USING SOME TYPES OF INTERVENTION VARIABLES TO STUDY THE EFFECT OF THE VACCINE ON THE NUMBER ON THE NUMBER OF CORONAVIRUS INFECTIONS USING THE INTERVENTION ANALYSIS MODEL

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Abstract

Corona viruses are a widespread family, which is a large family of viruses that may cause disease to humans and animals, and it is known that many of them cause respiratory infections in humans and symptoms (fever, dry cough, pain and muscle aches, sore throat, diarrhea, loss of sense of taste or smell) and some symptoms are severe such as (difficulty or shortness of breath, chest pain, inability to speak or move). Vaccine doses on Corona disease and the data on which the study relied is a time series representing the weekly averages of the number of infections (4/3/2020) until (19/12 /2022) weekly The data was recorded through the daily bulletins announced by the Ministry of Health, and (146) views were obtained, which represent the number of injuries and the data on which the study reliedon a time series representing the rates. It has been concluded that the second intervention variable (the variable of the sudden start step function and the permanent effect of the intervention after one period of the event) has a strong intervention effect on the number of infections, meaning that the effect of the intervention for this variable is to start two weeks after taking the vaccine .the appropriate model to represent the number of infections with the Corona virus is the model of the third intervention variable a test t . we find that the intervention variables the first, second and third variables in terms of the number of infections with the Corona virus

1.1 Introduction

The Almighty said in writing the Holy Qur'an in the name of Allah, the Most Gracious, the Most Merciful, « Corruption appeared on land and sea with what the hands of people have gained, so that some of those who have worked may return » The truth of God Almighty »«Verse (41) of Surat Al-Rum In the year (2019), a disease or epidemic began to appear in your exile in humanity, and all channels of the world have been circulating and that the World Health Organization has been circulating statistics of infection and deaths every day. Especially since it started with China, then moved to Italy, and the countries of Europe remained and then the rest of the other countries. The disease has been called the Coronavirus or [COVID-19]. Scientists are trying to uncover a vaccine that will help stop the spread of the disease. After several months, several vaccines appeared, including the Pfizer-BioNTech vaccine, the most used vaccines in the Arab countries with 10 countries so far among the 6 vaccines used by the Arab countries, and the AstraZeneca vaccine ranked second with 9 countries: Saudi Arabia, the Emirates, Kuwait, Oman, Bahrain, Morocco and Egypt, in addition to Iraq, while the Pfizer vaccine is used in Saudi Arabia, the Emirates, Qatar, Kuwait, Oman, Bahrain, Jordan, Lebanon, Tunisia and Iraq, and Iraq, our dear country, was not far from this disease, at the beginning of 2020, in the third month, the incidence of this disease began and then continued to increase. Different types of vaccines have been used in our country, such as the Pfizer vaccine, the AstraZeneca vaccine and others, and to study the effect of these vaccines on the number of deaths. We used several types of intervention effect variables to find out whether vaccine doses reduced the number and mortality of this disease and whether the number of recoveries increased after taking vaccine doses. Or was the effect of vaccine doses temporary, that is, when taking the dose, the effect is good, and then the number of infections and deaths increases and the cases of recovery decrease, and to know the type of variable effect of the intervention. We used the method of analyzing the intervention, which depends on tracking the phenomenon (the variable Corona disease) and for a certain period of time based on the values of this phenomenon. That is, it depends on the general pattern of the time series of high or low in it. Which indicates or substitutes the existence of an external event (intercepted event) intercepted this time series and caused it either to rise or fall. And that the model used to represent this series affected by the external event is the intervention model (Intervention model)The intervention model depends on two random compound compounds and the intervention effect function and that the intervention effect function depends on the type of intervention variable used so is the pulse variable or step variable and whether the variable continuous event or temporal This thesis dealt with four chapters included the first chapter introduction and the goal of the research and its problem and the most important research and studies that dealt with the models of intervention analysis. The second chapter is the theoretical side has focused on the most important terms and concepts about the models of intervention analysis and functions of intervention analysis and variables of the impact of intervention and methods of estimation and for the third chapter has represented the applied side of the definition of Corona disease and a description of the data used and analysis of the values of building the intervention model for each variable of the intervention and then determine the best model that represents the phenomenon under study best representation and the last chapter is the fourth chapter, which discussed the most important conclusions and recommendations reached by the researcher

1-2 The problem of research : The determination of the variables of the impact of the intervention depends on the availability of data used in the research before and after the event (i.e. the availability of data deaths from Corona disease in addition to the nature of this data and its behavior and whether it is stable or unstable. As well as the quality of the intervention variable used and what is the appropriate mathematical conversion method used for the model and how the model is estimated

1-3 Research Objectives: The research aims to study the number of infections with the Corona virus (weekly registrations) through the use of some types of intervention variables to determine the effect of vaccine doses on the infection of Corona disease and to know the weekly epidemiological situation in Iraq and whether the vaccine led to a reduction or increase in the number of deceased Intervention models are compared to determine which of the intervention variables have the greatest impact on Corona disease infection using the comparison criterion (MSE).) As well as studying the effect of vaccine doses, whether their effect on infections increased or decreased.

