

Analytical Explanations of the Concept of the Fixed Term and the Random Error Term in Econometric Models

Munadhil Al-Juwari¹, Khalil Hameed Radhi², Amer Omran Al-Mamouri³

Abstract

The error term or disturbance term plays an important role in the econometric model, and there are several reasons for including it in the econometric model, including issues related to measurement problems, the omission of variables from the econometric model, or for contingency reasons or related to abnormal human behavior from the general rule, or for inaccurate description of the models or inaccurate preparation of the data. The fixed term or intercept also has different meanings in the econometric model, such as the mathematical meaning, the econometric meaning, the fixed term without meaning, or the fixed term with a negative sign, and others.

Keywords: Fixed Term, Random Error Term, Econometric (Standard) Models.

INTRODUCTION

Econometrics is a science that does not differ much from other sciences. As we know, there are some preconceived ideas and concepts (a priori), such as some of the functional relationships used to study and analyze various economic phenomena and economic criteria, such as the positive or negative signs of the parameters or constants (such as the slope and the fixed term) or the period or range taken by these constants or numerical parameters. The natural sciences approach other sciences, such as the social sciences, as deterministic concepts and assumptions are replaced by statistical assumptions. Perhaps one of the main tasks and functions of econometrics lies in developing methods with an impact on conducting estimates of the relationships between various economic variables in a quantitative manner, where knowledge or expertise about economic phenomena or problems can be developed by conducting accurate mathematical and quantitative description of models and economic relationships, as the most important analytical method used in economics or social and natural sciences alike. One of the things emphasized in the social sciences, especially in neoclassical economics, is the shape and slope of the demand curve for goods and services and how it changes with rising or falling prices or the introduction of consumer income and its impact on this analytical direction. The functional relationship is affected by the fixed term or changes in the slope or both.

The Research Problem

The current study addresses the following problem:

The differences in the parameters of the fixed term and the disturbance or error term have negative effects on the application of the econometric model, which have not been taken into account by some econometricians.

The Importance of the Research

The research derives its importance from the effective role of the econometric model and the fixed term and the disturbance or error term in the practical and applied field of these models in real life.

The Objective of the Research

The research aims to identify the importance of the fixed term and the random variable in econometric models and to understand their nature and the reasons for their inclusion in the econometric models.

¹ College of Administration and Economics, University of Karbala, E-mail: Munadhil.a@uokerbala.edu.iq

² College of Administration and Economics, University of Karbala

³ College of Administration and Economics, University of Karbala, E-mail: Amer.almamury@uokerbala.edu.iq

The Research Hypothesis

The research is based on the hypothesis that:

(There is an impact of the fixed term and the disturbance or (error) term in the econometric model and the possibility of its application in practical life.

THE RESEARCH METHODOLOGY

The descriptive or theoretical inductive approach was adopted in the study of the research, moving from the specific to the general.

The Structure of the Research

In order to provide a scientific overview of the research topic and to fulfil its objective and test the hypothesis, the research was structured as follows:

The First Axis - Economic Models (their Concept and Objectives)

1. Linear Regression Models
2. Non-linear Regression Models
3. Qualitative Response Regression Models
4. Dynamic Models
 - a. Autoregressive Models
 - b. Autoregressive Distributed Lag Models
 - c. Survival Models
 - d. Panel Data Regression Models

The Second Axis – Components of the Economic Model and its Terminology.

The Third Axis – An Economic (Analytical) Vision of the Concept of the Fixed Term and the Random Variable in Econometric Models.

THEORETICAL FRAMEWORK OF ECONOMIC MODELS

This section will address the following topics:

Concept of Economic Models

Generally, a model is defined as a simplification of reality devoid of complexities and confusions, serving as a simplified description of truth by setting assumptions about the human behavior intended to be tested, containing a set of equations that describe the behavior of economic theory (Najm Al-Din,1989). It is also defined as a miniature form of the subject under study, but economists are interested in models built on a specific idea (ibid). An economic model is a crucial element in the science of economics designed to solve real-world problems using various available methods such as mathematical techniques, computer systems, or analytical methods (Basu, 2009). Alternatively, it is an academic and research work based on a range of different theories and quantitative and qualitative models aimed at analyzing or evaluating specific situations and understanding their effects on any economic phenomenon affecting society at any time or place (Arturo & Estrada, 2015, p. 1). An economic model serves as a formal framework to embody the essential characteristics or features of a complex system, usually taking the form of mathematical equations or software programs (Mahboub, 1998). An economic model is an important tool in mainstream economics as it represents a simplified picture of economic reality or a summary of the relationships between economic variables, presenting these relationships in a manner far removed from complexity. The following graph illustrates the economic model.

