# Department of Business Administration

## B U S I N E S S  R E S E A R C H

Semester / Year **: Semester IV / Part II (CBCS)**

Name of the Teacher **:** Sneha Dutta

Name of the Topic **:** *Hypothesis Testing*

## An Introduction to the concept of Hypothesis (es) Testing

**Introduction and Definition** :

Science mainly consists of two main factors on which its working depends first is the body of the knowledge and the other one is the method of the inquiry. The body of knowledge involves the various laws, theories, hypothesis etc. and the other factor of inquiry methodology consists of the various mechanisms that help a great deal in the addition of the theories etc to the body of the knowledge.

The word hypothesis was originated from a Greek word hyposthenia whose actual meaning is to suppose, a proposal. Thus hypothesis is defined as a supposition, assumption or recognition that is made for the sake of dispute. It is an uncertain clarification/explanation for the observation, phenomenon and any scientific research that are to be checked and experienced for more information or a message or an opinion for the certain partial verification (Browein, 2008).

Hypothesis and the theories are generally responsible for the movement of knowledge from the unknown to the known. Hypotheses play a very important and a critical role in the assertion of a particular thing, as they are able to describe certain facts and are also able to explain the various relationships between these facts. As a result of this, hypotheses help a great deal in the investigation operations or activities.

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On the institution of the problem to be answered in the process of the research, the researcher forms various tentative or possible solutions to these problems these proposed answers or the solutions are referred to as the hypothesis. But a very critical and essential point to be kept in mind here is that these propositions are not at all verified in nature.

So Hypothesis can be referred to as the interpretation of certain facts which is just a possible solution or a tentative answer to a problem and is completely or partly unverified in nature. Then afterwards on its establishment, it ceases to be a hypothesis and then finally becomes a theory or a principle. The word 'Hypothesis' has come from the Greek word hypo (means under)and tithenas (means to place) together these words indicate towards the support they provide to each other on the placement of the hypothesis under the evidence, which acts as a foundation.

***According to George A Luniberg, hypothesis can be defined as a 'tentative generalization, the validity of which remains to be tested. In this elementary stage, the hypothesis may be very hunch, guess, imaginative data, which becomes the basis for an action or an investigation.'***

A very vital point that should be kept in mind about the hypotheses is that these are not theories these only have some linkage to the theory but hypothesis is not that much elaborated as the theory is. But it can be said that the hypothesis is derived from the theory.

| Role and Functions of hypothesis (es) |
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| 1. Helps in the testing of the theories. |
| 2. Serves as a great platform in the investigation activities. |
| 3. Provides guidance to the research work or study. |
| 4. Hypothesis sometimes suggests theories. |
| 5. Helps in knowing the needs of the data. |
| 6. Explains social phenomena. |
| 7. Develops the theory. |
| 8. Also acts as a bridge between the theory and the investigation. |

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| 9. Provides a relationship between phenomena in such a way that it leads to the empirical testing of the relationship. |
| 10. Helps in knowing the most suitable technique of analysis. |
| 11. Helps in the determination of the most suitable type of research. |
| 12. Provides knowledge about the required sources of data. |
| 13. Research becomes focused under the direction of the hypothesis. |
| 14. Is very helpful in carrying out an enquiry of a certain activity. |
| 15. Helps in reaching conclusions, if it is correctly drawn. |

## Sources of hypothesis (es)

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| 1. Observations made in routine activities. |
| 2. Theories based on the scientific approach. |
| 3. Analogies. |
| 4. Knowledge obtained from the functional executives. |
| 5. Results of the research and development department. |
| 6. Experience of the investigator. |

## Characteristics of hypothesis (es)

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| 1. Should be very specific in nature. |
| 2. Concept of the hypothesis should be clear. |
| 3. Should be empirically testable. |

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| 4. Should be related to the devices and the techniques that are available. |
| 5. Should relate to the body of the theory. |
| 6. Should recognize the specific variables and their relations. |

Hypothesis testing tends to discerns the effect of one factor on another by exploring the relationship's statistical significance. For example, one may be interested in how much rainfall affects plant growth. In a business context, a hypothesis test may be set up in order to explain how much an increase in labor affects productivity. Thus, hypothesis testing serves to explore the relationship between two or more variables in an experimental setting. Business managers may then use the results of a hypothesis test when making management decisions. Hypothesis testing allows managers to examine causes and effects before making a crucial management decision.

An empirical study begins with writing a hypothesis. If there is no hypothesis, we will not be able to test any cause and effect relationship. Therefore, it's important to write a hypothesis that can be tested and can offer some great insights into a situation.

In the simplest words, a hypothesis:

- is an assumption or a supposition,
- which can be tested and analyzed
- on the basis of one's observation
- of a set of random variables

And a statistical hypothesis is an assumption about a situation or a population that can be represented and tested via any or a combination of statistical methods.

