

## STUDYING THE DETERMINANTS OF DIVORTIALITY IN IRAQ. A TWO-STAGE ESTIMATION MODEL WITH TOBIT REGRESSION

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### ABSTRACT

In this article, we are trying to determine the threshold point for the social phenomenon of divorce, through a two-stage estimation model (Heckman). In order to obtain consistent estimates, the censoring threshold in divorce is zero. The Tobit regression maximum likelihood estimator under zero censoring threshold produces inconsistent parameter estimates when the constant censoring threshold ( $\epsilon$ ) is non-zero and unknown. The recording of a zero rather than the actual censoring threshold value is typical of economic data. The difficulty is the determination of the threshold point in economic and social research and other phenomena where the limited dependent variable. As in the last years, divorce has become a wide-spread phenomenon in Iraq, affecting families and community. The present study aims to determine the factors that affect divorce decision. This being the first objective of the study, the second objective of the study is to determine the variables influencing divorce rates at individual level and to diagnose the factors clearly contributing to the increase of divorce cases.

**KEYWORDS:** Tobit Regression, Two-Stage (Heckman), Divorce, Threshold Point

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## 1. INTRODUCTION

Tobit regression models are regression models where the dependent variable is censored (limited). These models are very common, e.g., in econometric analysis, and most of the literature related to this type of models is developed under the normality assumption. A brief review on Tobin's work and some theoretical results for the limited dependent normal regression model are presented. It is well known that the use of standard tools such as estimating an ordinary least squares regression equation on the subsample of individuals above a censoring threshold will produce invalid inferences (see, e.g., Greene 1997:949-58; Maddala 1983:165-70). Because of this problem, researchers often use the Tobit regression estimator (Tobin 1958; Amemiya 1984:3-7) with censored dependent variables. The use of Tobit regression model to study censored and limited dependent variables has become increasingly common in applied social science research over the past two decades.

The phenomenon of divorce is one of the most dangerous phenomena affecting any society in the world, because it is the main reason for the disintegration of the family, the dispersion of its members and the consequent major imbalance in the social system based on the cohesion and harmony of the family as they constitute the nucleus of the primary human society in general. Since its modern state was formed in the 1920s, Iraq has not been distinguished from the rest of the world in terms of architecture, art, literature and systems of laws. Instead, it was characterized by the stability of the Iraqi family and the cohesion of its ties in the past. Since the beginning of the judiciary and the civil status departments to formally register marriage contracts and divorce, there has been no noticeable rise in divorce rates in the modern society. The family in which the divorce occurs is subject to criticism and even rejection by its surroundings. But the deteriorating conditions and wars experienced by the Iraqi society, because of the succession of regimes in the country, has heavily impacted the Iraqi population in general. The political, economic and social conditions in Iraq in the period from 1991 to 2003 show that there are new difficulties that have emerged in the family arena. In this respect, the divorce index has increased sharply and reached a dominant place as a social phenomenon. This phenomenon was further exacerbated by the openness and changes in ethnicity after 2003, when many families have been disintegrated and collapsed, causing many damage to Iraqi society and its family structure.

Statistics show that the appearance of divorce has increased significantly in recent years. According to a statement issued by the Higher Judicial Council of Iraq [HJCI,2017], the divorce claims for 2004 was 28,689 cases, raised to 33,348 cases in 2005, to 35,627 cases in 2006, raised again to 38,536 cases in 2007 and then increased to achieve the highest rate in 2009, amounting to 58% and 66,372 cases of divorce. Finally, in 2015 and 2016 the number of divorces was 91,301 with an increase of 9%, reaching 97,273 cases of divorce.

For the estimation of social data, we use Tobit regression model, containing observations. Some variables are equal to zero for a number of the observations in the data set. In general, this phenomenon can be named censored or truncated data. Censoring and truncation are different concepts of a Tobit regression analysis applied to estimate social science research and to assess the bias by using OLS estimation. The results show that biased estimates are obtained by using OLS (Smith & Brame, 2003).