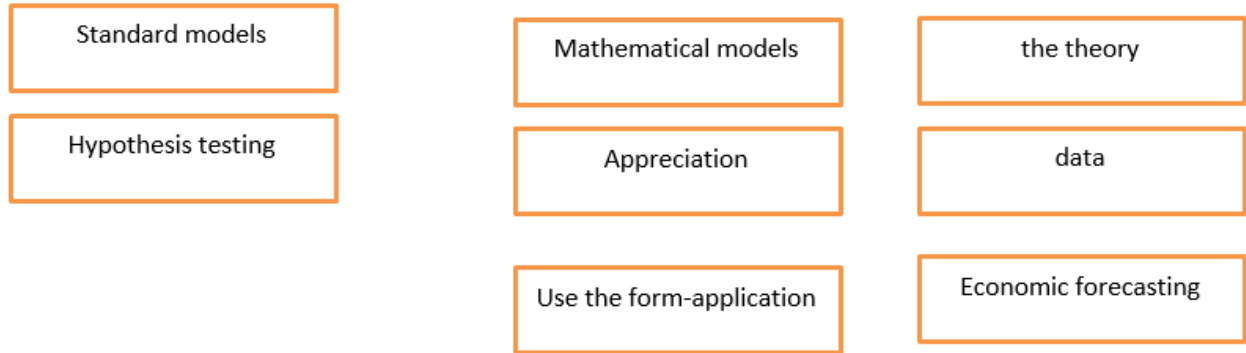


Figure 1. Economic Model.

Source: (Gujarati & Porter, 2009).

Secondly, Objectives of Economic Models:

There are specific objectives for economic models, including the following (Bakheet, 2000):

1. Used as tools for economic forecasting of the future.
2. Evaluating existing or proposed economic policies.
3. Analyzing the economic structure of the national economy.

Thirdly, Classification of Economic Models:

Economic models can be classified into different categories based on various criteria, as follows (Najm Al-Din,1989):

A. Based on Purpose:

Classified into descriptive models, analytical models, or decision-making models.

B. Based on Time:

Classified into static models and dynamic models.

C. Based on Construction Tools:

Classified into mathematical models and statistical models.

D. Based on Economic Analysis:

Divided into partial economic analysis models and general economic analysis models.

E. Other Classifications:

Such as deterministic models like mathematical economics models and stochastic (non-deterministic) models, including standard economic models that accept the presence of random errors, while mathematical economics models do not assume the existence of random errors.

Fourthly, Components of Economic Models (Mahboub, 1998):

An economic model can be in the form of a single equation or several equations, such as linear equations. Regarding the components of a standard model, it consists of a dependent variable and one or more independent variables that are related by a functional relationship, meaning that:

$$Y=F(X_1,X_2,X_3,\dots\dots\dots X_n)\dots\dots\dots(1)$$

The above relationship is written in the form of a linear relationship, such as:

$$Y=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\dots\dots\dots\beta_nX_n\dots\dots(2)$$

Whereas:

α and β are constants for the estimated relationship or parameters, and this relationship may be non-linear, such as:

$$Y = \alpha + \beta\sqrt{X} \quad (3)$$

Fifth: Structure of Economic Models (Bakheet, 2000; Mahboub, 1998)

The equations of the economic model may be structural equations in microeconomics, as in:

$$Q_d = \alpha - \beta P \quad (4)$$

$$Q_s = -\beta + \beta P \quad (5)$$

$$Q_d = Q_s \quad (6)$$

The equation (4) is a demand equation, representing a behavioral equation, while equation (5) is a supply equation, also a behavioral equation. However, equation (6) is a definitional equation, akin to identities. Alternatively, the equations of the economic model in macroeconomics can be as follows::

$$Y = C + I + G \quad (7)$$

National income adjusted for consumption, investment, and government spending - a definitional equation -

$$C = \alpha + \beta Y_d \quad (8)$$

Behavioral equation - consumption equation

$$Y_d = Y_T \quad (9)$$

Disposable income equation - definitional equation

$$T = T_y \quad (10)$$

The tax equation is a behavioral equation

The economic model consists of constants (intercept and slope) and variables, as follows:

Parameters or Constants

These are like α and β and others in the aforementioned models. They can be positive, for example, in the demand or supply equations, and are referred to as constants or parameters.