Weekly number of injuries (4/3/2020) until (19/12 /2022) weekly The data was recorded through the daily bulletins announced by the Ministry of Health, and (146) views were obtained, which represent the number of injuries.

Chapter Two: Theoretical Aspect

1.2**Intervention analysis**

Intervention analysis is one of the statistical methods used in time series by tracking the occurrence of the studied phenomenon according to a certain time period and then predicting this phenomenon based on the different values that appeared in the time series of this phenomenon and the intervention is defined as the event that makes a sudden change or change after a certain period at the level of time series. The intervention leads to the deviation of the time series down or up or may give other formulas for change (7) To know the effect and nature of change on the course of the time series, we need to use statistical methods such as building a dynamic stochastic model for data that includes the probability of change. Through it, it is possible to identify the nature and amount of change in the time series there.

2.2 Functions of the effects of **the intervention**

Function of Intervention effect variables

Intervention variables can be divided into two parts in terms of their impact, they are either that their occurrence is permanent) or the occurrence of the intervention effect is temporary and then disappears, so the intervention variable is temporary, and therefore the intervention variable can be defined is that variable that works only for a limited period over the total length of the time series and we will symbolize the intervention effect variable with the symbol I_t Since the functions of the intervention effect variables depend on this variable, we will have the following functions:

1- Step function step function
2- pulse function
3- Ramb regression function

1-2-2 Step function II

The intervention variable of this function takes a value of zero before the event effect and takes a value of one at and after the event occurs and the formula for it is

$$= \begin{cases} 0 & .if \quad t < T \quad \text{قبل الحدث} \ldots \\ 1 & .if \quad t \geq T \quad \text{عند وبعد الحدث} \end{cases} \quad \ldots (2-1) I_t = S_t^T$$

where S^T_t represents thestep function and its permanent effect is integrated by I_t

2-2-2**: Pulsefunction**

The variable of the intervention effect of this function takes a value of zero before and after the event and takes a value of one at the event only and the formula has

$$I_t = \text{Unlocking } P_t^T = \begin{cases} 0 & if\ t \neq T \text{قبل وبعد الحدث} \\ 1 & if\ t = T \text{عند بدء الحدث} \end{cases} \quad \ldots (2-2)$$

where P_t^T represents the pulse function (and the temporary pulse effect is combined by I_t 1-B).

3-2-2) - Ramp functio regression function **n**: The variable effect of the intervention of this function is used in cases where the event is exceptional or its impact is continuous in change and at a constant rate and its use is rare and the formula for it

$$I_t = R = \begin{cases} 0 & if\ t < T \\ t - T + 1 & if\ t \leq T \end{cases} \quad \ldots (2-3)$$

<u>3-2 Types of intervention effects: because of the diversity in the variable of the impact of the</u> intervention, which is either permanent or temporary and also that each variable intervention of them has compounds of intervention are either gradual or suddenly sudden so there are in general four types of variables of intervention effects, namely: -

1- Sudden onset and permanent effect of intervention
2- Gradual beginning and permanent effect of intervention
3- Sudden start and temporary intervention effect .
4- Gradual start and temporary intervention effect , gradual effect

Note that each type of these effects are independent of the other and have a specific formula that distinguishes them and the model may consist of one or more of these four types and each type of these four types will be discussed as follows: -

1-3-2) **(sudden onset and permanent impact of intervention , sudden effect**

The effect of the intervention of this function is constant starting at a known period of time and the formula for this function WS_t^T ... $(2-4)$ $f(I_t)$ =

whereN W represents the unknown parameter and represents the S_t^T intervention variables, which is in the following form

$$000\ldots 0\underbrace{1}_{T}11\ldots 1$$

As T means the period of occurrence of the event and the beginning of the effect and that 1 means the presence of an effect of the event, while 0 means the presence of an effect of the event, so we note that the effect of the intervention has a direct impact on the original data, whether the time series data is stable or unstable (requires taking differences to achieve its stability) and that the intervention variable after taking the first difference is as follows (1 S_t^T .. (Daddy Jack) $0\underbrace{0}_{T}11$.And that the formula for the function to find the effect of intervention when taking the first differences of the data

