Applied Econometrics

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Lecture - 32
Hypothesis Testing

Hello, and welcome back to the lecture on Applied Econometrics. Today we are going to talk about another very important topic that is called hypothesis testing. And the reason hypothesis testing is important because whenever we will do any statistical test, we will try to see the significance of that test whether we can accept the result or that we may not accept the result.

So that all is lying on the basic concept of how we do the hypothesis testing. And it is extremely important to realize the fundamentals of hypothesis testing. So in this lecture, we will introduce what we mean by hypothesis testing. So we remember that whenever we do any sort of estimation or any sort of decision making, or inferencing, based on the observation, based on different data points, we always do it from a sample of data points, right?

And we know we call it sample statistic, right? So let us say it is a sample mean. And the reason we do that is because we really do not have, it is almost impossible to actually get all the population data. And it actually is really difficult to actually enumerate anything from the population data because of the sheer volume, and the data can you know spread across time. So it is because of that challenge, we always use a sample statistic to do an estimate of the population parameter.

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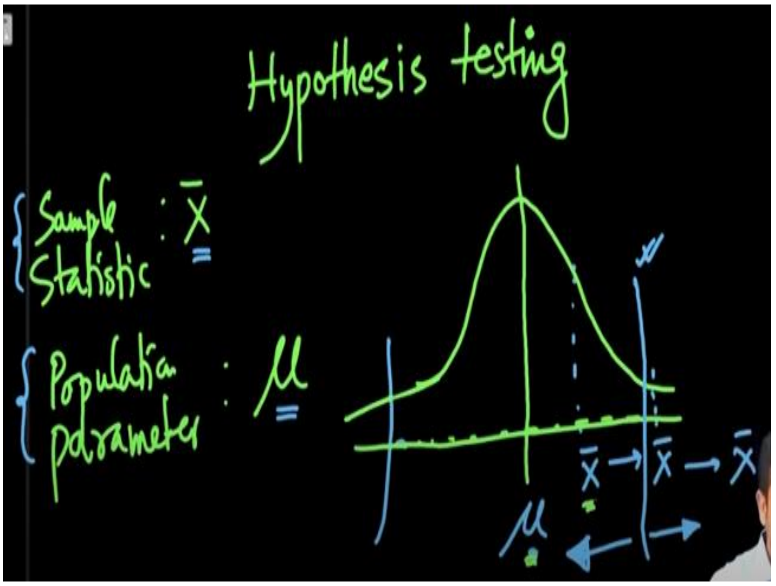

So let us say a sample statistic is x bar, which we will use. Let us say we write sample statistic. And we use the sample statistic to estimate a population parameter mu, let us say. Now we know that we really do not know the population parameter, and yet we have to estimate the population parameter. So because of this dilemma that we have to estimate something, and we have no clue about what is the true value of that, there are certain rules that we have to derive.

And let us say first let me explain the problem. Let us diagrammatically show how we can actually conceptualize the relationship between a population parameter and a sample statistic. So let us say the true population parameter, let us say this is a distribution of all the values that we can get of the sample statistic, and here is my, let me use a different color.

So this is my population parameter, okay. Now I have to estimate this value or I have to actually based on the sample statistic, I have to say, whether this sample is actually representing this population, whether the sample statistic is representative of the population parameter. So to do that, I have to actually plot the values of let us say x bar. So let us say I have got my x bar here, okay.

Now I have to say depending on this two information that let us say this mu the true population parameter is here and I have my sample statistic here. And then I have to say, whether the sample is actually representing the population, all right? Now how can I say that, how can I say that had it been here? Let us say the x bar was here. What I would have said or x bar is here what I would have said, okay.

So how do I actually take a call on whether this x bar is actually representing the mu, okay? Now to do that there are two things that you have to keep in mind. One is that how close I want the x bar to be for the true mu, right? So how close I want the x bar from the true mu? So if it is very close, I can say with certainty that yeah, it seems that the x bar is actually representing mu.

