

Predicting the Effect of Sterilization Policy on the Reserved Money in the Iraqi Economy Using ARIMA* and ANN** Models

Sameer F. Neamah^{1*}, Akram S. Yousif²

¹Dept. of Economic Science, College of Administration and Economy, University of Zakho, Kurdistan Region – Iraq.

²Dept. of Economy, College of Administration and Economy, Nawroz University, Kurdistan Region – Iraq.

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ABSTRACT:

The Central Bank's borrowing of a portion of excess liquidity and its accumulation in its balance sheet as liabilities with interest, its frequent raising of the legal reserve ratios, intervening in the exchange market through the purchase of foreign currency, then absorbing the effect of this purchase on local liquidity, providing deposit facilities with interest and offering its Central Bank orders to banks in the subsidiary market all come under the title of sterilization policies. This is quite evident from minimizing local crediting. In an attempt to control excess liquidity, the factors determining monetary sterilization policy and reserved money have been attended to so as to concisely forecast the course of the monetary variables until the year 2030 in order to maintain the stability of the monetary basis from the impact of the changes in oil price. This has been conducted through the adoption of prediction models of Auto-Regression Moving Averages (ARIMA) model in addition to the Artificial Neural Networks model (ANN) since the growth in government expenditure indicates that the monetization of oil revenues has caused a structural fiscal deficit in the Iraqi economy. Such a deficit should be restricted by the sterilization policy through monetary policy tools. Based on this, the balance of the budget in an economy depending on oil revenue cannot guarantee economic stability unless public spending is managed with a degree of independence from the fluctuations in oil price.

KEYWORDS: Sterilization Policy, Reserved Money, Excessive Reserves, Issued Currency, Auto Regression Moving Averages, Artificial Neural Network.

1. Introduction:

The reasons behind choosing this research topic wholly lie in the nature of the governmental expenditure which grows by an average higher than that of the total local product in the long run. It does not depend on the growth of the governmental revenues that are dependent on some ordinary sources other than oil. This growth in the governmental expenditure is due to the monetizing of oil revenues that has caused a structural financial deficit in the economy which should be restricted by the sterilization policy through the monetary policy tools. As such, the budget balance in a yield economy which depends on oil cannot be granted economic stability on the condition that the public expense is managed by an amount of independence from the fluctuations in oil prices.

This research aims at predicting the policy of monetary sterilization, banks reserves and issued currency by using two models, namely ARIMA and ANN till 2030. It further aims at measuring the effect of sterilization policy on the reserved money. Sterilization policy refers to the policy adopted by the Iraqi Central Bank in its attempt to control the changes in the oil prices on the monetary basis by controlling the excess liquidity levels. It is worthy to note that the degree of sterilization is measured by the change in the net of the local credit as a result of the change in the foreign assets (the constituents of the monetary basis in assets side, with the reversed relation between them, or through the ratio of the net of foreign assets to the monetary basis. When the ratio exceeds one, it indicates the existence of active sterilization. The indicators of the monetary policy are evident from the constituents of the reserved money which in turn indicates the negativity of the net of the local credit in the assets side of the

public budget of the Iraqi Central Bank. A main reason is the existence of an excess of the current account of the payment balance.

On this basis, the significance of the current research is embodied in predicting the effect of monetizing the foreign currency through sterilization policy on the reserved money represented by the exported currency and the Banks' hard currency and by controlling the excess liquidity bases on the sterilization policy and using the updated mediatory monetary tools and evaluating the impact of the monetary sterilization policy on the constituents of the monetary basis of demand by predicting by measuring that impact on the Iraqi economy till 2030.

The problem of the research is represented by the answer provided for the following main question: Can Iraqi Central Bank through the policy of monetary sterilization affect reserved money in case there are any changes in the oil price? This main question comprises the following sub-questions: How can monetary sterilization policy contribute to the limitation of the exported funds and the banks' foreign currency throughout the period of the study? Will the international decrease in oil prices weaken the effect of the sterilization policy on the monetary basis? As such, the research sets out of the following hypotheses:

- The monetary policy is liable to the risk of the liquidity excess due to the increase in oil revenues.
- The monetary policy is lacking a sterilization policy due to monetize oil revenues on the reserved money.
- The monetary sterilization policy can contribute to the restriction of the issued money and the banks' reserves in case

* An Autoregressive Integrated Moving Average (ARIMA) □

** Artificial Neural Networks (ANN) □

* Corresponding Author.

the government resources are larger than its expenditure registered the net of the foreign assets and entirely the opposite. d. The right track of predicting the sterilization policy can be identified by means of using both ARIMA and ANN till 2030.

2. Related Works:

- Jakob Christensen's (2004) analyzed the relation between the large capitalist fluxes and the efforts of sterilization policy in Czech Republic during the period 1993-1996 by using the VAR model which comprises local credit, foreign reserve and local and foreign interest rates. The study concluded that in spite of the primary success in sterilizing the capital fluxes, the sterilization strategy was increasingly costly and unsustainable. The commercial banks got the chance to play sterilization, as they borrowed by a low price from abroad and invested the money locally in the high revenue of sterilization bonds.
- B. Ming Zhang's (2012) attempted to explain the reason behind the success and the sustenance of the sterilization policy in China during the first decade of the 21st century. The study concluded that the Chinese government established a technique to distribute the costs of sterilization among Chinese People's Bank, commercial banks and families living sectors. On one hand, Chinese commercial banks should take over some sterilization costs by purchasing the Central Bank's low-revenue bills and maintaining high level of the require reserves. On the other hand, the Chinese families took over some of the sterilization costs by overtaking the prices of the interest rate of the negative real deposits. The Chinese families became the victims of this financial suppression in facing the pressures of the change of the growth model from the investment paid by consumption.
- C. Mahmood Jammam's (2014) aimed at pointing out the role of the sterilizing monetary policy by the Algerian Central Bank for the period (1999-2012). The study concluded that the application of the monetary sterilization policy in Algeria did not long forever, especially in case oil prices remained going high for a longer period and that the fund of controlling the resources played a great role in activating the sterilization policy in case it was compared to the newly introduced monetary tools as it was isolating huge amounts of money from the monetary situation freely (i.e., without any cost). Added to that, the same amounts contributed to decrease the net of local assets as they were saved in an account following the state treasury at the Algerian Central Bank. That is to say, it played a double role free of costs.
- D. Ashima Goyal's (2019) aimed at highlighting the role of sterilization in limiting the flux of assets in India from 2006 to 2017 by means of the data of bills and the actual exchange rate and adopting ARIMA methodology and the Hypotheses of the minor squares (OLS). The study concluded that the tools of sterilization policy have a significant effect on the use of long-term bills and on the fluxes of assets and that constant sterilization by means of swaps process can restrict monetary offer.

