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# A Survey of Statistical Tools in the Field of Economics and other Fields

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## ABSTRACT

This paper examined the application of some statistical principles in a named field of economics. The role of statistics in different stages of traditional econometric methodology was well examined without leaving out its limitation. Some specific real life situations that often relates to economics and other related fields were also considered.

**Keywords:** *Econometric methodology, statistics, Regression, forecasting, estimation, parameters, Hypotheses.*

## 1. INTRODUCTION

Statistics, a physical scientific method of collecting numerical facts about a subject called data, analyzing it and making valid inferences is a very important discipline. It is a discipline which interconnects all other disciplines in biological and physical sciences, medicine, pharmacy, agriculture, engineering, law, art amongst all with economics, a vital social science discipline not an exemption. All these disciplines count on the knowledge of statistics by employing and translating some cogent information about a subject into 'numerical facts' called data. These information are often gathered according to some statistical principles.

The concept of counting, ordering and sampling techniques are as a matter of fact used in data collection.

Economics, a social science subject which study human behaviours in relation to ends and scarce means which have alternative uses, makes use of statistical principles in econometrics.

Microeconomic theory states that other things being the same, a reduction in the price of a commodity is expected to increase the quantity demanded of that commodity. Thus, economic theory only postulates a negative or inverse relationship between the price and quantity demanded of the commodity. But, the theory itself does not provide any numerical measure of the relationship between the two variables. That is, it does not tell how much the quantity will go up or down as a result of a certain change in price of the commodity. It is the job of econometrician to provide numerical estimates which however, employs the principle of statistics.

Also, in the field of pharmacy, drugs are formulated based on facts (translated to numbers) obtained about the incidence or prevalence rate of new or pre-existing diseases while drugs are dispensed based on the data obtained from physicians. In Medicine, drugs are recommended and administered based on facts obtained from patients' records and examinations revealing susceptibility or resistance to a disease, age, sex, body-mass indices, allergies, activities and past ailments. The practice of law will not be a success if reference to past cases are not allowed in the pursuit of law suits. Breweries, distilleries, confectioners and manufacturers in general make use of the concept of sampling found in statistics to get desirable end products.

Descriptive statistics, the second half of inferential statistics, helps to gather empirical data, records them, tabulates them or charts them and then try to describe the pattern in their development over time and perhaps detect some relationship between various economic magnitudes. Statistics found in economic statistics 'ecostat' is used basically as a descriptive aspect of economics. Econometrics uses statistical methods after adapting them to problems of economic life. These adapted statistical methods are called econometric methods.

In particular, econometric methods make use of adjustment which consists primarily of the specification of stochastic (random) elements that operate in the real world and enter into the determination of the observed data, so that the latter can be interpreted as a random sample (rather than fixed) to which the methods of statistics can be applied. As a matter of fact, the main goals of econometrics which include analysis, policy making and forecasting, all rely on statistics. Analysis entails testing of economic theory while policy making uses supply of numerical estimates of the coefficients of economic relationships for forecasting economic magnitudes and decision making. We note that the three goals are mutually exclusive for a successful econometric application. The division of econometrics (a field of economics) includes theoretical and applied econometrics. Theoretical econometrics involves the development of appropriate methods for the measurement of economic relationships. Hence, econometric techniques are basically statistical techniques which have been adapted to the particular characteristics of economic relationships.

Applied econometrics includes the applications of econometric methods to specific branches of economic theory. It examines problems encountered and the findings of applied research in the field of demand, supply, production, investment, consumption and other sectors of economic theory. Hence, applied econometrics involves the application of tools of theoretical econometrics, whose backbone is statistics, for the analysis of economic phenomena and forecasting behaviours.

## 2. ROLES AND LIMITATION OF STATISTICS IN THE FIELD OF ECONOMICS

Econometrics, a field of economics employs statistical methods after adapting them to problems of economic life. This section highlights the procedures to be followed when testing an economic theory, the relevance of statistics to these procedures as well as the limitation of statistics in this area. These procedures are presented schematically as follows:

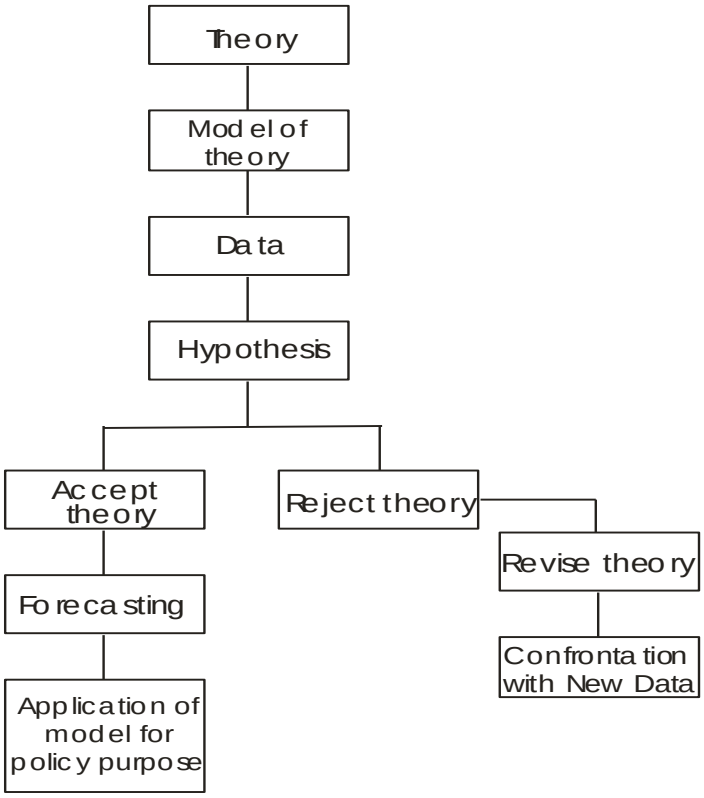


**Figure 1: An Economic Theory is always Formulated by using Statistical Ideas**

An illustration stated below will make this clearer.
Economic theory postulates that the demand for a commodity depends on its price, on the prices of other related commodities, on consumers' income and tastes. This is an exact relationship because it implies that demand is completely determined by the above four factors. No other factor, except those explicitly mentioned influences the demand.

Thus, the demand equation is written as

$$Q = \beta_0 + \beta_1 P + \beta_2 P_0 + \beta_3 I + \beta_4 T \qquad (1)$$

Where $Q$ is the quantity demanded of a particular commodity, $P$ the price of the commodity, $P_0$ the price of other related commodities, $I$ consumers' income and $T$ the tastes while $\beta_0, \beta_1, \beta_2, \beta_3$ and $\beta_4$ are the coefficients of the demand equation.

The demand equation (1) above is exact because it implies that the only determinants of the quantity demanded are the four factors which appear on the right hand side of the equation. The quantity demanded will change only if some of these factors change. No other factor may have effect on demand. Yet, It is common knowledge that in economic life that many more factors may affect demand. The invention of a new product, a war, professional changes, changes in law, changes in income distribution, immigration or emigration may influence demand. Human erratic behaviour influenced by rumours, prejudice, traditions and many more may also make demand fluctuate.
These 'unforeseen factors' are taken into account by the introduction of a random variable (defined as the result of a statistical experiment) with specific characteristics so that the demand function (1) is written in stochastic form as

$$Q = \beta_0 + \beta_1 P + \beta_2 P_0 + \beta_3 I + \beta_4 T + \mu_i \qquad (2)$$

Where $\mu_i$ represents random factors which affect the quantity demanded.

This step in the theory modeling is a key step towards accuracy achieved by statistical principle. The next step is to fit the model to observational data referring to actual behaviour of economic units-consumers or producers. The aim of this stage is to establish whether the theory can explain the actual behaviour of the economic units. If it does, we accept the theory as valid. If not, we reject the theory or we may modify the theory using additional new observations. This is achieved by estimation of model for its parameters.

The size of parameter estimates are of great significance in any case (McCloskey and Ziliak). The reliability of estimates is of greater significance in inference (Engsted)

Estimation of model is a purely technical stage which requires the knowledge of various econometric methods, their assumptions and the economic implication of the estimates of the parameters. Apart from estimation, the reliability and validity of the results is carried out by statistical theory found in parameter significance tests. In the nut shell, traditional methods of getting reliable estimates as well as accurate model fits come in tune with the method of least squares and coefficient of determination since we seek the best model for our data from a list of models by considering the model with the least error sum of squares (ESS) and the highest coefficient of determination value.

Researchers have argued that significance tests are useful tools in those cases where statistical models often serve as input in the quantification of an economic model (Engsted), hence it is important that the statistical models are well specified. In certain areas of macro economics, researchers clearly distinguish between statistical testing and economic significance. It is stated that where statistical testing plays a relatively minor role in model evaluation, models are inherently

mispecified and consequently are evaluated empirically by other methods than statistical tests.

The limitation of statistics lies in the fact that its methods of measurements are sometimes developed on the basis of controlled experiments in laboratories. Hence, statistical methods of measurement are not considered appropriate for economic relationships, which cannot be measured on the basis of controlled experiments because such experiments cannot be designed for economic phenomena.

## 3. APPLICATION OF STATISTICAL TOOLS IN ECONOMETRICS AND OTHER RELATED SITUATIONS

We are familiar with the idea of a model in everyday life, and we can readily visualize a range of models of varying complexity and sophistication. Models are used in various walks of professional life since they are small scale representations of specific physical entities.

The concepts of demand and supply are ideally modeled by regression in economics. The beauty of regression lies in the establishment of relationships between variables while the major task of modeling lies in its accuracy. 'Modeling via regression' gave several important results some of which are considered below:

### The Cobb-Douglas Model

This is a non-linear function of the form

$$Y_t = \beta_1 X_{2t}^{\beta_2} X_{3t}^{\beta_3} e^{\mu_t}, \quad t = 1, 2, \ldots \qquad (3)$$

with $Y_t$ representing the output (GDP), $X_{2t}$ the labour intput and $X_{3t}$ the capital input.