And if it is a little far, then we have like we have to have a decision rule to say well, so at least if it is left to this bar, then I can say that x bar is representing mu. But if x bar goes here, on the right side of the bar, then I can say that perhaps x bar is not representing the mu, right? And same is true if I take a two-tailed test, so I will have to in this similar manner I have to take a decision, okay.

Now, so that is one thing. So you know how if I can actually have some idea about the distance I want the x bar to be from mu. The second point is that how frequently, how frequently I want x bar to be close to mu or far away from mu. So depending on that, depending on these two factors like the distance and the frequency of occurrence of x bar close to mu or away from mu, we will decide whether we are going to say that x bar is representing the true population parameter mu or it is not representing the true population parameter mu, okay? So we use certain terms to explain this.

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One is that we call something null hypothesis. We will often hear this null hypothesis. And we call something alternative hypothesis, alternative hypothesis. Let me explain these terms. But before I get into that, I let me explain the basic concept behind what is null hypothesis, what is alternative hypothesis. So the basic concept is like that. So null hypothesis essentially maintains the status quo.

It maintains the status quo. What I mean by maintaining status quo? It is like the law of motion, like the idea of inertia. So if something is in one state, the null hypothesis always presumes that state to be perpetuating, that state to be continuing, okay. And alternative hypothesis on the other hand, assumes that the status quo is disrupted. There is some disruption here okay, some disruption.

So I will explain with an example what I mean by this maintaining the status quo and what I mean by the disruption. So let us say in our school we actually, we have got to know that, you know the Python language is really being sort of you know, the companies are really expecting people to have some idea about Python, Python language, okay.

And so knowing that what we decided that let us have a Python course, okay. So we have every other courses, but along with that, we also introduce a Python course so let us say. And when I introduce a Python course, say 50% of my students, or whatever percentage of my students have actually enrolled into the Python course. Now I want to know, whether that training in Python course has actually increased the earning of my students, okay.

And my null hypothesis actually, you know, always it will always maintain the status quo. So it will always presume the status to remain as it is. So it will basically mean that my, it will assume that the students earning has not increased because of the training. So it will assume that the Python course training has no impact on the earning.

Whereas alternative hypothesis, since it kind of thinks about a disruption, it will think of a change from the status quo, okay. So it will think that actually the income has increased, okay, the income of the students have increased. So how do I say it with confidence? So that we will see. But essentially the idea of null and alternative hypothesis remains there.

So null hypothesis always presumes maintenance of the status quo, whereas alternative hypothesis presumes some sort of disruption, okay. So with this, there are you know like, we have some convention as in how we, you know, talk about null hypothesis, how we talk about alternative hypothesis. But before I get there, let me actually give you an example. And this example is of white swan.

And this example is really very, you know, it is a really popular example when we explain null hypothesis and alternative hypothesis. And this is essentially to explain how we make any scientific pursuit to knowledge, you know, the idea of scientific pursuit of knowledge. I will explain with this example. So the white swan example it goes like this. So we know the swans are white, right?

So we can say that all swans are white, right? So then, how do I actually know if all swans are white? So null hypothesis is that, I write null hypothesis, the swan is or let me say the swan, the swan is white, okay. Now a scientist does not, is not interested to gather more and more and more information about the whiteness of the swan. He knows, he or she knows that the swan is white.

So he can go to Australia, he can go to Europe, he can go to Latin America to actually gather more information about the color of the swan. And basically, he can just keep on gathering the fact that the swan is white. Now that is something the scientist you know, any scientist is not interested. So what is the interest of a scientist?

He is perhaps interested to see a swan of a different color because his interest is actually finding something new, right? His interest is to create some sort of disruption, right, some disruption. So he is more interested to see a black swan perhaps or a blue swan perhaps or a green swan, perhaps. And for that, let us say he actually end up going to some, let us say some island in Pacific.