3. Background

3.1. The Essence of Sterilization Policy

This part of the study will be devoted to the presentation of a brief account on defining the sterilization policy and measuring the sterilization degree and as follows:

3.1.1. Definition of Sterilization Policy: Sterilization is the monetary operation that aims at controlling the raise in the net of foreign assets by decreasing the net of the local assets (Aizenman, and Glick, R 2009). By so doing, the stand by monetary basis remains constant. This is achieved by the intervention of the Central Bank by the Open Market Operations, the increase in the obligatory stand by and fixing the monetary multiplier (Kose, 2009: 17). Sterilization is also defined as the operations practiced by the Central Banks in the aftermath of the increase in the international reserves that

simultaneously looks after the increase of the monetary offer since the Central Banks purchase the foreign currency by the local currency. This leads to an increase in the reserved money in terms of the liabilities, i.e., the exported currency and the banks reserves available at the Central Bank and that through multiplier the monetary offer increases. In such a case, those countries face a liquidity excess in the banking system. As such, they intentionally resort to the sterilization policy; the Central Bank lends a part of the excess liquidity and its accumulation in terms of the liabilities of the public budget versus the interest costs that are overtaken by the Central Bank, and sometimes with the increase in the obligatory reserve rates (Ali, 2015: 222). That is to say, when the payment balance of a certain economy is in a deficiency state, the Central Bank intervenes, buys the local currency and sells the required international reserves. When the Central Bank does not do any other operation, the monetary basis will decrease (Jang, 1997: 17).

The tools of the sterilization policy adopted in the Iraqi economy; that is the open market operations, the policy of discount return and direct lending, obligatory stand byes, in addition to the foreign currency sale outlet) through the sale of international assets versus the assets of the local currency to maintain monetary stability to absorb the liquidity excess by equalizing the reserved money (Gilal, et. al., 2017). This is on one hand. On the other hand, the banks' investment at the Central Bank with interest so as to cancel a part of the effect of foreign reserves on the reserved money or through the practice of pressure on the multiplier by minimizing the size of the funds to be lent. Consequently, the monetary offer approaches the monetary basis. If the Central Bank reduces the local credit by means of sterilization, the foreign reserves will increase by the indicator of fixing the interest rate. As such the function foreign stand byes depends on the monetary basis. The outcome will be that the increasing demand on the local funds will lead to an increase in the foreign stand byes through the current account excess, at the time the excessing offer of the local funds will lead to the decrease of the reserves and in return the monetary basis (Ali, 2018: 233-240).

3.1.2. Measuring Sterilization Degree: Monetary sterilization degree can be measured on the basis of the following equation: (Mansour, 2012: 5)

$$\Delta NDA = C + B \Delta NFA + E_i$$

Where:

ΔNDA : the change in the net of local assets.

ΔNFA : the change in the net of the foreign assets.

B: coefficient of monetary sterilization.

C: an absolute constant

E_i : other variables affecting the sterilization process.

If the value of the sterilization coefficient ($B = -1$), we will have the state of full sterilization when the change in the net of foreign assets is of the size of the change in its local assets. That is to say, if one unit of NDA is decreased whenever one unit of NFA is sold, full sterilization will be brought about and the impact on the stand by funds (The monetary basis) equals zero. In case ($B = 0$), the sterilization policy does not exist and any lower change in the foreign assets will directly affect the reserved money. Finally, if ($0 > B > -1$), there will be partial sterilization. In such a case, the Central Bank will react to the fluxes of capitals whether towards inside the country or abroad by a low sterilization coefficient; i.e., a relative expansion or shrinkage is allowed according to the state of the flux of the reserved money. In other words, when the bank sells one unit of the foreign assets, it may decrease or increase less than one unit in the local assets (HOANG, et. al., 2020).

3.2. Analysis of the Effect of Sterilization on the reserved money in Iraqi Economy for the Period 2004-2019.

The monetary policy in Iraq is subject to the components of the reserved money that are restricted by the oil revenues through

the public budget of the country. The reserved money expands with the increase in the net of the local credit or the net of the international reserves. If the Central Bank goes far in its monetary expansion; i.e., increasing the local credit under the circumstances of oil revenues of Iraq and other oil revenue countries, there will be an increase in the monetary offer. This would lead the other component of the monetary basis to decrease; that is the net of the foreign assets since the official exchange rate is constant in the Iraqi economy. When the Central Bank intervenes through the selling the currency and sells the foreign currency, the reserved money will diminish on two levels: the first is that decreasing the foreign assets of the Central Bank represents a policy of sterilizing the monetary expansion as far as assets are concerned. The second aspect is that such a procedure would decrease the local credit through the absorption of the local currency. As such, the sterilization policy in all its forms represents the operation of transferring the nonmonetary liabilities and the capital in the public budget of the Central bank to the assets side with a negative sign. Such a sterilizing procedure suffices in the concept of the net of the local assets; As such, it becomes negative (due to moving it to assets side) which has a counterpart represented by the net of the foreign assets. Here, the Central Bank cannot directly control the exported currency. That is why it depends on the public demand through the public expenditure. The last is limited by the oil revenues within certain and known limits. Also, this leads to an increase in the monetary basis by increasing the banks' assets or increasing their deposits at the Central Bank (The reserved money) which has a counterpart represented by increasing the foreign reserves in assets side. The funds offer will increase so as to align with the new level