The presence of many zeros can lead to a number of econometric problems when using Ordinary Least Squares to estimate the unknown parameters of a regression model. There are a number of econometric approaches to deal with the problem of zeros. Most fall under the heading of limited dependent variables estimation methods (Humphreys, 2010).

The work of (Odah et al, 2017) analyzed the determinants of bank loans value, when the data has to be censored from left side at censored point equal to zero. The Tobit regression model represents the most appropriate model to use. The study aimed to apply Tobit regression model and Ordinary Least Squares method in order to reveal the most important factors affecting loans provided by Iraqi banks and the best method for data estimation. The results from Tobit and OLS estimations show that bias can result when estimating Iraqi bank loans using OLS if bank loans are restricted.

The first objective of the study is to determine the factors the affect divorce decision, and the second objective is to determine the most important factors causing divorce in Iraq while identifying the impact of each of these factors on the phenomenon of divorce, in order to reach statistical indicators that help the concerned parties to find an appropriate explanation for the reasons and thus draw conclusions and recommendations that help in making the appropriate decision by the decision makers. The study is built through data analysis using the Two-Stage Estimation of the Tobit regression model. As data is censored if OLS is used, biased estimates will be produced, as illustrated in the previously mentioned

literature (Roman, 2013). This is the best method to analyze restricted data in Tobit regression model. In this paper, we seek to apply the Tobit regression model on censored data. Section 2 includes the Two-Stage (Heckman) Estimation for Tobit regression. Section 3 includes the sample and data analysis and the conclusions are contained in Section 4.

## 2. TWO-STAGE (HECKMAN) ESTIMATION FOR TOBIT REGRESSION

In spite of the significance of divorce, it has become one of the most dangerous phenomena affecting Iraqi society, because it is the main reason for the disintegration of the family, the dispersion of its members, consequently creating major imbalance in the social system. Formal studies analyzing the determinants of divorce have been scarce and mostly confined to descriptive analysis, so we will use in our study the Tobit regression model with Two-Stage (Heckman).

It presented a Tobit regression model for the first time by [James Tobin, 1958] in the field of economic measurement, through his study of family expenses for durable goods, user regression model can take into account expenses as a dependent variable model values positively could not be negative.

A two-step model is applied in our study for data analysis. The Heckman two-step selection model assumes that there are two decisions regarding divorce. In this sense, the residuals from the selection equation are used to construct a new variable, the Inverse Mills Ratio, introduced as an explanatory variable in the second step of the model.

Divorce analysis according to Heckman method will be a two-stage process. In the first stage, the factors determining the decision to divorce, while in the second stage the influential factors for divorce are analysed. The two aspects are considered to be independent, although the decision is made by the same individual.

According to the context of our research, the empirical analysis proceeds in the following two stages:

First, we run binary probit regressions using the sample of respondents, in order to find out which of the selected variables have a significant influence in the decision to divorce, where the binary dependent variable is the decision to choose the divorce and not to continue the marriage. Specifically, 1 denotes that a person is divorced (where all divorce cases were considered to take values from one to five) and 0 denotes otherwise (in other words, there is no divorce status for the respondent).

In the second stage, we focus on the determinants of the factors the affect divorce, through Tobit regression model, because the dependent variable is represented by the number of divorces. This variable is censored at zero point where the threshold point is zero, as some individuals indicated zero divorces, while others a certain quantity (divorce cases are ranging from zero to five). The case differs from one individual to another.