Variables

These are the dependent variables such as (Q_d) , (Q_s) , (T) , (Y) , (C) in the previous equations, which are determined within the model. On the other hand, the variable (P) in the demand and supply equations is an independent variable. There are also external variables such as (G) (government spending) and (I) (investment). The term "predefined variables" includes external variables and lagged variables, such as the following equation:

$$Y = \alpha + \beta Y_{t-1} + G \quad (11)$$

Where all of G, Y_{t-1} are called predefined variables.

Linear Models (Gujarati, 2015)

These models are either linear in both parameters and variables, or linear in parameters and non-linear in variables.

For example:

$$\ln Y_i = \alpha + \beta X_i + u_i \quad (12)$$

It is a linear model in parameters and non-linear in variables, or the following linear logistic model:

$$\ln \frac{1-y_i}{y_i} = \beta_1 + \beta_2 X_i + u_i \quad (13)$$

Or a function model cobb-Douglas, linear in parameters and non-linear in variables:

$$\ln Y_i = \alpha \ln L + \beta \ln K + u_i \quad (14)$$

Nonlinear Models (Gujarati, 2015)

Examples of these models include the following example for calculating the economic growth rate of the gross domestic product or population of a region, etc.:

$$Y_i = B_1 e^{b_2 X_i} + u_i \quad (15)$$

Qualitative Response Models (Gujarati, 2015)

In these models, the dependent variable is a qualitative variable that takes two values: one for the presence of a phenomenon and zero for its absence. An example is the relationship between education level (educated or uneducated) and earning a wage, as seen in the following qualitative model:

$D_i = f(w_i) \dots \dots (16)$, where:

$D_i = 1$ takes one educated worker.

$D_i = 0$: illiterate worker.

Another example of qualitative models is the relationship between electoral votes and the number of votes, that is:

$D_i = f(N_i) \dots \dots ()$, where:

$D_i = 1$ takes one vote for the Republican Party.

$D_i = 0$: Vote for the Democratic Party.

1- Aggregated Repeated Data Models (Logit Model) (Gujarati, 2015):

An example of this model is a model that counts aggregated or repeated households owning a home at a specific income level. For each income level (X_i) , there are (N_i) households, and (n_i) of them are families that own a residence or house, where:

$$N_i \geq n_i$$

The general form of this model is:

$$\frac{P_i}{1-P_i} = \beta_1 + \beta_2 X_i \quad (17)$$

Whereas:

P_i : The probability that the family owns the house

1- The possibility of families not owning the home

X_i : income

Dynamic Standard Models (Gujarati, 2015): Here is the translation to English

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 Y_{t-1} + \beta_3 Y_{t-2} + \dots \quad (18)$$

b- Autoregressive Distributed Lag (ARDL) model and its example:

$$Y_i = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \dots + \epsilon_i \quad (19)$$

2- Survival models:

These are models that depend on the time period of persistence, such as the lifespan of a regular light bulb, the survival time of cancer patients, or specific factors affecting an air raid.

Longitudinal Data Models

These models integrate time series and cross-sectional models and are referred to as panel data. They encompass various types of effects, including aggregate effects, fixed effects, and random effects.

* Behavioral equations include intercept and slope.

** Definitional equations, unlike behavioral equations, do not include intercept and slope and are more akin to identities.

Axis Two – Analysis of the Structure and Terminology of Economic Models:

As previously mentioned, the standard model consists of variables and parameters or constants. These constants include the intercept and slope, both of which have an impact on the function, as follows:

Intercept

The intercept causes the function to shift upward or downward, known as a shift, as illustrated above in the linear consumption function.:

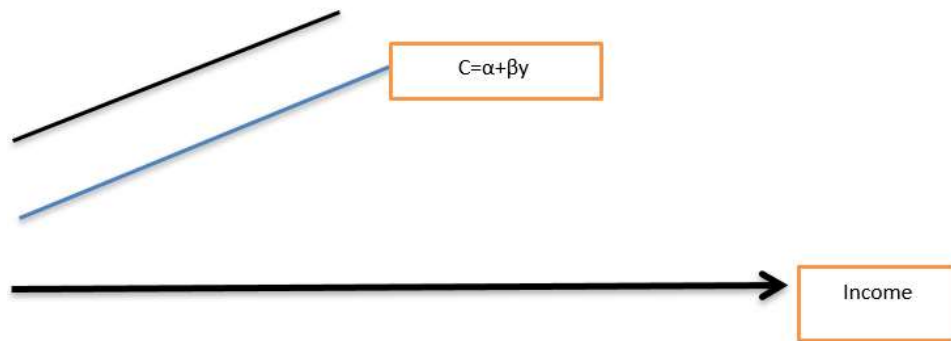


Figure 2. Constant limit.