$$\frac{W}{1-B} S_t^T \quad \ldots \quad (2-5) = f(I_t)$$

Where T means the time of occurrence of the event, while t means the time of the beginning of the effect of the event and B: represents the backward rebound coefficient, but when the effect of the intervention appears after several periods of the *occurrence of the event, that is, the intervention variable is as follows* S_t^T

$$1\ldots 011\ldots \underbrace{0}_{T}\ 0\ldots 0$$

And that the formula of the function is

... (2-6)

$$f(I_t) = wB^b S\ T_t$$

Where b) represents the parameter of differences (the parameter of lost time) and that the effect of permanent intervention for this function begins several periods after the occurrence of the event when b = 0 we get the function in the equation (2 - 4) and when b = 1 we get the function of the impact of intervention after only one period of the occurrence of the event and the formula of the function is

(2-7) WBS_t^T =c(I_t)

The effect of the permanent intervention of this function begins one period after the occurrence of the event

2.3.2 Gradual onset and lasting impact of intervention

Permanent gradual effectsThe intervention effect of thestep function variable does not appear all directly, but appears gradually and the formula for the function f

(I_t) =$\frac{wB}{1- \ B} S_t^T$ $(2-8)$

The effect of the permanent intervention of this function is gradually increasing and begins one period after the occurrence of the event and that the value of □ is 1>□>0 When it is 0 = □ produces us the function in equation (2-7), which is the fixed effect function (type I), i.e. the function in which the intervention is only one period after the occurrence of the event and when □=1, the effect increases linearly and the formula of the function is as follows: …

(2-9). f(I_t) = $\frac{wB}{1-B} s_t^T$

And that the effect of permanent intervention for this function increases gradually and begins at the time of the occurrence of the event

3.3.2 Sudden onset and temporary intervention effect **, sudden effect**

The effect of the intervention in terms of the pulse and the mathematical formula of the model and the form are: - .

f(I_t) $= \frac{wB}{1- \ B} p_t^T$ $(2-10)$

The effect of the temporary intervention of this function gradually decreases and begins one period after the occurrence of the event and when the effect occurs in the same period in which the intervention occurred, W=WB and the equation (2-10) will be formulated as follows:

f(I_t) $= \frac{w}{1- \ B} P_t^T$ $(2-11)$

From this function, different cases will appear to us as follows: - When □=1 and when substituting this value into equation (2-10), a function will be produced for us that enters with the following formula

(2-12) f(=I_t) $\frac{wB}{1-B}$ p_t^T

From this function, the effect of the temporary intervention lasts for several periods and steadily and begins one period after the occurrence of the event, but when substituting the value of □ = 1 in equation (2-11), the formula of the function will become

(2-13) f(=I_t) $\frac{w}{1-B} p_t^T$

The effect of the temporary intervention of this function lasts for several periods and steadily and begins at the period of occurrence of the event, but when substituting with a value of0 = □, when substituting in equation (2-10), a function will result in the effect of the term w in which it continues only and the formula of the function ej

(2-14) f(I_t)=WB p_t^T ...

The effect of the temporary intervention of this function lasts for one period and begins one period after the occurrence of the event, and when substituting its value of 0 =□ in equation

(2-11), the following function is produced for us

(2-15) f(I_t)= W p_t^T

As the effect of the temporary intervention of this function lasts for one period representing the periodof occurrence of the event, butif we expect that the effect will be gradually decreasing for a certain period and then its effect will be constant and continue for several periods, the function will be in the following formula

f(I_t) = (……..(2-16)$\frac{w_1B}{1- \ B} + \frac{W_2B}{1-B}$)p_t^T

The effect of the temporary intervention of this function decreases and then proves for several periods and begins after one period of the occurrence of the event and when the effect occurs at the same period of time in which the intervention occurred, the equation (2-16) will be formulated as follows

f(I_t) = ($\frac{W_1}{1- \ B}$ +) ... (2-17)$\frac{W_2}{1-B}$ p_t^T

The effect of the temporary intervention of this function decreases and then stabilizes for several periods and begins at theperiod of the event

4-3-2) Gradual **start and temporary, gradual effects**The effect of intervention for this function gradually increases until it reaches its highest value before it begins to disappear gradually and the formula for this function is =$\frac{W0}{1- \ _1B_1- \ _2B_2}$)$p_t^T$ $_{(2-18)}$)=f(I_t)

To show the effect of a gradually increasing intervention for this function and then the effect of a temporary intervention decreases

4-2 **Intervention model** :Suppose that the time series at equal intervals of time is represented by y_{t-1} . y_t . y_{t+1}

Before determining the intervention function for this time series, the general formula of the intervention model can be written as follows:

Intervention)+(noise) (2-19))Output series)=)