Conditioning was used to estimate the Tobit regression model from the researcher through a simple modification (Heckman, 1976). Based on the proposals of Gronau, 1974, the Two- Stage Estimator of Tobit regression model is the following:

$$y_i^t = \beta^t x_i^t + e_i \quad e_i \sim N(0, \sigma^2) \quad (1)$$

$$y_i = \begin{cases} \beta_i^t x_i^t + e_i, & \text{if } \beta_i^t x_i^t + e_i > 0 \\ 0 & \text{if } \beta_i^t x_i^t + e_i \leq 0 \end{cases} \quad (2)$$

**where  $y_i^t$ :** Represents Latent variable; it is generated through traditional linear regression model according to the formula ( $I_i = \beta^t x_i$ ); it is non-observer when  $y_i^t < 0$ .

**$e_i$ :** Random error, the set represents all the variables; it is non-observed influencing in the dependent variable  $y^t$  distributed  $y^t \sim N(0, \sigma^2)$  which *i.i.d.*

**$y_i, x_i$ :** is the independent variable and the dependent variable known each  $i = 1, 2, \dots, n$ .

To apply the Two-Stage estimation method (Heckman) of the Tobit regression model, the following equation is used (Amemiya, 1984):

$$y_i = \beta_i^t x_i + \sigma \lambda(\delta^t x_i) + e_i \quad \text{for } i \text{ such as } y_i > 0 \quad (3)$$

where we have  $\delta^t = \beta/\sigma$

They are calculated ( $\lambda$ ) according to the following formula:

$$\lambda(\beta) = \frac{\phi(\beta)}{\Phi(\beta)} \quad (4)$$

As: 
$$e_i = y_i - E[y_i | y_i > 0]$$

That  $E[e_i] = 0$ , variance  $e_i$

It can be rewritten as follows:

$$\begin{aligned} E[y_i | y_i > 0] &= \beta^t x_i + \sigma \lambda(\delta^t x_i) \\ V_{e_i} &= \sigma^2 - \sigma^2 \delta^t x_i \lambda(\delta^t x_i) - \sigma^2 \lambda(\delta^t x_i)^2 \end{aligned} \quad (5)$$

To estimate the Tobit regression model through the Two-Stages Estimation method, the following steps are applied (Heckman et al., 1999):

- Estimate ( $\hat{\delta}$ ) by Probit Maximum Likelihood Estimator.
- Implement a regression  $y_i$  on  $x_i$  &  $\lambda(\hat{\delta}^t x_i)$  a method (OLS) observations using positive of only  $y_i$ , as follows:

$$y_i = \beta_i^t x_i + \sigma \lambda(\hat{\delta}^t x_i) + e_i + \zeta_i \quad \text{for } i \text{ such that } y_i > 0 \quad (6)$$

As: 
$$\zeta_i = \sigma [\lambda(\delta^t x_i) - \lambda(\hat{\delta}^t x_i)]$$

The vector formula (6) is used as follows:

$$y = \beta x + \sigma \hat{\lambda} + e + \zeta \quad (7)$$

where ( $\zeta, e, \hat{\lambda}, y$ ) are vectors size  $n_1$ ,  $x$  with matrix  $n_1$  indicates the ranks corresponding to the positive observations of  $y_i$  (Bushway et al., 2007). The formula (7) can be reformulated as follows:

$$y = \hat{\beta} y + e + \zeta \quad (8)$$

Where  $\hat{\beta} = (x, \hat{\lambda})$  &  $\vartheta = (\beta^t, \sigma)^t$ .

The Heckman estimator for the Two-Stages Estimation of  $\vartheta$  known is:

$$\hat{\vartheta} = (\hat{\beta}^t \hat{\beta})^{-1} \hat{\beta} y \tag{9}$$

The estimations through the two formulas, (8) and (9) clearly show consistency. Its asymptotic distribution is done through the equations:

$$\sqrt{n_1}(\hat{\vartheta} - \vartheta) = (n_1^{-1} \hat{\beta}^t \hat{\beta})^{-1} \left( n_1^{\frac{1}{2}} \hat{\beta}^t e + n_1^{\frac{1}{2}} \hat{\beta}^t \zeta \right) \tag{10}$$