Therefore, the main elements of a hypothesis include:

- a guess, a theory or a statement
- observation (study of something)
- population (data to be gathered by observing population)

However, a meticulously thought and refined hypothesis is not a guess.

**Methods of writing a Hypothesis :**

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You know what a hypothesis is; what purpose it serves; how it is to be tested. The entire study or experience revolves around a hypothesis. So, a slight mistake in writing a hypothesis could result in wastage of time, money and effort.

While testing a hypothesis is a complex procedure, writing a hypothesis is the trickiest part. Needless to say, you need to be extremely careful when writing a hypothesis that you're going to test. It is thinking about the right question – a question that can be tested and results obtained from it can enhance your understanding or meet your objectives.

Remember that there is no single tried and tested method of writing a hypothesis. You can see a generic relationship between two variables and then can refine it. Here is an example:

"*Males and females differently handle employee issues*".

In this statement, we wrote a generic hypothesis. It is not measurable.

"*Females handle employee issues better than males*".

The second statement provides a direction, as in who does better. When you compare two things, it means a situation is measurable.

"*If females are assigned the task of handling employee issues, then they will do a better job than males because females have higher emotional quotient*".

The third statement, as you can see, offers specific details. The difference in the level of emotional quotient of males and females sets the scene. It is measurable and quantifiable.

Therefore, a well written hypothesis should be:

- ***Measurable***
- ***Quantifiable***
- ***Testable***

Hypothesis Testing

Hypothesis testing refers to a formal process of investigating a supposition or statement to accept or reject it. The econometricians examine a random sample from the population. If it is consistent with the hypothesis, it is accepted. Otherwise it is rejected.

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**Types of Hypothesis**

**There are two types of hypothesis – Null and Alternative.**

1. **Null Hypothesis:** It is denoted by $H_0$. A null hypothesis is the one in which sample observations result purely from chance. This means that the observations are not influenced by some non-random cause.
2. **Alternative Hypothesis:** It is denoted by $H_a$ or $H_1$. An alternative hypothesis is the one in which sample observations are influenced by some non-random cause.

A hypothesis test concludes whether to *reject* the null hypothesis and accept the alternative hypothesis or to *fail to reject* the null hypothesis. The decision is based on the value of X and R.

**Points to be noted:**

- Rejection implies that the null hypothesis is not true and alternative hypothesis can be accepted.
- Fail to reject implies that there are no sufficient reasons to completely reject the null hypothesis or prefer alternative hypothesis over null hypothesis.

## Decision Errors in Hypothesis Testing

Before we jump onto the process of hypothesis testing, let's learn about the errors that can result from it. The errors are divided into two categories:

**Type I Error:** Type I error occurs when null hypothesis is rejected even when it's true. This error leads to a conclusion that a relationship or a supposed effect exists when in reality it doesn't.

- The probability of committing Type I error is called alpha and is denoted by α.
- This probability is called the significance level.
- Also known as the error of first kind.
- It's a focus of skepticism

**Examples:**

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- A fair and balanced coin should result in equal heads and tails when flipped. Let's say a coin is flipped 20 times, it will result in 10 heads and 10 tails while in fact it may not.
- An experiment showing that a medical treatment is curing a disease when actually it is not.

**Type II Error:** Type II error occurs when a null hypothesis is not rejected even when it's false. This is actually a case of failure to reject. There are not sufficient evidences or reasons for preferring alternative hypothesis over null hypothesis.

- Type II error is when a researcher fails to detect an effect that is present.
- The probability of committing Type II error is called Beta and is denoted by β.
- And the probability of not committing a Type II error is called Power Test (1 – β).
- Also known as the error of second kind.

**Examples:**

- Fire breaks out but fire alarm doesn't ring.
- A survey showing that stress doesn't hamper one's life when it actually does.

**When Null Hypothesis is:**

| **True** | | **False** |
|---|---|---|
| **Reject** | **Type I Error** | **Correct Decision** |
| **Do Not Reject** | **Correct Decision** | **Type II Error** |

**When Alternative Hypothesis is:**

| **True** | | **False** |
|---|---|---|
| **Reject** | **Type II Error** | **Correct Decision** |

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| **Do Not Reject** | **Correct Decision** | **Type I Error** |

## Steps in Hypothesis Testing

Researchers follow a formal process to test a hypothesis and determine whether it is to be rejected. The steps include:

1. **Stating the Hypotheses**

   The first step involves positioning the null and alternative hypotheses. Remember, that these are mutually exclusive. If one hypothesis states a fact, the other must reject it.

2. **Making Statistical Assumptions**

   Consider statistical assumptions – such as independence of observations from each other, normality of observations, random errors and probability distribution of random errors, randomization during sampling, etc.

3. **Formulating an Analysis Plan**

   This includes deciding the test which is to be carried out to test the hypothesis. At the same time, we need to decide how sample data will be used to test the null hypothesis.