Thus, the general formula of the intervention model consists of two parts, the first part is noise, which represents a statistical model of errors, which we will symbolize NT, while the second part represents (intervention), which represents the kinetic model, which includes the time series in addition to the impact of the intervention, and thus the equation (2-19) can be formulated as follows:

=f(□,W,ε) +N_t...................(2-20))y_t

Where to N_t represent the components of error. As for

f (□,w,ε) represents a function dependent on time t and this function can allow to show the effect of intervention only after making all external variables represent indicative variables either zero or one (Indicatorvar varabies) and that

W,□ represents unknown parameters, while ε represents external variables, and equation (2-20) can be reformulated as follows:

$$y_t = f(I_t) + N_t \qquad (2-21)$$

Where (represents the variables of the effect of the intervention while (I_t f (represents the function of the variables of the effect of the intervention that can be formulated according to the following equation I_t)

$$f(I_t)=\begin{cases} \frac{U(B)}{(B)} I_t & \text{عندما التاثيردائم} \\ \frac{U(B)}{(B)} (1-B)I_t & \text{عندما التاثيرمؤقت} \end{cases} \qquad (2-22)$$

U(B) and □(B) represent intervention compounds, called polynomials to U and □ respectively.

$$\frac{U(B)}{(B)} = \frac{U0+u_1B^1+U_2B^2+\dots+UsB^S}{1- \ {}_1B^1- \ {}_2B^2\dots- \ rB^r} \quad \dots \qquad (2-23).$$

)) We get another version of the intervention model, which is

$$\begin{cases} \frac{U(B)}{(B)} I_t + N_t & \text{عندما التاثير دائم} \\ \frac{U(B)}{(B)}(1-B)I_t + N_t & \text{عندما التاثيرمؤقت} \end{cases} \quad \dots(2-24\ )= \quad y_t$$

5-2 formulation of the intervention model: The intervention model consists of two parts**,** the first part of the kinetic model, which represents the effect function of the variable intervention f (The I_t)second part represents the model of error compounds and the equation (N_t2-24) illustrates this, so to find and formulate the intervention model, the two models or parts must be determined, each one individually as follows:

1.5.2 Identification of the model of error componentsN_t: The model of error components is determined on the random behavior of the random series of the time series before the event. The N_tARIMA model of this time series is determined before the event. Agencies

First: In the case of the ARIMA model**:**

$$y_t = f(I_t) + \frac{(1-\theta_1 B)}{(1-\varphi_1 B)} a_t \qquad (2-25\ )$$

Second: In the case of the AR(P) model:

$$y_t\ = f(I_t) + \frac{1}{(1-\emptyset_1 B} a_t \qquad (2-26)$$

Third: In the case of the MA(q) model ***:***

$$y_t = f(I_t) + (1-\theta_1 B\ )a_t\ \dots \quad (2-27)$$

(2-5-2) Determination of the effect function of the intervention variable f(I_t): The function of the intervention variable is determined f and depending on the type of effect of the intervention variable has been explained in paragraph () and then compensates the formula of this function in equation (2-21), which represents the formula of the (I_t) intervention model, after the models of error compounds have been compensated in $\emptyset(B) = 1 - \emptyset_1 B - \emptyset_2 B^2 \dots - \emptyset_P B^P$ this formula, so we will find the effect function of the intervention variable f) N_t defined in equation (I_t)2-22)) for each type of effect of the intervention variable and then replaced by the general formula of the intervention model as follows

First: The first variable: a variable step function sudden start and permanent impact of the intervention and that the effect function of the intervention variable f (I_t)defined according to the equation (2-4) Thus, the general formula of the intervention model of the ARIMA model results from the compensation of equation (2-4) in equation ($y_t = f(I_t) + \frac{\theta(B)}{\varphi(B)} a_t$) as follows

$$y_t = WS_t^T + \frac{\theta\ (B)}{\varphi\ (B)} a_t \quad \dots \quad (2-28)$$

As for the ARIMA model (1,1,1), the general formula of the intervention model results from substituting the equation (2-4) in equation (2-25) and will become as follows:

$$y_t = WS_t^T + \frac{(1-\theta_1(B)}{(1-\emptyset(B)}a_t \ldots \qquad (2-29)$$

As for the AR(P) model, the general formula of the intervention model results from substituting equation (2-4) into equation ($y_t = f(I_t) + \frac{1}{\varphi(B)}a_t$) as follows:

$$y_t = WS_t^T + \frac{1}{\emptyset(B)}a_t \ldots \qquad (2-30)$$

As for the AR model (1,1,0), the general formula of the intervention model results from substituting the equation (2-4) into equation (2-26) as follows:

$$y_t = WS_t^T + \frac{1}{(1-\emptyset_1 B)}a_t \quad \ldots \quad (2-31)$$

As for the model in the case of MA(q) in ($y_t = f(I_t) + \theta(B)a_t$ the general formula of the intervention model results from substituting equation (2-4) in equatio($y_t = f(I_t) + \theta(B)a_t$ n as follows:

$$y_t = WS_t^T + \theta(B)a_t \quad \ldots \quad (2-32)$$

In the case of the model (0,1,1) MA , the general formula of the intervention model results from the compensation of equation (2-4).