The probit M.L.E of  $\hat{\delta}$  estimate is consistent. Then,

$$PLim n_1^{-1} \hat{\beta}^t \hat{\beta} = Lim n_1^{-1} \beta^t \beta \tag{11}$$

where  $\beta = (x, \lambda)$ , as:

$$n_1^{\frac{1}{2}} \hat{\beta}^t e \rightarrow N[0, \sigma^2 Lim n_1^{-1} \beta^t \Sigma \beta] \tag{12}$$

where  $\sigma^2 e = E e e^t$  represents a matrix of the size  $n_1 \times n_1$  elements. The diameter  $V_{el}$  is defined as (5), using sequential Tyler estimator  $\lambda(x^t \hat{\delta})$ .

$$\zeta = -\sigma \left( \frac{\partial \lambda}{\partial \beta^t} \right) (\hat{\delta} - \delta) \tag{13}$$

Through the two formulas (3) and (11), the formula below results:

$$V_{\hat{\vartheta}} = \sigma^2 (\beta^t \beta)^{-1} \beta^t [\sigma^2 (1 - \Sigma) x (x^t D_1 x)^{-1} x (1 - \Sigma)] \beta (\beta^t \beta)^{-1} \tag{14}$$

The formula (14) will produce consistent and unbiased estimators (Puhani, 2000). Form the parameters that will be estimated in a Two-Stage Estimation method through data analysis we use R programming.

### 3. THE SAMPLE AND DATA ANALYSIS

The study population consists of 93 males and 34 females. The questionnaire was distributed to a random sample in the Personal Status Court in Muthanna City. The data were collected during the period from 12 July to 4 September 2017 through the application of the questionnaire 127 people surveyed. This sample was important in determining the reasons that affect the divorce because each of them has a reason to choose the divorce and not to continue the marriage. The respondent sample was the group of husbands and wives, auditors to the Court of Personal Status in the Muthanna City for the purpose of marriage or divorce. The questionnaire contains 11 questions defining each of the independent variables in Table 1 as follows:

**Table 1: The Description of the Variables**

Variable Definitions	Symbol
Age at marriage (years)	AGE
Gender (1 –Male/0 – Female)	GEN
Education – the highest level of education completed (1-Less than tertiary education/0- Tertiary education)	EDU
Occupational of the husband or wife (1-Employee/0-Otherwise)	OCC
Income of the family (USD)	INC
Number of children	CHILD
Number of years married (years)	YEARS
Type of marriage (1- Traditional/0- Otherwise)	TYPE
Children (1- Yes/2- No)	NOT CHILD
Marital infidelity (1- Yes/2- No)	INFID
The husband or wife has an account on social media website (1- Yes/0- No)	SOCIA

After transforming the data from the questionnaire in order to obtain statistical data structure, the nominal variables were transformed into quantities. Also, the analysis of the Tobit regression model requires the data distribution according to normal distribution.

One dependent variable is represented by the number of divorces. This variable is censored at zero point where the threshold point is zero, as some individuals indicated zero divorces, while others a certain quantity (divorce cases are ranging from zero to five). The case differs from one individual to another.

In order to determine the variables influencing the divorces at Iraqi individual level, the Tobit regression model will be composed for the dependent variable, which represents the number of divorces. For the independent variables as listed above, the regression model was tested on the studied phenomenon in order to identify the social problems, more precisely the divorce cases problem.

We started the analysis by running the Forrest. D Nelson test (Nelson, 1981). To establish the validity of the selection of the Tobit regression model for the analysis of the phenomenon under study, the selection model must be validated. To apply this test, the following steps are taken:

- $H_0$ : The model is appropriate
- $H_1$ : The model is inappropriate

$$\rho = N \left[ \frac{1}{N} x^t y - \hat{E}_{xy} \right]^t (\hat{C}_1 - \hat{C}_0)^{-1} \left[ \frac{1}{N} x^t y - \hat{E}_{xy} \right] \tag{15}$$

Statistic  $\rho$  follow distribution  $\chi^2$  approximate degree of freedom A.