Linearizing (3) by taking the natural logarithm, it yields:

$$\ln Y_t = \alpha + \beta_2 \ln X_{2t} + \beta_3 \ln X_{3t} + \mu_t \qquad (4)$$

where $\alpha = \ln \beta_1$

This model was proposed for the analysis of the Mexican Economy by estimating its parameters.

A production function data of Mexican economy between 1955-1974 was fitted to the model and the estimated Cobb-Douglas function was found to be

$$GDP = 0.5292 \text{Labour}_t^{0.1810} Capital_t^{0.8827} \qquad (5)$$

The labour and capital inputs may be adjusted to give desirable GDP (output). The Cobb-Douglas model was also proposed for the demand for money in Canada by re-specifying the variables as follows, so that

$$M_t = \beta_1 R_t^{\beta_2} Y_t^{\beta_3} e^{\mu_t} \qquad (6)$$

where $M_t$ depicts the derived or long-run demand for money, $R_t$ the long term interest rate and $Y_t$ the aggregate real national income.

The estimation may also be carried out conveniently by linearizing (6)

So that (6) becomes;

$$\ln M_t = \ln\beta_1 + \beta_2 \ln R_t + \beta_3 \ln Y_t + \mu_t \qquad (7)$$

### The Logistic Model

This model is popular with population growth. It is of the form

$$Y_t = \frac{\beta_1}{1 + e^{(\beta_2 + \beta_3 t)}} + \mu_t \qquad (8)$$

$Y_t$ represents the population, t the time measured chronologically while $\beta_1, \beta_2$ and $\beta_3$ are the parameters of the model.

As a result, a data of U.S. population growth between 1970-1999 was fitted to it so that an estimated U.S. population growth model

$$Y_t = \frac{1432.739}{1 + e^{1.7966 - 0.0117t}} \qquad (9)$$

was obtained.

(9) measures the underlying growth rate of the U.S. population w.r.t. time

### The Polynomial Regression Model

The polynomial regression model of the third degree with form

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 X_i^2 \beta_3 X_i^3, \quad i = 1, 2, \ldots, n \qquad (10)$$

was proposed for a data of total production cost ($Y_i$) and output ($X_i$) of a commodity given below, since its scatter diagram resembles an elongated S-shape whose pattern follows the much celebrated law of diminishing returns.

| Output | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| TPC | 193 | 226 | 240 | 244 | 257 | 260 | 274 | 297 | 350 | 420 |

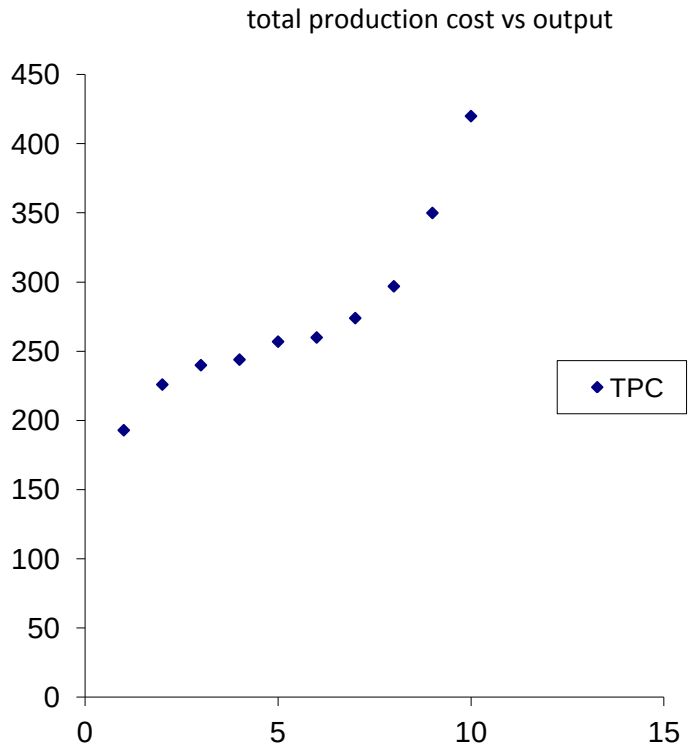


**Fig.2**

We fitted the data to the proposed model in (10) above so that we have an estimated model

$$Y_i = 141.7667 + 63.4776X_i - 12.9615X_i^2 + 0.9396X_i^3 \quad (11)$$

There are countless number of useful models in different areas of statistics.

## 4. CONCLUSION

Some roles of regression, a field of statistics have been examined in a field of economics and other real life situations. The limitations of statistical application to the field of economics had been also discussed. Some important application of regression as a statistical tool for estimation was also discussed with their applications to some popular econometric models.

In econometrics, data collection techniques, model specification, model estimation, forecasting and hypothesis testing make use of statistical principles, I therefore conclude that econometric methods are statistical methods specifically designed for peculiarities of economic phenomena and other real life situations.

Again, since other disciplines adopt and rely on the use of past information facts (data) in their practices, I also conclude that statistics is indispensable in all other disciplines.

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