In equation (2-27) as follows

$$y_t = WS_t^T + (1-\theta_1 B)a_t \quad \ldots \quad (2-33)$$

Second: The second variable: e and the variable of the step function (sudden onset and permanent effect of the intervention after one period of the occurrence of the event, that is, the effect of the intervention begins after taking the first difference and the formula is the intervention effect function for this variable shown in equation (2-7) and that the formula of the intervention effect model for the ARIMA model (P, d, q) and 1,1,1) ARIMA, AR(P), AR(1,1,0), MA(q) and MA(0,1,1) results from substituting equation (2-7) in equations) respectively as follows according to the following table

Table (1-2) shows the formula of the intervention effect models for the second variable

$y_t = WBS_t^T + \frac{\theta(B)}{\emptyset(B)}a_t \quad \ldots \quad (2-34)$	ARMA(P,d,q)
$y_t = WBS_t^T + \frac{(1-\theta_1 B)}{(1-\emptyset_1 B)}a_t \quad \ldots (2-35)$	WEAPON(1,1,1)
$y_t = WBS_t^T + \frac{1}{\emptyset(B)}a_t \quad \ldots \quad (2-36)$	THE (P)
$y_t = WBS_t^T + \frac{1}{(1-\emptyset_1 B)}a_t \quad \ldots \quad (2-37)$	AR(1,1,0)
$y_t = WBS_t^T + \emptyset B a_t \quad \ldots \quad (2-38)$	MA(q)
$y_t = WBS_t^T + (1-\theta_1 B)a_t \quad \ldots \quad (2-39)$	MA(0,1,1)

Third: The third variable: It is the variable of the step function (sudden onset and permanent effect of the intervention after several periods (b) of the occurrence of the event and the formula for the effect function of the intervention variable is explained in equation (2-6). To find the formula of the intervention effect model for the model

ARIMA (p,d,q), ARIMA (1,1,1), AR(P), AR(1,1,0), MA (q) and MA (0,1,1) and we will substitute equation (2-6) into equations) respectively. Table (2-2)) shows the formula of the intervention impact model as follows

Table (2-2) shows the formula of the intervention impact models for the third variable.

General version of the intervention model	prototype
$y_t = W B^b S_t^T + \frac{\theta(B)}{\emptyset(B)} a_t$ ... (2 − 40)	ARMA(P,d,q)
$y_t = W B^b S_t^T + \frac{(1-\theta_1 B)}{(1-\emptyset_1 B)} a_t$ ... (2 − 41)	ARIMA(1,1,1)
$y_t = W B^b S_t^T + \frac{1}{\emptyset(B)} a_t$ ... (2 − 42)	THE (P)
$y_t = W B^b S_t^T + \frac{1}{(1-\emptyset_1 B)} a_t$ ... (2 − 43)	AR(1,1,0)
$y_t = W B^b S_t^T + \theta(B) a_t$ ... (2 − 44)	MA(q)
$y_t = W B^b S_t^T + (1-\theta_1 B) a_t$ ... (2 − 45)	MA(0,1,1)

(1-6-2) Estimation using simple linear regression equation The intervention model can be estimated using the linear and simple regression equation as follows, and after determining the formula of the intervention model using the ARIMA model in equation (2-28), we rewrite it as follows:

$$\frac{\emptyset(B)}{\theta(B)} y_t = \frac{\emptyset(B)}{\theta(B)} W(B) S_t^T + a_t \quad ... \quad (2-46)$$

Since, it is known and assuming that the series of forces θ(B)$\emptyset(B)$W(B) converges to one (= 1 / /B) which is the equation of a *circle with the center of the origin and radius one. The equation (*2-46*) can be written in the form of a simple linear regression model as follows:*

$$y_t = \beta x_t + a_t \quad ... \quad (2-47)$$

$$\beta = W(B) \quad ، \quad x_t = \frac{\emptyset(B)}{\theta(B)} S_t^T \quad ، \quad y_t = \frac{\emptyset(B)}{\theta(B)} Z_t$$