of the monetary basis. Yet, it will go with the sterilization policy when the banks are financed by the issuances of the Central Bank orders to be purchased by the banks. Based on that, an aim of the sterilization policy is to control the general rise in the prices by following up the relative rate of the funds within the Iraqi economy. In other words, the stability of the real funds which is a function that is reversely correlated with inflation and proportionally with the funds offer. In such a case, the monetary policy will resort to the sterilization procedures so as to control the levels of liquidity by repurchasing the largest amount of the local currency due to the increase in the effective total demand (The government's selling) of the foreign currency. Due to the inflexibility of the production system, the rise in the level of the prices will align with economy so as to absorb a part of prices rise through imports. The other part will align with the sterilizing policy so as to control the reserved money sources which are represented by the monetary reserves and the excessive reserves that are deposited by the commercial banks at the Central Bank. In an attempt to keep the interest rate as a nominal fixer of inflation, the monetary policy resorts to the monetary sterilization policy through its tools. Here and to make the sterilization policy more effective, whenever the excessive reserves at the banks rise due to the large size of the governmental deposits, we endeavor to make Iraq have a long-term exchange market parallel to the current exchange market through the selling currency so as to control the increase in the foreign reserves (The government is the source of the foreign currency) especially when the banks hesitate in crediting the private sector. Table (1) demonstrates the analysis of the Impact of sterilization policy on the reserved money.

Table (1): Analysis of the Impact of sterilization policy on the reserved money in Iraqi economy for the period 2004-2019

Sterilization Degree	Sterilization Value* (7) -1/5	Covering International Reserve of the Exported Currency % (6)	Total Foreign Assets of The Central Bank (Billion ID) (5)	Banks reserves at the Central Bank (billion ID) (4)	Exported Currency (Billion ID) (3)	Net of Local Credit (Billion ID) (2)	Stand by Funds (Billion ID) (1)	Year
	0.83	126.04	10,109	4,199	8,020	2,110	12,219	2004
	1.29	174.00	17,846	3,538	10,256	-4,052	13,794	2005
Excessive Sterilization	1.49	219.519	26,158	5,604	11,916	-8,638	17,520	2006
	1.33	245.49	38,375	13,176	15,632	-9,567	28,808	2007
	1.38	276.74	58,958	21,554	21,304	-16,100	42,858	2008
Full Sterilization	1.15	216.078	52,224	21,101	24,169	-6,954	45,270	2009
	1.12	217.256	60,217	26,092	27,717	-6,408	53,809	2010
	1.28	234.381	75,370	26,540	32,157	-16,673	58,697	2011
	1.28	227.23	81,312	27,606	35,784	-17,922	63,390	2012
Semi-Excessive Sterilization	1.23	223.33	90,097	32,899	40,360	-16,838	73,259	2013
	1.16	192.997	76,973	26,347	39,883	-10,743	66,230	2014
	1.1	164.403	63,435	19,302	38,585	-5,548	57,887	2015
	0.85	117.410	53,106	17,359	45,231	9,484	62,590	2016
Semi-Full Sterilization	0.96	130.873	57,893	16,269	44,236	2,612	60,505	2017
	1.13	171.735	76,017	22,896	44,264	-8,857	67,160	2018
Full Sterilization	1.03	154.180	79,918	25,415	51,834	-2,669	77,249	2019

Source: Iraqi Central Bank, General Directorate of Statistics and Researches, The Annual Newsletters (2004-2019)

Table (1) demonstrates the impact of sterilizing the oil revenues through the foreign assets on reserved money especially after

the weak contribution by the commercial banks to the growth and the contribution of the private sector to the total local

* Sterilization value refers to the outcome of dividing the total of foreign assets at the Central Bank by the total of the reserved money of the liabilities from the public budget of the Central Bank that equals the monetary Base.

production. This has obliged the Central Bank, by means of using all mediating tools, to control the levels of excessive liquidity which is known as sterilization policy. Such a policy has a set of objectives; the most important of which is maintaining the monetary stability by facing the fluctuations in oil price, which plays the largest role in the economy and in the components of the total local product. Table (1) above also shows a proportional relation between the foreign assets and the issued currency which is expressed by the coverage coefficient since when the foreign assets increase, the ratio of the coverage coefficient increases which are duly reflected through the degree of the monetary sterilization. An indicator of the negativity of the net of the local credit is noticed in the assets part of the monetary base. It is also noticed that when a decrease takes place in the international reserves, the degree of sterilization decreases. Hence it should be stressed that the government is the source of the foreign currency; the government sells this currency to get the local currency. The private sector in Iraq is the purchaser of the foreign currency that has a governmental asset from the Central Bank through the selling of the currency.

Further close looking into the table unravels the point that the exported currency forms two thirds of the reserved money throughout the period of the research, and that the banks reserves of the legal and excessive funds form one third of the reserved money. This is a clear indicator of the bank's non-contribution to the growth of the total local product; a point that obliges the monetary policy to intervene in the form of sterilizing the oil revenues by dollar and its effect on the monetary base.

The monetary policy resorts to, through the open market operations, buy the tools of the governmental debts at the banks. This leads to an increase in the local credit; and due to sterilization, it is reflected in the form of increasing the excessive reserves of the commercial banks. When the banks utilize their reserves, the exported currency increases on the account of the excessive reserves of the reserved money here. If the banks have utilized a part of the excessive reserves in facilitating deposit for an interest or have purchased the Central Bank orders, such a process will change the type of demand for the banks as they become indebted to the Central Bank. This will ultimately result in reducing the net of the local credit of the Central Bank of the amount of the banks' investment in its tools. Such an operation is in essence the sterilization policy by means of which the Central Bank absorbs a part of the additional liquidity that is resulted from its policy in facilitating governmental lending.