4. **Investigating Sample Data**

   At this stage, sample data is examined. It's when we find scores – mean values, normal distribution, t distribution, z score, etc.

5. **Interpreting Results**

   This stage involves making decision to either reject the null hypothesis in favor of alternative hypothesis or not to reject the null hypothesis.

## Accepting or Rejecting Null Hypothesis

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This is an extension of the last step - interpreting results in the process of hypothesis testing. A null hypothesis is accepted or rejected basis P value and the region of acceptance.

**P value** – it is a function of the observed sample results. A threshold value is chosen before the test is conducted and is called the significance level, which is represented as α. **If the calculated value of P ≤ α, it suggests the inconsistency between the observed data and the assumption that the null hypothesis is true**. This suggests that the null hypothesis must be rejected. However, this doesn't mean that alternative hypothesis can be accepted as true. This is when Type I error occurs.

**Example:** You roll a pair of dice once and assume that these are fair and hence the result shown by rolling the dice would be fair.

The null hypothesis is – the dice are fair. You've assumed a significance level (α) of 0.04.

Now you roll the dice and observe that both show 6. The p value will be 1/36 or 1/ (6*6) assuming that the test static is uniformly distributed. The p value comes out to be 0.028 which is less than the assumed value of α. On this basis the null hypothesis is rejected. It suggests that the assumption suggesting that dice are fair is not correct.

**Region of Acceptance** – It is the range of values that leads you to accept the null hypothesis. When you collect and observe sample data, you compute a test static. If its value falls within the specific range, the null hypothesis is accepted.

**Example:** You might hypothesize that the average weight of the students in a school is 30 kgs. To test this hypothesis, you collect a random sample and compute the mean score. If the sample mean falls close to the hypothesized mean, say between 29 and 31, you accept the null hypothesis. The region of acceptance, therefore, is 29 and 31. The values falling outside this region will fall in the region of rejection.

## The sequencing of activities stating the procedure to be undertaken

### Testing Procedure

1.The first step is to state the relevant null and alternative hypotheses. whether the alternative hypothesis can either be accepted or stays undecided as it was before the test.

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| 2.The second step is to consider the statistical assumptions being made about the sample in doing the test; for example, assumptions about the statistical independence or about the form of the distributions of the observations. |
| 3. Decide which test is appropriate, and stating the relevant test statistic. |
| 4. Derive the distribution of the test statistic under the null hypothesis from the assumptions. For example, the test statistics may follow a Student's t distribution or a normal distribution. |
| 5. The distribution of the test statistic partitions the possible values of T into those for which the null-hypothesis is rejected, the so called critical region, and those for which it is not. |
| 6. Compute from the observations the observed value of the test statistic. |
| 7. Decide to either fail to reject the null hypothesis or reject it in favour of the alternative. The decision rule is to reject the null hypothesis H0 if the observed value is in the critical region, and to accept or "fail to reject" the hypothesis otherwise. |

## Introduction to the concept of Level Of Significance

Once sample data has been gathered through an observational study or experiment, statistical inference allows analysts to assess evidence in favor or some claim about the population from which the sample has been drawn. The methods of inference used to support or reject claims based on sample data are known as ***tests of significance***.

Every test of significance begins with a ***null hypothesis*** $H_0$. $H_0$ represents a theory that has been put forward, either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved. For example, in a clinical trial of a new drug, the null hypothesis might be that the new drug is no better, on average, than the current drug. We would write $H_0$: there is no difference between the two drugs on average.

The ***alternative hypothesis***, $H_a$, is a statement of what a statistical hypothesis test is set up to establish. For example, in a clinical trial of a new drug, the alternative hypothesis might be that the new drug has a different effect, on average, compared to that of the current drug. We would write $H_a$: the two drugs have different effects, on average. The alternative hypothesis might also be that the new drug is better, on average, than the current drug. In this case we would write $H_a$: the new drug is better than the current drug, on average.

The final conclusion once the test has been carried out is always given in terms of the null hypothesis. We either "reject $H_0$ in favor of $H_a$" or "do not reject $H_0$"; we never conclude "reject $H_a$", or even "accept $H_a$".

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If we conclude "do not reject $H_0$", this does not necessarily mean that the null hypothesis is true, it only suggests that there is not sufficient evidence against $H_0$ in favor of $H_a$; rejecting the null hypothesis then, suggests that the alternative hypothesis may be true.

(*Definitions taken from Valerie J. Easton and John H. McColl's Statistics Glossary v1.1*)

## Significance Levels

The ***significance level*** $\alpha$ for a given hypothesis test is a value for which a *P-value* less than or equal to $\alpha$ is considered statistically significant. Typical values for $\alpha$ are 0.1, 0.05, and 0.01. These values correspond to the probability of observing such an extreme value by chance. In the test score example above, the *P-value* is 0.0082, so the probability of observing such a value by chance is less that 0.01, and the result is significant at the 0.01 level.

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