And to represent the series of random errors (a_tWhite noise) and using the least squares i, the estimate of the parameter (β) will be

$$\hat{B} = \frac{\sum_{t=1}^{n} y_t x_t}{\sum_{t=1}^{n} x_t^2} \quad ... \quad (2-48)$$

$$V(\beta) = \frac{\sigma_a^2}{\sum x_a^2}$$

And that y_t the values of and will change according to the nature of the x_t Box-Jenkins model and according to the nature of the variable type of the intervention effect function

Chapter Three
Applied side

3-1 Introduction: In this chapter, the applied aspect has been given a brief overview of Corona disease (Covid-19) and the symptoms and causes of this disease and the application of time series models by using the intervention variable for the time series through the use of some intervention variables to determine the effect of vaccine doses for Corona disease on the weekly recordings of the number of people infected with the Corona virus in Iraq and to determine which is better in predicting the number of infected people through the use of the intervention model (Intervention model)

(2-3) Coronavirus (Covid-19)

Definition of Corona : - It is known that Corona disease causes shortness of breath or difficulty in breathing and pain in
Muscles. Chills. Sore throat . Runny nose. Headaches. Chest pain. red eye and its severity ranges
Present Corona disease between very mild and severe, and some people do not show symptoms, and disease
Coronavirus (COVID-19) is an infectious disease that causes rapid irritability, confusion and confusion. Low level
Consciousness (which is sometimes associated with seizures, anxiety, depression, disorders, as well as symptoms include fever and cough).
The disease can cause pneumonia or difficulty breathing that many
Corona viruses cause respiratory infections in humans, ranging in severity from colds to diseases
More severe such as East respiratory syndrome and severe acute respiratory syndrome

(3-3) Data description The data that was taken is a time series representing the weekly recordings of the number of those who died of the Corona virus in Iraq for the period from 14/3/2020 to 19/12/2022, where the number of deaths was taken, as the data was recorded through the weekly bulletins announced by the Iraqi Ministry of Health, and (146) views were obtained.

(4.3) Data collection Data Collection : The data was obtained from (Department of Public Health) - Iraqi Ministry of Health, including the number of people infected with the Corona virus (Covid-19), and it reached 146 views for the period 4/3/2020 until 19/12/2022, as the number of injured is (2465395) injuries, and Table (1-3) shows the number of injuries

Table (1-3)

Weekly registrations of the number of people infected with the Corona virus in Iraq for the period (4/3/2020) until19/12/2022))

t	Number of injured	t	Number of injured	T	Number of injured	t	Number of injured	t	Number of injured	T	Number of injured
1	110	27	30059	53	29632	79	46626	105	11713	131	638
2	104	28	28819	54	31648	80	37001	106	7928	132	740
3	292	29	30372	55	33816	81	27770	107	5146	133	733
4	372	30	29962	56	36147	82	20174	108	3896	134	674
5	440	31	24193	57	41354	83	15951	109	1994	135	296
6	195	32	23400	58	38663	84	15364	110	2422	136	193
7	250	3	2562	5	5342	85	1183	11	1819	13	186

		3	9	9	8		1	1		7	
8	456	34	23477	60	52804	86	11619	112	1365	138	237
9	460	35	23889	61	50014	87	10006	113	2113	139	373
10	581	36	20396	62	40086	88	7943	114	550	140	460
11	1012	37	16640	63	35626	89	6839	115	765	141	704
12	1907	38	5266	64	23977	90	5573	116	803	142	703
13	4919	39	23699	65	30141	91	5187	117	700	143	651
14	7852	40	11102	66	32669	92	5109	118	704	144	411
15	10272	41	9496	67	28173	93	3928	119	944	145	321
16	14040	42	7661	68	32089	94	2967	120	1835	146	283
17	15092	43	4512	69	36964	95	2165	121	4288		
18	16840	44	902	70	41865	96	1602	122	13226		
19	15026	45	4562	71	52831	97	455	123	25384		
20	17353	46	5431	72	60240	98	2599	124	22661		
21	19131	47	5221	73	132174	99	11716	125	25009		
22	20685	48	5795	74	5084	100	36216	126	18698		
23	25194	49	7020	75	81168	101	47534	127	9026		
24	28467	50	12686	76	66221	102	48338	128	4773		
25	26396	51	20545	77	58200	103	31277	129	2342		
26	29273	52	26909	78	46405	104	14930	130	1316		

(**5-3) Data Analysis** To analyze the data on the number of cases of Corona disease, we will first draw this time series based on the table
1-3) and Figure 1-3 represent the time **series** of the number of casualties