3.3.Predicting the Impact of the Sterilization Policy on the Reserved Money in Iraqi Economy to 2030 by Using ARIMA and ANN Models

In this part of the study, Box and Jenkins models' side by side with Artificial Neural Networks Model are used to predict the impact of sterilization policy on the reserved money in the Iraqi economy until 2025. This will be conducted by means of analyzing the chronological orderings of the variables throughout the period 2004-2019 and as follows:

3.3.1. Predicting the Impact of the Sterilization Policy on the Reserved Money in Iraqi Economy to 2030 by Using ARIMA Model: This part of the study is intended to identify the models related to prediction, whether linear or nonlinear models. An example is ARIMA model and as follows:

3.3.1.1. Autoregressive Integrated Moving Average Model (ARIMA): The ARIMA model indicates that when the original time series is stationary, it is said to be nonintegrated. If the purpose is to get the differences of the original series times (d) until it becomes stationary, then it is said that the original series is integrated by the degree (d). As such, the Autoregressive Integrated Moving Average Model has three ranks: The autoregression rank (p), the integration rank (d), and the moving average rank (q) and is written as (p, d, q) ARIMA. That is to say, it is a time-series of autoregression of merged moving averages (Kujarat, 2015: 1079-1082).

3.3.1.2. Description of the Study Variables: The current study has made use of the data of the Iraqi Central Bank in the construction of a standard model. The adopted data under study are annual for the period 2004 to 2019. These variables will be expressed as follows:

- Reserved money will be briefly symbolized as M0.
- The net of the foreign assets at the Iraqi Central Bank (TA).
- Sterilization Policy (ST).

3.3.1.3. Determining the Degree of the Stability of Time Series Data:

The outcomes of the analysis of the time series under research has been clarified to determine their stability throughout time by conducting the tests of the unit root and determining the degree of their stability by using Diki Fuller expanded test. Table (2) demonstrates the outcomes of the tests of the unit root of the variables under study. It is evident from Table (2) that according to Diki Fuller expanded test, the time series of the variables (the net of the foreign assets at the Iraqi and Central Bank and reserved money) does not give a stationary degree aligned in level. In other words, it contains the unit root and becomes aligned after taking its second difference. This indicates that it is integrated of the second degree (Ibn Al-Dhab et al., 2017: 221-224).

Table (2): A Summary of the Results of Diki Fuller Expanded test of the Stability of the Chronological Series of the Period (204-2019)

The Result	The Tabulated Value ADF	The Calculated Value ADF	The Variables
	At the significant degree 0.05		
Stable at the second difference	3.212696 -	- 3.405770	The Total of the Foreign Assets at the Central Bank (TA)
Stable at the second difference	1.982344-	2.553443-	The Stand by Funds (M0)

Source: The researcher's work depending on the outcomes of the EViews 10

3.3.1.4. Determining the Prediction Rank: This stage witnesses the identification of the modal's degrees or ranks AR(p) and MA(q) respectively through the two functions of the partial and simple autocorrelation after the series stability. To generalize the regression Model AR (1), we use AR(p). The

number within the brackets represents the degree of the autoregression process. For example, AR (2) will be of the second degree and take the following form

$$Y_t - \partial = a_1(Y_{t-1} - \partial) + a_2(Y_{t-2} - \partial) + u_t$$

This means Y_t follows an autoregression of the second degree or the AR (2) operation. In other words, the value Y at the time t depends on its value in the previous period by two periods. Also, AR(p) will be an autoregression of the degree P and as follows:

$$Y_t - \delta = a_1(Y_{t-1} - \delta) + a_2(Y_{t-2} - \delta) \dots + a_p(Y_{t-p} - \delta) + u_t$$

And the Moving Average Model MA(q) in its simplest form is of first degree and as follows:

$$Y_t = u + B_0 u_t + B_1 u_{t-1}$$

as u is stationary. The MA(1) model of the moving average implies that Y_t as a dependent variable depends on the value of the current random variable as an interpreting variable. This is illustrated by Table (3):

Table (3): Determining the Prediction Rank of Reserved Money Variable

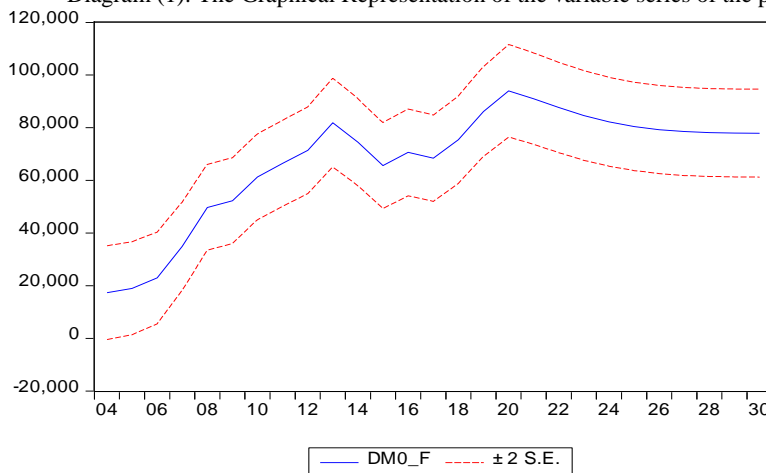
Dependent Variable: D(DM0)				
Method: ARMA Maximum Likelihood (BFGS)				
Date: 03/25/20 Time: 14:50				
Sample: 2007 2019				
Included observations: 13				
Convergence achieved after 10 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-99.20840	656.3314	-0.151156	0.8841
AR (1)	-0.638267	0.455997	-1.399717	0.2043
AR (2)	-0.821899	0.427202	-1.923910	0.0958
AR (3)	-0.305254	0.399539	-0.764015	0.4698
AR (4)	-0.669942	0.255130	-2.625882	0.0341
SIGMASQ	32110182	22300830	1.439865	0.1931
R-squared	0.819336	Mean dependent var		98.69231
Adjusted R-	0.690290	S.D. dependent var		13876.06
S.E. of regression	7722.253	Akaike info criterion		21.37299
Sum squared	4.17E+08	Schwarz criterion		21.63374
Log likelihood	-132.9244	Hannan-Quinn criter.		21.31940
F-statistic	6.349176	Durbin-Watson stat		2.205683
Prob(F-statistic)	0.015507			
Inverted AR	.32+.78i	.32-.78i	-.64+.73i	-.64-.73i

Source: Researchers' Work depending on the outcomes of the Eviews10.

