M.A. Semester – II
Paper: CC-9: Statistical Methods
Topic: Statistical Hypothesis and Types of Errors

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Introduction

In common language, hypothesis simply states a mere assumption or some supposition to be proved or disproved. But in case of a researcher hypothesis it is a formal question that is intended to resolve. Thus a hypothesis may be defined as a proposition or a set of proposition set forth as an explanation for the occurrence of some specified group of phenomena either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts. It brings clarity, specificity and focus to a research problem, but is not essential for a study.

In other words, it can be said that a hypothesis is a hunch, assumption, suspicion, assertion or an idea about a phenomenon, relationship or situation, the reality or truth of which is not known. A researcher calls these assumptions, assertions, statements or hunches hypotheses and they become the basis of an inquiry. In most studies the hypothesis will be based upon either previous studies or on the researcher's observations.

There are many definitions of a hypothesis. According to **Kerlinger**, 'A hypothesis is a conjectural statement of the relationship between two or more variables'.

Webster's Third New International Dictionary (1976) defines a hypothesis as a proposition, condition, or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be determined.

Black and Champion define a hypothesis as 'a tentative statement about something, the validity of which is usually unknown'.

In another definition, **Bailey** defines a hypothesis as a proposition that is stated in a testable form and that predicts a particular relationship between two (or more) variables. In other words, if we think that a relationship exists, we first state it as a hypothesis and then test the hypothesis in the field.

According to **Grinnell** a hypothesis is written in such a way that it can be proven or disproven by valid and reliable data – it is in order to obtain these data that we perform our study.

The functions of a hypothesis

While some researchers believe that to conduct a study requires a hypothesis, having a hypothesis is not essential as already mentioned. However, a hypothesis is important in terms of bringing clarity to the research problem. Specifically, a hypothesis serves the following functions:

i) The formulation of a hypothesis provides a study with focus. It tells what specific aspects of a research problem to investigate.
ii) A hypothesis tells what data to collect and what not to collect, thereby providing focus to the study.
iii) As it provides a focus, the construction of a hypothesis enhances objectivity in a study.
iv) A hypothesis may enable the researcher to add to the formulation of theory. It helps in concluding specifically what is true or what is false.

Quite often a research hypothesis is a predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependent variable.
For example, students who receive counselling will show a greater increase in creativity than students not receiving counselling or the automobile *A* is performing better than automobile *B.* These are hypotheses capable of being objectively verified and tested. Thus, it may be concluded that a hypothesis states what we are looking for and it is a proposition which can be put to a test to determine its validity.

Characteristics of Hypothesis

A hypothesis must possess following characteristics:

i) Hypothesis should be clear and precise. If the hypothesis is not clear and precise, the inferences drawn on its basis cannot be taken as reliable.
ii) Hypothesis should be capable of being tested. In a swamp of untestable hypotheses, many a time the research programmes have bogged down.
iii) Hypothesis should state relationship between variables, if it happens to be a relational hypothesis.
iv) Hypothesis should be limited in scope and must be specific. It should be remembered that narrower hypotheses are generally more testable
v) Hypothesis should be stated as far as possible in most simple terms so that the same is easily understandable by all concerned
vi) Hypothesis should be consistent with most known facts i.e., it must be consistent with a substantial body of established facts.
vii) Hypothesis should be amenable to testing within a reasonable time.
viii) Hypothesis must explain the facts that gave rise to the need for explanation. This means that by using the hypothesis plus other known and accepted generalizations, one should be able to deduce the original problem condition.

Types of Hypothesis

i) **Null hypothesis**: Let us assume a case where method A is compared with method B about its superiority and if we proceed with the assumption that both methods are equally good then this assumption is termed as the null hypothesis. It is generally symbolized as H_0

ii) **Alternative Hypothesis**: As against this, if we think that the method *A* is superior or the method *B* is inferior, we are then stating what is termed as alternative hypothesis. It is denoted by Ha

For example: Let us assume that we want to test the hypothesis that the population mean (μ) is equal to the hypothesised mean (μ_{H0})

$$H_0 = \mu = \mu_{H0} = 100$$

If our sample results do not support this null hypothesis, we should conclude that something else is true. What we conclude rejecting the null hypothesis is known as accepting the alternative hypothesis. In other words, the set of alternatives to the null hypothesis is referred to as the alternative hypothesis. If we accept H_0, then we are rejecting Ha and if we reject H_0, then we are accepting Ha. For the above example we may consider following possible alternative hypothesis:

Table 1

Alternative Hypothesis	To be read as follows
$H_a : \mu \neq \mu_{H0}$	The population mean is not equal to 100; it may be more or less than 100
$H_a : \mu > \mu_{H0}$	The population mean is greater than 100
$H_a : \mu < \mu_{H0}$	The population mean is less than 100

The null hypothesis and the alternative hypothesis are chosen before the sample is. In the choice of null hypothesis, the following considerations are usually kept in view:

i) Alternative hypothesis is usually the one which one wishes to prove and the null hypothesis is the one which one wishes to disprove. Thus, a null hypothesis represents the hypothesis we are trying to reject, and alternative hypothesis represents all other possibilities.

ii) If the rejection of a certain hypothesis when it is actually true involves great risk, it is taken as null hypothesis because then the probability of rejecting it when it is true is α (the level of significance) which is chosen very small.

iii) Null hypothesis should always be specific hypothesis i.e., it should not state about or approximately a certain value.

Errors in Hypothesis Testing

Type I and Type II errors: In the context of testing of hypotheses, there are basically two types of errors that can arise. We may reject H0 when H0 is true and we may accept H0 when in fact H0 is not true. The former is known as Type I error and the latter as Type II error. In other words, Type I error means rejection of null hypothesis which should have been accepted and Type II error means accepting the null hypothesis which should have been rejected. Type I error is denoted by α (alpha) known as α error, also called as the level of significance of test; and Type II error is denoted by β (beta) known as β error. In a tabular form the said two errors can be presented as follows:

Table 2

	Decision	
	Accept H_0	Reject H_0
H_0 (true)	Correct decision	Type I error (α error)
H_0 (false)	Type II error (β error)	Correct decision)

The probability of Type I error is usually determined in advance and is understood as the level of significance of testing the hypothesis. If type I error is fixed at 5 per cent, it means that there are about 5 chances in 100 that we will reject H_0 when H_0 is true. We can control Type I error just by fixing it at a lower level. For instance, if we fix it at 1 per cent, we will say that the maximum probability of committing Type I error would only be 0.01.
But with a fixed sample size, *n*, when we try to reduce Type I error, the probability of committing Type II error increases. Both types of errors cannot be reduced simultaneously.

There is a trade-off between two types of errors which means that the probability of making one type of error can only be reduced if we are willing to increase the probability of making the other type of error. To deal with this trade-off in business situations, decision-makers decide the appropriate level of Type I error by examining the costs or penalties attached to both types of errors. If Type I error involves the time and trouble of reworking a batch of chemicals that should have been accepted, whereas Type II error means taking a chance that an entire group of users of this chemical compound will be poisoned, then in such a situation one should prefer a Type I error to a Type II error. As a result one must set very high level for Type I error in one's testing technique of a given hypothesis. Hence, in the testing of hypothesis, one must make all possible effort to strike an adequate balance between Type I and Type II errors.