Where:

$$C_1 = C \left[ \frac{1}{N} x^t y; \beta, \sigma \right] = \frac{1}{N} x^t C x \tag{16}$$

$$C_0 = \frac{1}{N^2} [x^t \Phi x \quad x^t \phi] w(\beta, \sigma)^{-1} \begin{bmatrix} x^t \Phi x \\ \phi^t x \end{bmatrix} \tag{17}$$

$$E_{xy} = E \left[ \frac{1}{N} x^t y; \beta, \sigma \right] = \frac{1}{N} [x^t \Phi x \beta + \sigma x^t \phi] \tag{18}$$

To complete the test, the researcher applied the formulas. The test calculated according to the formula (18) was as follows:

**Table 2: Forrest D. Nelson Test Results**

$\chi^2_{Calculate}$	$\chi^2_{Tabulated}$
$\chi^2_C = 4.07514$	$\chi^2_T = 19.675$

Comparing the calculate value  $\chi^2_C$  with the table value  $\chi^2_T$ ,  $\chi^2_C$  is less than  $\chi^2_T$ , we infer that there are no significant differences statistically they are sufficient to reject the model  $H_0$ . Therefore, it will be accepted, and this means that the applicable model has been well choosing it.

Table 3 below shows the statistical description for the dependent variable and independent variables while the following is an analytical presentation of these measures mean with the standard deviation for each variable of the model variables.

**Table 3: Descriptive Statistics for Each Independent Variable and Dependent Variable**

Variable	Obs	Mean	Std.dev.	Variance
AGE	127	37.2126	8.37952	150.054
GEN	127	0.7721	0.45192	0.198
EDU	127	0.6378	0.48254	0.380
OCC	127	0.5323	0.46432	0.411
INC	127	533.4409	803.96041	720217.016
CHILD	127	0.8425	1.17801	0.865
YEARS	127	4.9055	3.74681	44.261
TYPE	127	0.6320	0.48680	0.424
NOT CHILD	127	0.6063	0.49050	0.546
INFID	127	0.8346	0.37297	1.981
SOCIA	127	0.9764	0.15247	0.395
Divorced	127	2.1732	1.78486	3.186

**3.1 Estimation Two-Stage of Tobit Regression**

The first objective of the study is to determine the factors the affect decision to divorce, through the results of Table 4. We found that age has a strong positive impact on the decision to divorce, social media sites also have a significant impact on divorce decisions, as well as income. At the same time, we find the rest of the factors (gender, education, occupational, child, years married, type of marriage, not child and marital infidelity) do not significantly affect the decision to divorce, as was expected.

**Table 4: Results of the Probitregression Model**

Variable	Coef.	Std. Err.	t-value	$P >  t $
AGE	0.1444365	0.0233873	6.176	6.58e-10
GEN	-0.0387082	0.3653799	-0.106	0.9156
EDU	-0.2222043	0.3390066	-0.655	0.5122
OCC	0.2463305	0.4116445	0.598	0.5496
INC	0.0004454	0.0002104	2.117	0.0343
CHILD	-0.3887768	0.2210644	-1.759	0.0786
YEARS	-0.0675317	0.0525393	-1.285	0.1987
TYPE	-0.0537258	0.3434738	-0.156	0.8757
NOTCHILD	-0.0863410	0.4886758	-0.177	0.8598
INFID	-0.2398445	0.4624700	-0.519	0.6040
SOCIA	-2.8531856	0.6864336	-4.157	3.23e-05
log Sigma	0.5157508	0.0792613	6.507	7.67e-11

**Log-likelihood:** -206.4877

The second objective of the study is to determine the factors the affect divorce, through the results of Table 5:

**Table 5: Results - Two-Stage (Heckman) Estimation of Tobit Regression Model**

Variables	Coef.	Std. Err.	t-value	$P >  t $
AGE	-0.129	0.018	-7.1667	0.000
GEN	0.2120	0.0161	13.1677	0.0000
EDU	-0.1358	0.0336	-4.0416	0.000
OCC	-0.258	0.3947	-0.65366	0.4363
INC	521.362	18.075	28.8447	0.000
CHILD	0.2297	0.4059	0.5659	0.8637
YEARS	-0.010	0.105	-0.098	0.922
TYPE	0.157	0.216	0.726	0.215
NOT CHILD	-0.271	0.0168	-19.4702	0.000
INFID	0.301	0.028	10.075	0.000
SOCIA	0.273	0.0167	16.347	0.000
_SE <sup>1</sup>	-0.4255811	0.5884499	(Ancillary parameter) <sup>2</sup>	
R <sup>2</sup>	0.901			

Table (5) shows the final results with all the significant variables of the phenomenon studied. The analysis of the estimations, stander error and t value analysis show the significant factors affecting the number of divorces. The pseudo-R square is 0.901, meaning that the independent variables explain 0.901% from the in variation of number of divorces, proving the strength of the Tobit regression model in representation of the studied phenomenon data.

We know that the value ( $\beta$ ) of the relationship between the response variable and covariates. If ( $+\beta$ ) it means positive relationship and if ( $-\beta$ ), it means negative relationship.

We will mention the significant variables and their relationship (positive or opposite) with the dependent variable from the results shown in table (5). The relationship between divorces and age at marriage is inverse. Also note the negative coefficient. The coefficient of the independent variable "gender" is positive because the variable has a positive relationship with the dependent variable (divorce). We find that the relationship between the dependent variable "divorce" and the independent variable "educational qualification" is an inverse relationship – negative coefficient. At the same time,

1. The parameter labelled \_SE is the "selection effect," or bias correction factor.

2.  $\lambda(\cdot)$  is known as the hazard rate and its reciprocal is known as Mill's ratio; the study of Tobin, (1958) [30] showed that the value  $\lambda(\beta)$  can become asymptotic to a linear function for  $\beta$  when,  $-1 \leq \beta \leq 5$ .



the higher the academic qualification, the lower the divorce cases. The coefficient of the independent variable (income) is positive because the variable has a positive relationship with the dependent variable (number of divorces) - the higher the income, the higher the number of divorces. The variable "not having children" has an inverse reference with the dependent variable, since whenever a divorce occurs there is no child between the divorced. The more cases of marital infidelity, the greater the divorce cases because the relationship between the independent variable (marital infidelity) and the dependent variable (divorce) is positive. Each spouse has an account on social networking sites (Facebook, Twitter and Instagram). The more divorce cases, the more likely the relationship between the independent variable the "husband or wife has an account on social media website" and divorce is a positive one. The other variables have no significant effect since they are not statistically significant at the 0.05% level, with the dependent variable divorce.

#### 4. CONCLUSIONS

In this work, the number of divorces in Iraq was estimated, and due to the fact that they are censored, Tobit regression model analyses and the threshold censoring, because of its importance in producing unbiased estimates, were used. When studying divorces as dependent variables, we find that variable data is censored at zero and this means the Tobit regression model is the appropriate model to be use with Two-Stage (Heckman) method. Divorce analysis according to Heckman method is a two-stage process. In the first stage, the factors determining the decision to divorce are identified, while in the second stage the influential factors for divorce are analyzed. The two aspects are considered to be independent, although the decision is made by the same individual. Through the results of table 4 we were able to determine the most important variables affecting the decision to divorce, and we were able to determine the factors the affect divorce, through the results of table 5.

The results of the analysis show that the estimates are unbiased. The phenomenon of divorce was studied because it is of great importance in the life of society. Divorce is a global phenomenon whose dangers are prevalent in most countries the world. One of the main reasons for the increase in divorce cases is marital infidelity, as well as the preoccupation of the couple with social networking sites. Other variables also have an impact on the increase in divorce rates.

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