It is noticed from the contents of Table (3) that the rank is (ARIMA (4 ,2 ,0) as the degree of autoregression is AR= (4), the degree of moving averages is MA= (0) and we have already known the integration degree, namely (2) which means its stability at the second difference. It is also noticed that the partial and total significance are good according to the t-test as it reached (-2.625882) and the F-test as it reached (6.349176). The probability of each one of them is less than significant level (0.05) which means that the null hypothesis is rejected and the

alternative hypothesis is accepted as both coefficients have statistical significance. As for the coefficient R2 which represents the correlation force and effect, it equals 0.81 as it is illustrated in the table above; i.e., 81%, the interpreted and clarified percentage and 19% which is interpreted by factors other than those listed in the model and which includes the random variable or errors in estimation. The following graphical diagram shows the prediction of the variable of Reserved money in the Iraqi economy to 2030.

Diagram (1): The Graphical Representation of the variable series of the predicted reserved money and residuals



Forecast: DMO_F	
Actual: DMO	
Forecast sample: 2004 2030	
Included observations: 27	
Root Mean Squared Error	15195.49
Mean Absolute Error	12324.93
Mean Abs. Percent Error	23.11827
Theil Inequality Coefficient	0.114505
Bias Proportion	0.344633
Variance Proportion	0.030782
Covariance Proportion	0.624585
Theil U2 Coefficient	1.050028
Symmetric MAPE	19.88177

Table (4): Determining the prediction rank of the variable of the total of foreign assets at the Iraqi Central Bank

Dependent Variable: D(DTA)				
Method: ARMA Maximum Likelihood (BFGS)				
Date: 03/26/20 Time: 08:30				
Sample: 2007 2019				
Included observations: 13				
Convergence achieved after 10 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.40042	0.723841	14.36839	0.0000
AR (1)	1.631745	0.210011	7.769803	0.0000
AR (2)	-0.694948	0.183046	-3.796580	0.0025
SIGMASQ	0.040240	0.019658	2.046943	0.0632
R-squared	0.884713	Mean dependent var		10.82619
Adjusted R-squared	0.855891	S.D. dependent var		0.610170
S.E. of regression	0.231631	Akaike info criterion		0.370849
Sum squared resid	0.643835	Schwarz criterion		0.563996
Log likelihood	1.033211	Hannan-Quinn criter.		0.380739
F-statistic	30.69592	Durbin-Watson stat		2.521315
Prob(F-statistic)	0.000007			
Inverted AR Roots	.82-.17i	.82+.17i		

It is noticed from the contents of Table (4) that the rank is ARIMA (2, 1, 0) as the degree of autoregression is AR= (2) and that the degree of moving averages is MA= (0) with the integration degree previously known which is (2). This means that it is at the second difference. The full and partial significance is good based on the t-test, as it is (-3.796580) and the F-test (30.69592). The probability of each one of them is less than the significance level (0.05). Accordingly, the null hypothesis is rejected and the alternative hypothesis is accepted, which also means that both coefficients have

statistical significance. As for the restriction coefficient R2 which represents the correlation force and impact, it equals 0.88 as it is demonstrated in the table above, namely 88% which represents the interpreted and clarified percentage. As for the 12%, it is interpreted by other factors unlisted in the model which comprises the random variable or errors in estimation. The following graphic diagram demonstrates the prediction of the variable of the total of the foreign assets at the Central Bank to 2030.

Diagram (2): The Graphic Representation of the Series of the Variable of the predicted Total Foreign Assets at the Central Bank and the residuals.

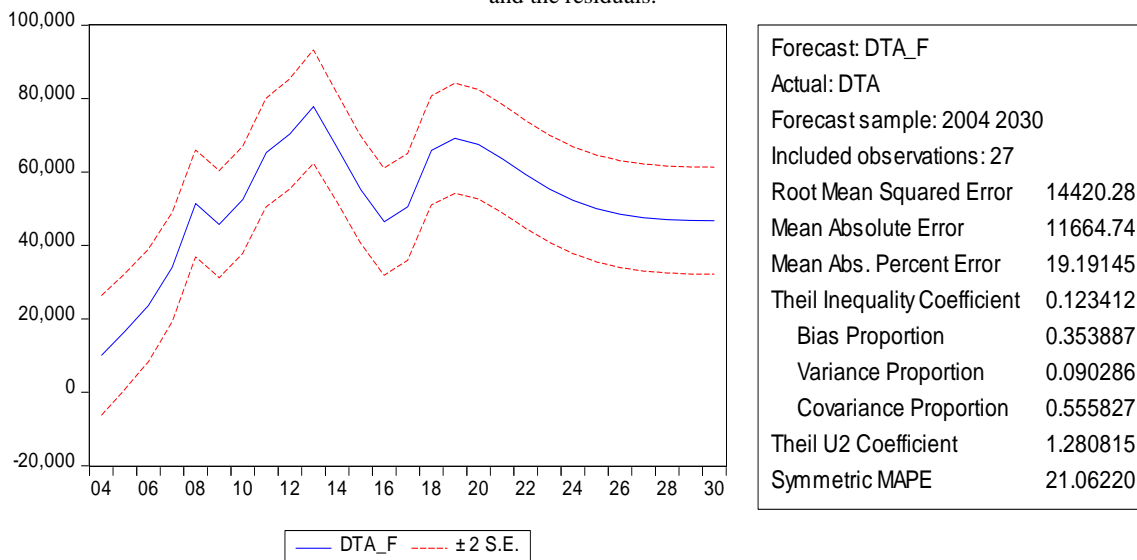


Table (5): The Direction of the Variable of reserved money and the total of the Foreign Assets at the Iraqi Central Bank until 2030 by Using ARIMA Model.

Sterilization Policy	The Net of Foreign Assets at the Central Bank (Billion Dinar)	Reserved Money (Billion Dinar)	Years
0.92	77,899.04	84,707.06	2020
0.90	73,337.82	81,872.53	2021
0.87	68,236.82	78,702.55	2022
0.84	63,638.70	75,845.09	2023
0.82	59,969.21	73,564.72	2024
0.80	57,294.14	71,902.31	2025

0.79	55,496.48	70,785.17	2026
0.78	54,388.94	70,096.90	2027
0.77	53,778.42	69,717.50	2028
0.76	53,497.90	69,543.17	2029
0.76	53,417.82	69,493.40	2030

From the preceding table and by using the model that determines every variable according to the ARIMA models, the directions of the variables have been predicted. After modifying the time series and making them stable, we could arrive at the future values of the variables until 2030.