Figure (1-3) shows the series of **infections before taking the vaccine**

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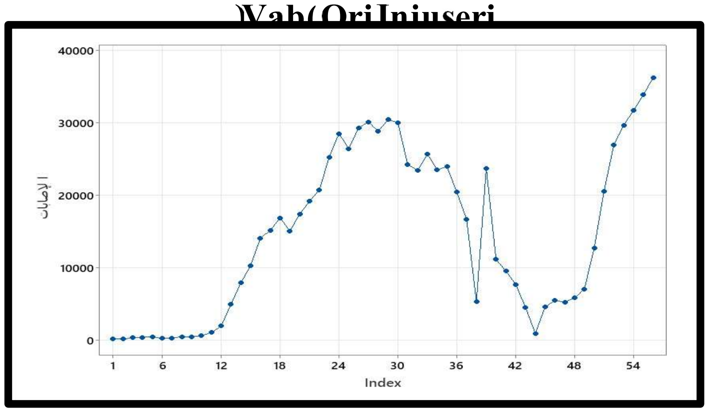

AC

To study the effect of the vaccine dose on the number of infections in Table (1-3), we will divide the time series before taking the vaccine from the period 14/3/2020 to the date of the first vaccine dose on 1/4/2021 and by (56) views As for the second part in the series, it represents the second series and begins after the period of taking the vaccine, that is, from 1/4/2021 to 19/12/2022 and by (90) scenes, and Figure (2-3) shows the time series before taking the vaccine

(6-3) Building a random model of the number of infections before the vaccine After determining the time series of the number of infections before the effect of taking the vaccine, which amounted to (56) pedestrians, we will determine the appropriate box - Genghis model for this series data before the effect of taking the vaccine dose byconducting the steps of the Box Genghis methodology and the following table shows that

Table 2.3

Bic	Aic	prototype
16.087	16.051	ARIMA (1,0,0)
16.08	16.043	ARIMA (1,1,0)
16.171	16.096	ARIMA (2,1,0)
16.153	16.079	ARIMA (2,0,0)
16.236	16.125	ARIMA (2,1,1)
16.311	16.162	ARIMA (2,1,2)
16.083	16.046	ARIMA (0,1,1)
16.173	16.099	ARIMA (0,1,2)
17.66	17.586	ARIMA (0,0,2)
16.236	16.125	ARIMA (1,1,2)
16.	16.068	ARIMA (1,1,1)

Table (2-3) We find that the best model of the Jenkins Box model is the ARIMA model (1,1,0) i.e. the model

Self-regression of the first class for possessing less AIC and value (16.043) Lowest Bic value and value (16.08)

Thus, the time series model for the number of infections before the effect of taking the vaccine dose is theARIMA model (1,1,0) and the estimated equation for this model is the equation (2-28).

$$\hat{y}_t = (0.17876)Z_{t-1} + a_t$$

And by simplification. Bnotto rely on equation (2-28) if

1+ 0.17876 B)$\hat{Z}_t = a_t$) ؛

$\hat{Z}_t = (1 + 0.17876\, B)^{-1} a_t$

7-3) Random model of errors: To build the random model of errors, we will use equation (2-30) N_t), which makes the time series model for each variable before the effect of the vaccine dose equal to the random model of errors, i.e.

$$N_t = \widehat{Z}_t$$
$$N_t = (1 + 0.17876\, B)^{-1} a_t$$

(8-3) General version of the intervention model As for the construction of the intervention model**,** we will rely on the general formula of the intervention model ARIMA (1,1,0) in the case of equation (2-31) and replace the random error model obtained and the general model of intervention will (N_t)*become as follows:*

$$y_t = f(I_t) + (1 + 0.17876\, B\,)^{-1} a_t$$

1+0.17876 B)$y_t = (\,1 + 0.17876\, B) f(I_t) + a_t$) ؛

((9-3) Application of intervention ***variable functions****: After determining the formula of the general intervention model and compensating with the components of errors in it, we will replace the functions of the intervention variables, where we will take several types of intervention variables and that each type has its own intervention variable function and these models have been clarified in equations*

كل حسب العام التدخل أنموذج يبين التالي والجدول *A variable function that enters and after making some simplifications on it.*

Table (3-3) shows the types of intervention models according to each intervention variable function

	function(I_t)*f*	*Variable*
1+0.17876*B*)=(1+0.17876 B)$y_t \omega S_t^T + a_t$)	ωS_t^T	*The first*
1+0.17876 B)=(1+0.17876 B)$y_t \omega B S_t^T + a_t$)	ωBS_t^T	*Second*
*1+0.17876 B)= (1*y_t+0.17876 B)$\omega B^b S_t^T + a_t$)	ω$B^b S_t^T$	*Third*

(**6.2.5.3) Assessment** Estimating the parameters of the intervention models in Table (10-3) after converting each of these models to the formula A simple linear regression model and Table (4-3) shows the formulas y_t ,x_t and each of the intervention models represents βa series of random errors a_t

