be like this. I can right like this. These are all points you know data that too for you know variable X, X, X means let us say output of a industry right. So, output of a industry as nothing but 10, 20, 30.

So, when I am writing X against X 10, 20, 30 and X indicates the output of industry so; that means, a the these are the industry outputs but what you know what context, what aspect, that is you know confuse all together. For instance, this may be you know 10 numbers or 10 quintals or 20 number, 20 quintal, 30 numbers or 30 quintals, something like that.

So, this is one issue. So, so that means, units measurement is one issue and second, how these data actually a collected and get that is. So, is it a for a particular company with respect to a particular year or with a with a particular industry with different years or you know different modes or something like that.

So, that is how the understanding of you know variables and understanding of you know data is very mandatory kind of you know requirement in engineering econometrics. Usually, data can be recorded, can be observed, can be gather in two different formats. So, far as a econometrics is concerned we have more such formats, but in the first and understanding is that you know data will be gathers with respect to time and data will be gathered with respect to cross sectional.

So, when we gather data with respect to time that is called as a time series data. When we gather data with respect to any cross sectional unit like you know organization, industry, sector, plant something like that, it is called as you know cross sectional data. So, when you are saying that you know time series data; that means, the data is recorded with

different point of time maybe, annually maybe quarterly, maybe weekly, maybe day wise, in that case the reference period is a you know single cross sectional unit it. It may be with respect to a particular organization particular industry or particular plant with different points of you know times.

But on the other side, when we will look for you know cross sectional kind of you know reporting or you know gathering, so, in that case it is also you know time series connected; that means, a for a particular year or a for a particular month or a particular week or particular day, how different plants are you know generating the output or how different sectors are generating output.

So, that that is how the if the understanding of you know time series data and cross sectional data to address the particular you know business problem or you know engineering problem. So, now so, the first understanding is the data and then the kind of you know variables. So, variables what I have mentioned you know can be qualitative and quantitative. So, when I am writing X, against X 10, 20, 30, then that is the quantitative representation. That is called as you know quantitative data.

But against x if I will write a, b, c then, this is a called as a qualitative informations; that means, x is a industrial kind of you know output and a if I write a, b, c, let us assume that you know a is kind of you know special category, b is another category, c is another category.

So, now how you to address all these things? So, this is what is called as you know qualitative kind of you know reporting. So, class 1 output, class 2 output, class 3 output, or class a output, class b output or class c output; class 1 class a grading, class b grading, class c grading. So, now, when you look of for any kind of you know analysis empirical testings, so a, b, c or class 1, class 2, class 3 will not actually help to estimate the process or to have the estimated output.

So, ultimately the qualitative information can be quantified; so that means, ultimately the need of the engineering econometrics is that, you know you must have variables and corresponding to it is variables, your informations that is what the data should be in numerically represented; a in the first and if the data is a already numerical represented and available, that is called as a quantitative data, then it is fine. If not, then the first step of this process, before you start the real econometrics that you know transfer this you

know qualitative information into some kind of you know numerical coding instead of writing a, b, c, you write 1, 2, 3.

Because ultimately, computers or you know softwares or you know kind of you know spread sheet, they will you understand recognize the numbers when will be apply for you know some kind of you know data analyst requirement or data analytics requirement.

So, that is how the structure of you know quantitative data and qualitative data and against in the variable wise. So, when since the particular you know package that engineering econometrics, 90 percent of the aspects is connected to you know regression modeling. So, one of the most important requirement for the regression modeling is the classification of you know dependent variable and the classification of you know independent variable. So, that means, it is the decision variable through which you can address the engineering problem.

But now, among the decision variables, the system requirement is that you know at least you must have two variables and out of that one must be dependent and one must be independent and that is what the requirement of you know regression technique regression modeling.

And by the way, if you we are in a system where we are acquainted with the different engineering's, you know environmental engineering backgrounds; so, in the different engineering backgrounds, so, the classification of dependent independent can be represented in various forms all together but you have to understand because in this course we will be dealing with you know different engineering problems.

In some engineering problem, let us say agricultural engineering, they use dependent variable versus independent variable but some of the cases like you know a industrial engineering, they may use the same terms in different like you know endogenous variable and exogenous variable, explained an explanatory. So, likewise you know, we have a different kind of you know word use or kind of you know the use of this language to address the you know you know the kind of you know econometrics problem.

So, what we will do in this case? So, there are different name against dependent variable and different names against independent variable; that means, these are the set of you know names which you are frequently used to represent the dependent variable and these

are the names which can frequently used for the independent variable. For instance, dependent variable, endogenous variable, explained variable effect, controlled, outcome, regressand, predictand, response, these are all this you know called as you know dependent. They are more or less similar and the terms are usually differently under a different situation and different engineering problems.

Similarly, in the case of a independent variables, it is the it is called as a you know exogenous, explanatory, cause, control, covariate, regressor, predictor, stimulus like this. So that means, all are same, but ultimately it is the basket of independent variable. Again with respect to different engineering problem, they use differently.

For instance, in a particular engineering problems, if they use independent variable, though out the problems they use independent variable. Another engineering problem, they may use actually extraneous variable is term instead of you know independent variable, then against you know throughout the problem, they will use the term exogenous variable like that you know must have clear cut understanding between dependent variable and independent.

So now, before we start the process of you know econometrics, you must know have the knowledge on you know variables understanding and data understanding then, we let you know the techniques understanding. After knowing the variables understanding, data understanding, technique understanding, you must be in a position to see oh how you can apply is this technique to you know to examine the theory with the help of data to gets some kind of you know new insights ok.

So, you know, so that means, these are the following steps and the kind you know requirement for addressing any kind of you know engineering problems. With this, we will stop here.

Thank you very much. Have a nice day.