3.3.2. Predicting the Impact of the Sterilization Policy on the Reserved Money in Iraqi Economy to 2030 by Using ANN Model

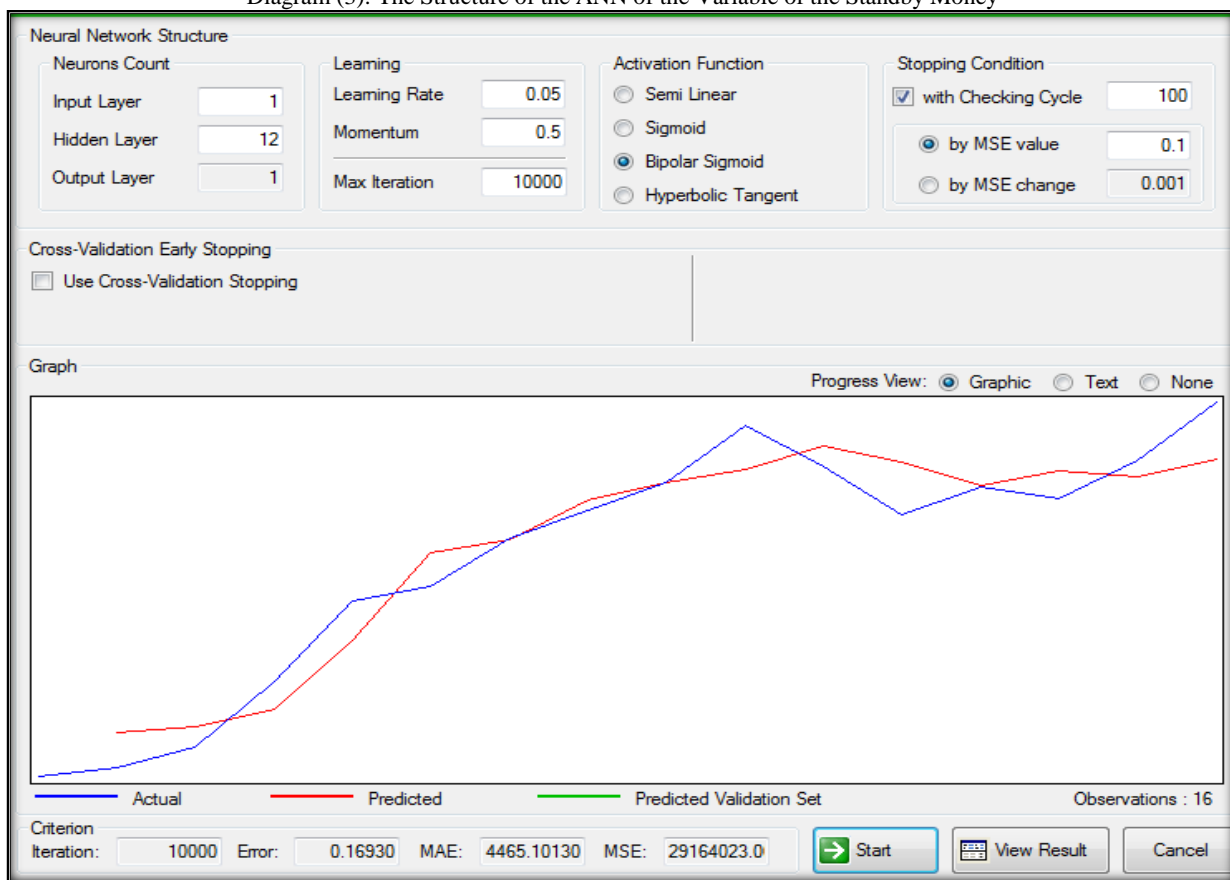
For the purpose of predicting the impact of the Sterilization policy on the reserved money in Iraqi Economy to 2030, the ANN model has been applied by using Zaitun Time Series

program. As such, the stage of constructing the ANN goes through the following stages to get the future predictions:

3.3.2.1. The ANN Construction Stage: The order specific to the ANN has been selected from the analysis list and the operation specific to performance of the ANN tool which contains. The structure of neural networks has been obtained as in the following diagram.

From the contents of the diagrams (3) and (4) the ANN structure is chosen and as follows:

Diagram (3): The Structure of the ANN of the Variable of the Standby Money



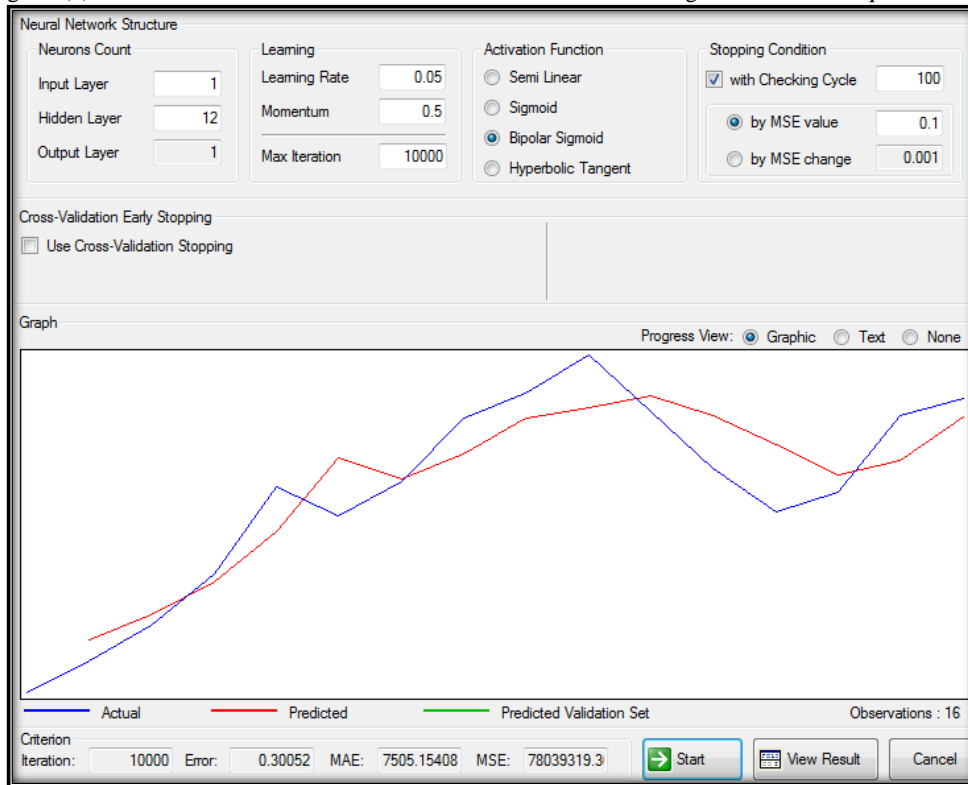
Source: Researchers' Work depending on the outcomes of the Zaitun Time Series.