Table (4-3) shows the formulas y_t of$B$. x_t

x_t	β	y_t	Intervention formula function	Variable
1+0.17876 (b)S_t^T)	ω	1+0.17876 (b)y_t)	ω S_t^T	The first
1+0.17876 (b)(bS_t^T)	ω	1+0.17876 (b)y_t)	ωBS_t^T	Second
1+0.17876 (b)$B^b S_t^T$)	ω	1+0.17876 (b)y_t)	ω$B^b S_t^T$	Third

As for the values to, we find them depending on the formulas in Table ($y_t x_t$4-3) and for each type of intervention variables as follows in an example of the first variable,

$$y_t = (1 + 0.17876\,\mathrm{B})y_t$$
$$y_t = y_t + 0.17876\,By_t$$
$$y_t = y_t + 0.17876\,y_{t-1}$$

Then we substitute a value and a value to get either value that we find for the variable as follows$y_t y_{t-1} y_t x_t$

$$x_t = (1 + 0.17876\,B)S_t^T$$
$$x_t = (S_t^T + 0.17876\,BS_t^T$$
$$x_t = S_t^T + 0.17876\,S_{t-1}^T$$

Substituting the values of , we find the values of the variable and so on for the determination of the intervention variables and after finding the values of $S_t^T\ S_{t-1}^T x_t y_t x_t$ and B can be estimated using the equation and for each model of the intervention model and for) the values of the parameters of the intervention model are placed

Table) shows the estimated values of the parameters of the model in Table (4-3)

$\hat{B}$	Model for variable
2016.447	The first
2040.957	Second
1968.547	Third

(11-3) Examination of the form: After estimating the linear regression parameters for each of the intervention variables, the stage of examining these variables comes to find out whether there is an effect of the vaccine dose intervention variable on the number of infections or not There is no effect of any significant parameter test for the linear regression model using the t test. βVaccine dose If the arithmetic value is greater than the tabular tt-value. This means that the intervention variable has no effect on the number of infections.

$t_{col} > t_{table}$ متغير التدخل له تأثير

$t_{col} > t_{table}$ متغير التدخل ليس لة تأثير

As for the test of the significance of regression for each model, we will use the F test, so if the arithmetic value of F is greater than the tabular value of F, this means that the regression model is significant, but if it is the opposite, it means that the regression model is not significant in the sense of

$F_{col} > F_{table}$ معنوي الانحدار

$F_{col} > F_{table}$ الانحدار غيرالمعنوي

The final step is to determine which model is the best among the models. Using the Mean Squares of Errors (MSE) criterion and that the best model is the one with the least (MSE) Mean of squares of errors and Table (-3 6) shows the values of t, F, MSE test results for them

Table (5-3) shows the values of t, F, MSE and the test results for each of the intervention variables for the data of the number of cases of Corona disease

MSE	F arithmetic	Say	T arithmetic	Variable Intervention
87991468.67	4.387	0.039	2.094	1
44545293.33	8.686	0.004	2.947	2

11795546.47***	27.163	0.000	5.212	3

The best model for owning less MSE

From Table (5-3) we note that the values of the coefficients of the intervention variables are large for all models and by comparing the value of the statistical test (t) for the parameter of each of the intervention variables with the tabular values (t = 1.66) we find that the first, second and third intervention variables are significant variables and have a very high moral intervention effect on the number of injuries, while the rest of the variables are non-significant and have no effect on the number of injuries, but in the F test The significant regression models are for the first, second and third intervention variables, while the rest of the intervention variables have non-significant regression models compared to the tabular F value at a significant level (0.05) and that the best model among the significant regression models is the third intervention variable model because it has the lowest average MSE error boxes and their value

MSE = 11795546.47) and that the intervention model for the third variable is

$$\hat{y}_t = 1968.547\, S_{t-6}^{T} + \frac{1}{1 + 0.17876} a_t$$

Chapter Four

(1-4) Conclusions Through the applied study, the researcher reached the following conclusions:

1- The third intervention variable (step function variable and permanent effect after 6 periods) has been reached with an intervention effect from weeks of taking the vaccine and continued

2- It has been concluded that the second intervention variable (the variable of the sudden start step function and the permanent effect of the intervention after one period of the event) has a strong intervention effect on the number of infections, meaning that the effect of the intervention for this variable is starting two weeks after taking the vaccine

3-The appropriate model to represent the number of infections with the Corona virus is the model of the third intervention variable and its formula

$$\hat{y}_t = 1968.547\, S_{t-l} + \frac{1}{(1 + 0.191\, B} a_t$$

(2.4) Recommendations

1- Expanding the study of unstable time series interference analysis
2- Interest in studying intervention analysis models in the agricultural, commercial and health aspects.
3- Study of the analysis of the intervention in themultivariate time series

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