Source: Prepared by the researcher.

Slope

The slope of the function can influence the functional relationship, and this change is qualitative and referred to as a “conversion.” An example of this is the increase in the slope of the consumption function due to price decreases, or the decrease in the slope of the mentioned function due to price increases, as illustrated above:

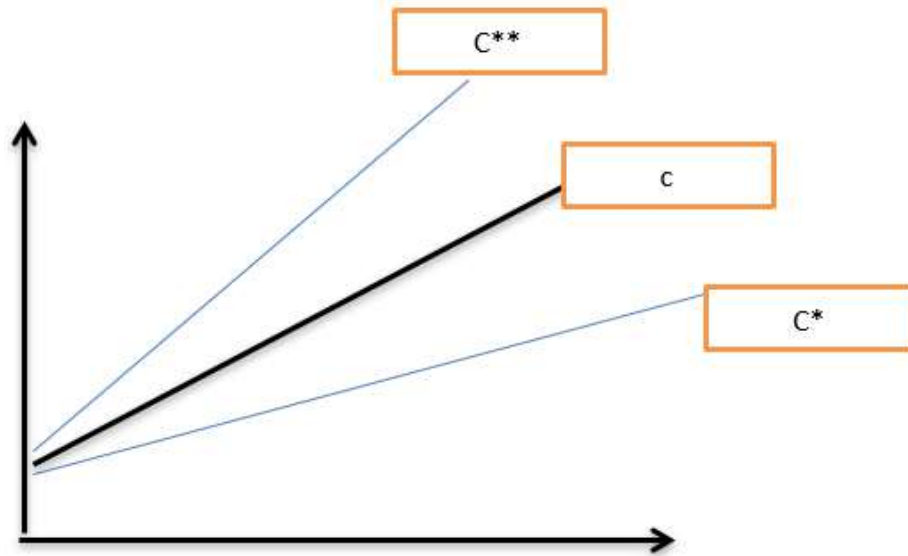


Figure 3. Change in slope.

Source: Prepared by the researcher.

The shift in the consumption function (its decrease) from (c) to (c^*) due to an increase in the general price level, while the increase in the consumption function to (c^{**}) is a result of price decreases.

Axis Three – Analytical Perspective on the Concept of Fixed Boundaries in Standard Models.

Upon contemplating the following relationship for the consumption function:

$$C_i = \alpha + \beta y_i + U_i \quad (20)$$

It consists of the constant term α , the slope β , and the disturbance or error term, denoted by u , where:

The fixed term

There are different meanings of the constant term in econometric models:

- 1- The mathematical meaning: It is the value of the dependent variable Y when the value of the independent variable is zero, such as:

$$Y = a + bx \quad (21) \text{ when } x=0$$

Van:

$$Y = a$$

$$\text{or } C = a + \beta y \dots (22) \text{ } y=0 \text{ when: } c=a$$

$$\text{Or: tax function: } T = t_0 + t_1 Y \dots (23) \text{ } Y=0 \text{ when } T=t_0$$

- 2- The econometric meaning:

It is the sum of the factors that affect Y but were not included by the researcher in the model (13).

- 3- The constant term with a certain condition: For example, the relationship between family income Y and grade average X , and the model is: $Y = 100 + 0.12X$

The independent variable X is under the condition that it is close to zero but not equal to zero.

- 4- The constant term without meaning: For example, the relationship between car sales S and wages W , i.e.:

$$S=100+7.4W$$

If $W=0$, then $S=100$ which is not reasonable as there cannot be a month with no wages.

The constant term with a negative sign:

$Y = -5 + 0.8X$ or: $Y = -a + bX$ and the reason for the negative sign is the presence of an outlier in the selected time series.

The error or disturbance term (u) is included in the econometric model for several reasons, as it constitutes one of the reasons for model misspecification and the stages of its preparation including the application stage. The random variable is included for reasons such as omitting variables from the model or reasons related to abnormal human behavior deviating from the general rule, or due to earthquakes, volcanoes, wars, discovery of a precious mineral, or a global rise in oil prices. Therefore, the reasons for including the random variable can be attributed to measurement problems, incomplete specification, or incomplete preparation of data.