For the neurological cells, the following parameters and hyperparameters have been determined:

- The number of input layers is (1).
 - The number of Hidden letters is (12).
 - The number of output layers is (1) which has automatically determined the predicted variable.
- As for training, it has determined the following:
- Determining learning rate (0.05).
 - Determining Momentum (0.5).
 -

- Maximum Iteration (10000).
- As for Stopping conditions, the following parameters have been determined:
- Auto determination of each 100 cycles.
 - Determining the value of the average of the error square (0.1).
 - Determining the variation of the average of the error square (0.001).

Diagram (4): The Structure of the ANN of the variable of the total of foreign assets at the Iraqi Central Bank



Source: Researchers' Work depending on the outcomes of the Zaitun Time Series.

3.3.2.2. The Stage of Initiating the Training Operations: At this stage, we set out to initiate the training operation and follow up the indicator of the average of the error square. After

repeating the operation for several times, we could arrive at a lesser indicator of the average of the error square, as it is illustrated in the following table.

Table (6): Summary of the Training Results

The variable of the total of foreign assets at the Central Bank		Reserved Money Variable	
Value	Criterion	Value	Criterion
8833.98	Root Mean Squared Error (RMSE)	5400.37	Root Mean Squared Error (RMSE)
7505.15	Mean Absolute Error (MAE)	4465.10	Mean Absolute Error (MAE)

Source: Researchers' Work depending on the outcomes of the Zaitun Time Series.

3.3.2.3. Prediction Stage: It is the last stage throughout which the ANN is for the purpose it has been constructed for

prediction. The preceding model has given future predictions till 2030 as illustrated in the following table.

Table (7): The variable direction of reserved money and the total of foreign assets at the Iraqi Central Bank till 2030 using ANN Model

Sterilization Policy	The total of foreign assets at the Iraqi Central Bank (1 billion Dinar)	Reserved Money (1 billion Dinar)	Years
1.03	76797.7068	74,222.3085	2020
0.80	59611.2914	74,168.9491	2021
0.66	48997.3477	73,524.0423	2022
0.84	57143.7025	67,589.0865	2023
1.04	75676.2056	72,370.6955	2024
1.13	85653.9870	75,349.6834	2025
1.04	79121.8406	75,702.4258	2026
0.79	61274.4823	77,537.3158	2027
0.59	46086.0801	76,903.6132	2028
0.67	51097.2602	75,428.3858	2029
0.99	75884.1275	76,167.5969	2030

Form the preceding Table and by using the model for determining every variable according to ANN model, the

directions of the variables have been predicted. After modifying the time series and stabilizing them, the future values of the variables until 2030 have been arrived at.

4. Comparing Results of ARIMA and ANN models

This section Compares the results obtained from Autocorrelation and Integrated Moving Average Model (ARIMA) with the Artificial Neurological Networks models. To compare between the two methods, the statistical criteria,

namely Root Mean Squared Error (RMSE), Mean Absolute Error (MAE) have been adopted so as to present a suitable model, as demonstrated by the following table.

Table (8): Comparison Between ARIMA model and ANN Model

Variable of the Total of Foreign Assets at the Central Bank		Money Variable Reserved		Model
(MAE)	(RMSE)	(MAE)	(RMSE)	
11664.74	14420.28	12324.93	15195.49	ARIMA
7505.15	8833.98	4465.10	5400.37	ANN

From the contents of Table (8), it is evident that the ANN method surpasses the ARIMA method due to the fact that ANN method has a lesser value of the statistical criteria to differentiate between the models. Based on this, it can be stated that the ANN is more suitable for the prediction operation of the chronological series of the variables throughout the period of the study.

5. Conclusions

- Due to the central exchange operations represented by the movement of the assets elements and the discounts in the public budget of the Central Bank of the importance of the international and financial position, there will be an operation of creating money in a yield economy where the oil finance evades the monetary basis and in such a way that leads to the intervention by the monetary authorities in the sterilization policy depending on the sum of assets, whether monetary or nonmonetary, the sum of the liabilities, the net of due capital either in the form of monetary demand or the net of the due capital including the capital.

- The main goal of the sterilization policy is that Central Bank lends a part of the excessive liquidity and its accumulation in the public budget in the form of demand for interest, and sometimes with the raising of the rates of the obligatory reserves. When the Central Bank intervenes in the exchange market by purchasing the foreign currency from the Government, and then starting the sterilization policy of the impact of the governmental expenditure on the fund offer, yet by three channels represented by the rates of the obligatory reserves and keeping them at the Central Bank, Selling the foreign currency to the private sector from the currency sale so as to withdraw a part of the liquidity and finally the facilitation of the bank deposits at the Central Bank by offering orders to the banks by auction.

- On comparing the models of predicting the sterilization policy in the Iraqi economy, it is evident that the ANN method surpasses the ARIMA model as the ANN has the statistical criteria of the least prediction error. As such, the ANN method is superior in terms of predicting the chronological series of the sterilization policy adopted in Iraq. Based on this, such models can be of benefit in terms of prediction so as to set the future plans, draw the policies, and take the suitable decisions in the light of predicting the variables that affect the sterilization policy and are represented by the foreign reserves and reserved money.