And he ended up finding some blue swan let us say or a black swan. So when he does that, he actually end up falsifying his claim that all swans are white. The claim was all swans are white, right till the point he actually identified that there is a blue swan somewhere, right? So the moment he found a blue swan, he can claim the null hypothesis, this H naught is actually false, okay.

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And this is called theory of falsification, theory of falsification. And this is famously explained by Karl Popper. Now because of this concept that we are always trying to falsify something and we never know if the null hypothesis is true, if the null hypothesis is absolutely true, we cannot say that, right? We cannot say that you know, the sun will always come from the east.

Someday we can see the sun is coming from the west, right? So because of that, we always say that null hypothesis, when we say, when you state null hypothesis, we say is not rejected, is not rejected. We never say it is accepted. We say is not rejected or rejected or rejected. But we do not say, we do not say, we do not say we accept the null, we accept the null. We do not say that.

We either say, we either say, we either say we reject the null or we say we do not reject the null. So basically it means that the evidence I have, given the evidence I have, I cannot reject the null right, because it is always dependent on the evidence I have. It is always dependent on whether, you know I could have gathered more evidence to see if the swan is of a different color right?

So that is basically the idea how we sort of talk about the, you know, how we talk about null hypothesis. And now let me give you another example.

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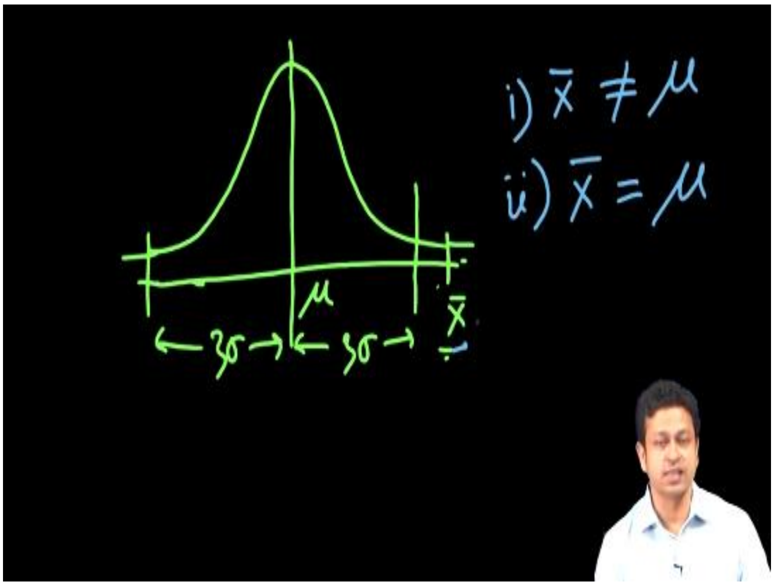

And this example, let us say I again draw a distribution and I have this time let us say I have let us say this is my 3 sigma, both side. And I have some my x bar is here, okay. My x bar is here. So as I said previously, I can say whether x bar is representing mu that depends on two things. One is the distance and second is the frequency of occurrence, okay.

Now if I have my x bar here, so there are two possibilities. One possibility is that x bar is actually coming from, the sample is actually not representing the population parameter okay. The sample is not representing the population, the sample statistic is not representing the population parameter or the sample is not drawn from the true population, it is drawn from some other population.

Or it could be that it is actually, it is actually representing the population, it is actually representing the population but for some extreme reason, I ended up finding this particular observation here, right? So it is also a possibility right? Since I have I am having many you know observations, so some observation might be extreme, right?

So if I find like some extreme observations, so how do I actually take a call whether that particular observation is actually representing the population. So essentially for that, statisticians have derived some decision rule. And we sort of, we will try to understand how we actually take a decision based on this kind of, based on the observations we have.

So with this, I will end the introduction lecture on hypothesis testing. And in the next lecture, I am going to explain the decision rule to actually do the hypothesis testing. Thank you.