Thus, the random variable is included in econometric models for several reasons, including (14):

Reasons related to the choice of the independent variable x , difficulty in measuring it, it being unknown, the presence of multiple variables with some omitted, or lack of sufficient data or a small number of observations.

Measuring human behavior and abnormal actions deviating from the general rule, or due to emergencies, floods, volcanoes, sudden discovery of a precious mineral, or sudden rise in oil prices. Data aggregation problem: Due to non-similar structures or obtaining inaccurate data or aggregating equations – such as consumption equations.

Inaccurate model specification: Incomplete specification of the model is another reason for including the random variable in econometric models.

Inaccurate preparation: Inability to prepare the required data with accurate measurements.

The following chart illustrates the random error:

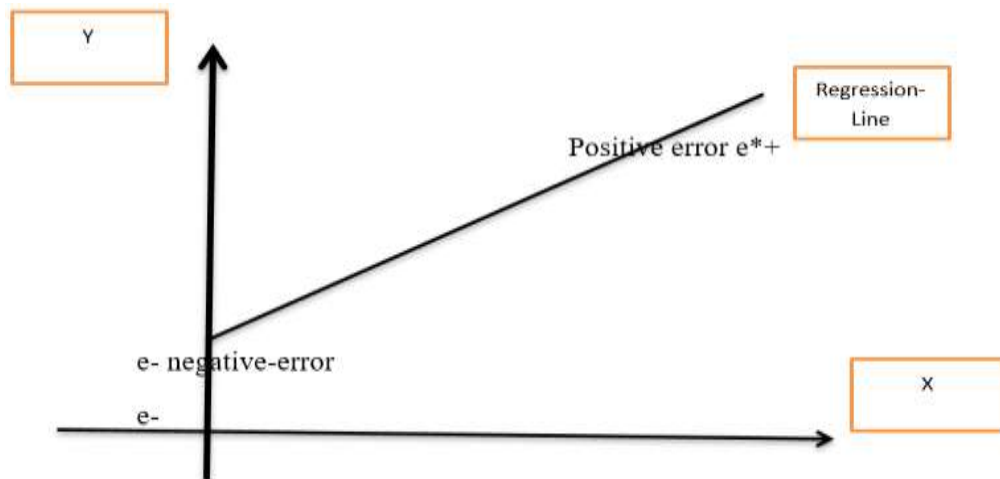


Figure 4.

Source: Prepared by the researcher based on different readings.

FIRSTLY: CONCLUSIONS

The following conclusions have been reached:

Economic models represent a miniature version of economic reality in various forms such as linear, nonlinear, dynamic, qualitative response, survival models, and others. They aim to achieve different objectives such as studying economic structure, evaluating existing economic policies, economic forecasting, and more.

An economic model consists of variables and constants (intercept and slope). The intercept represents the fixed boundary, which plays a significant role in shifting the function from one point to another, such as increasing salary from one level to another (quantitative change). Meanwhile, the slope also has an effect, albeit qualitative, on the function, such as the impact of price changes on the consumption function.

The fixed boundary is introduced into the model for various reasons and has different meanings. These include the mathematical meaning of the boundary, which is the value of the dependent variable when the independent variable equals zero, the standard representation of unexplained factors such as tastes, traditions, temperature, earthquakes, and others, and the meaningless boundary and the negatively signed boundary.

The random error term is included in the standard model for several reasons, such as the deletion of essential variables from the model, human behavior deviating from the general rule, volcanic eruptions, earthquakes, inaccurate model descriptions, or imprecise data preparation.

Standard models containing fixed boundaries are more comprehensive than mathematical models that lack error boundaries because they consider the effects of both explained and unexplained factors on the model. This is not the case in mathematical models. Therefore, standard economic models are probabilistic or stochastic compared to deterministic mathematical economic models.

The error or disturbance boundary affects the standard model and its application. It should be normally distributed with a mean of zero and constant variance. If this assumption is violated, the standard model suffers from statistical problems such as heteroscedasticity.

The economic meaning of the fixed boundary represents fixed costs in the total cost function, breakeven point in the consumption function, fixed investment in the investment function, indirect taxes in the total tax function, and other important economic meanings.

Secondly, Recommendations are as follows:

It is recommended to include the disturbance or error boundary in standard models to account for the impact of non-quantitative factors alongside quantitative factors on the dependent variable.

Conduct precise descriptions of standard models and avoid relying on extreme data points that affect the estimated boundary of the model, such as the negative sign of the fixed boundary and others.

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