- Activating other channels of the sterilization policy by establishing a system to manage the money of the public budget of the government by means of monetizing the oil revenues by dollar by its monetary excesses in ID at the Central Bank in a special account by coordinating between the two policies on the condition that this will be counterpartyed by facilitations for the financial policy provided by the Central bank without resorting to the issuance of orders specific for the Central Bank which takes over the costs of its benefits.

- The sterilization policy proves effective in minimizing the local credit; which means absorbing the liquidity excess and not decreasing the banking credit, but the opposite. As such the activation of a market for the debt stocks is required so as to achieve the financial depth by means of the open market operations though the method of selling and buying the tools of the governmental debt in order to control liquidity or through the agreement of repurchasing or the opposite repurchasing.

- On adopting sterilization in the presence of the oil financial control over the monetary basis, and the government is the source of the foreign currency, there should be careful follow up of the traces of the financial discipline at the level of effective overall demand compared to its effect on the rates of poverty and unemployment. As such, there should be compromise when sterilization is adopted and the effect of that on the overall economic variables.

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التنبؤ بأثر سياسة التعقيم على النقود الاحتياطية في الاقتصاد العراقي لغاية 2030 باستخدام نماذج ARIMA و (ANN)

الملخص:

أن قيام البنك المركزي باقتراض جزء من السيولة الفائضة ومراكمتها في ميزانيته العمومية بصفة مطلوبات عليها بفائدة ، واحيانا مع رفع نسب الاحتياطيات القانونية ، وكذلك تدخل البنك المركزي في سوق الصرف من خلال شراء العملة الأجنبية ، ثم امتصاص أثر هذا الشراء على السيولة المحلية اضافة الى تسهيلات الايداع للمصارف بفائدة ، وعرض حالات البنك المركزي على المصارف في السوق الثانوية تسمى جميعها بسياسة التعقيم (Sterilization)، والتي تظهر بوضوح من خلال تحجيم الائتمان المحلي، ويهدف السيطرة على السيولة الفائضة ، ثم دراسة العوامل المحددة لسياسة التعقيم النقدي والنقود الاحتياطية (Money Reserve)، لغرض التنبؤ الدقيق لمسار هذه المتغيرات النقدية لغاية عام 2030 بهدف الحفاظ على استقرار الاساس النقدي من أثر تغيرات اسعار النفط، وباستخدام نماذج التنبؤ لكل من نموذج الانحدار الذاتي والمتوسطات المتحركة (ARIMA) ونموذج الشبكات العصبية الاصطناعية (ANN)، اذ يشير النمو في الانفاق الحكومي سببه تنقيد الايرادات النفطية والذي سبب عجز مالي بنيوي في الاقتصاد العراقي ، والذي يجب ان يقيد بسياسة التعقيم عبر ادوات السياسة النقدية، لذلك فان توازن الموازنة في اقتصاد ريعي يعتمد على النفط لا يضمن له الاستقرار الاقتصادي بشرط ان يدار الانفاق العام بقدر من الاستقلال عن تقلبات اسعار النفط .

الكلمات المفتاحية: سياسة التعقيم، النقود الاحتياطية، الاحتياطيات الفائضة، العملة المصدرة، نموذج الانحدار الذاتي والمتوسطات المتحركة، ونموذج الشبكات العصبية الاصطناعية)

بيشبينيكينا كارتنيكرنا سياسة ستيريزاسيونى ل سهر درافى يدهك ل نابوروى يا عراقى دا، تا سالا 2030 بكارثينا موديلين ARIMA و ANN.

پۆخته:

په نابرينا بانكا ناوهندى بو ب قهرزكرنا بهشكى ژ درافى زنده وكومكرنهفهى يا وئ ل بودجا خواهيا گشتى دا ب شيويهى داخاركاريان كو سوود ل سهره ، وهندهك جارن ل گهل بلنديكرنا ريژه بين ياسايى بين يدهكى ، ههروهسا مايتيكرنا بانكا ناوهندى ل بازارى مهزاختنى دا ب رىي يا كرينا درافى بياني، كاريگهري يا وئ كرينى ل سهر درافى نافخويى هاته بكارثينا زنده بارى ئاسانكارين دانانا درافى ل ناؤ بانكا دا ل بهرامبه سوودا بانكى، ونيشاندانا سويفتين بانكا ناوهندى ل سهر بانكان ل بازارى لاوهكيى دا دبئنه فئ هه ميبى سياسهتا ستيريزاسيونى (sterilization)، كوب روونى ديار دببت ب رىي يا سنوورداركرنا دلنيابوونا نافخويى، وب ئارمانجا كونترولكرن ب سهر درافى زنده، ئه فاكته رين كارتنيكرنى ل سياسهتا ستيريزاسيونا درافى ودرافى يدهك دهن (Reserve Money)، بومه بهستا پيشبينيكينه كا هوير بو ريجهيا ئه فان گوزاوين درافى تا سالا 2030 ب ئارمانجا سه قامگرى يا سهرهكى يا درافى ژ كارتنيكرنا گوهورينين بهايين نهفتى، وب رىي يا بكارثينا موديلين پيشبينيكينى بو ههر ئيك ژ موديل خويهتى وتيكرابين لفوك (ARIMA) وموديل تورين دهستكر بين دهمارگهري (ANN)، دبئته دياركرن كو ئه گهري گهشه كرنا مهزاختين حكومى ژ بهر مونه تيكرنا داماتين نهفتى كو بوويه ئه گهري كورتهينا دارابى يا زيخانه يى ل نابوروى يا عراقى دا، كو پيدفى به ب سياسهتا مونه تيكرنى فه بهيته گرندان ب رىي يا ئالافين سياسهتا درافى، له ورا هه فسه نگيا بودجى ل نابوروى يا مولكانه يى دا پشتبه ستنى ب نهفتى دكهت گه رهننى يا سه قامگرى يا نابوروى ناكهت ب مه رجهكى كو و بداره دانا مهزاختين گشتى بهيته كرن تا راده يهكى ب سهره خوى ژ گوهورينين بهايين نهفتى.

په يقين سهرهكى : سياسهتا ستيريزاسيونى، درافين يدهك، يدهك زنده، درافى هناردهر، موديل لادانا خويهتى وتيكرابين لفوك، موديل تورين دهستكر بين دهمارگهري.