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MODELING AND FORECASTING WAR EFFECTS ON MACRO ECONOMICAL VARIABLES OF IRAN

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1. ABSTRACT

In this study, we aim to evaluate effects of the 8-year war between Iran and Iraq (1980-1988) on economical indices of Iran .The underlying objective of the paper is to provide support for a model that predicts these macro economical variables with the GMDH-neural network method. The macro economical variables that we analyzed include: gross domestic production (GDP)-investment – consumption- inflation- interest rate– net export- government budget .The results indicate that investment decreased, export was less than import therefore net export was negative, consumption in staple goods increased. Also, real interest rate increased and nominal interest rate decreased, government had deficit spending and finally, GDP reduced.

JEL codes: C53-C45-E27

Key Words: *modeling and forecasting – macro economic variables- GMDH_ neural network*

2. INTRODUCTION

War is a phenomenon with a lot of burden on Economy, human livelihood, health, culture, level of development and technology and some of the other subjects in these fields. One of the most important consequences of the war is its effects on economic structures of different societies. Thus prediction and modeling of war effects on economical indexes of a country is very important and definitely is so effective on decisions of government and politicians and for predicting same situation. The 8_year war between Iran and Iraq had great influences on Iran economy along with the macro economical variables changes. In this paper we analyzed these changing, modeled and predicted these macro economical variables with method GMDH-neural network.

3. METHOD AND MATERIAL

Through GMDH algorithm, a model can be represented as set of neurons in which different pairs of them in each layer are connected through a quadratic polynomial and thus produce new neurons in the next layer. Such representation can be used in modelling to map inputs to outputs. The formal definition of the identification problem is to find a function $\hat{f}$ so that it can be approximately used instead of actual one, f in order to predict output $\hat{y}$ for a given input vector $X = (x_1, x_2, x_3, ..., x_n)$ as close as possible to its actual output y. Therefore, given *M* observation of multi-input-single-output data pairs :

(*i=1,2,…,M)*, (1)

it is now possible to train a GMDH-type neural network to predict the output values $\hat{y}_i$ for any given input vector $X = (x_{i1}, x_{i2}, x_{i3}, ..., x_{in})$, that is

$$\hat{y}_i = \hat{f}(x_{i1}, x_{i2}, x_{i3}, ..., x_{in}) \qquad (i=1,2,...,N). \qquad (2)$$

The problem is now to determine a GMDH-type neural network so that the square of difference between the actual output and the predicted one is minimised, that is

$$\sum_{i=1}^{N} [\hat{f}(x_{i1}, x_{i2}, x_{i3}, ..., x_{in}) - y_i]^2 \rightarrow \min$$

(3)

General connection between inputs and output variables can be expressed by a complicated discrete form of the Volterra functional series in the form of

$$y = a_0 + \sum_{i=1}^{n} a_i x_i + \sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} x_i x_j + \sum_{i=1}^{n}\sum_{j=1}^{n}\sum_{k=1}^{n} a_{ijk} x_i x_j x_k + ...$$

(4)

which is known as the Kolmogorov-Gabor polynomial . This full form of mathematical description can be represented by a system of partial quadratic polynomials consisting of only two variables (neurons) in the form of

$$\hat{y} = G(x_i, x_j) = a_0 + a_1 x_i + a_2 x_j + a_3 x_i x_j + a_4 x_i^2 + a_5 x_j^2$$

(5)

In this way, such partial quadratic description is recursively used in a network of connected neurons to build the general mathematical relation of inputs and output variables given in equation (4). The coefficient a_i in equation (5) is calculated using regression techniques , so that the difference between actual output, *y,* and the calculated one, $\hat{y}$, for each pair of x_i , x_j as input variables is minimized. Indeed, it can be seen that a tree of polynomials is constructed using the quadratic form given in equation (5) whose coefficients are obtained in a least-squares sense. In this way, the coefficients of each quadratic function G_i are obtained to Optimally fit the output in the whole set of input-output data pair, that is

$$E = \frac{\sum_{i=1}^{M} (y_i - G_i())^2}{N} \rightarrow \min$$

(6)

In the basic form of the GMDH algorithm, all the possibilities of two independent variables out of total *n* input variables are taken in order to construct the regression polynomial in the form of equation (5) that best fits the dependent observations

(y_i , *i=1, 2, …, N*) in a least-squares sense. Consequently, $\binom{n}{2} = \frac{n(n-1)}{2}$ neurons will be built up in the first hidden layer of the feed forward network from the observations { (y_i, x_{ip}, x_{iq}); (*i=1, 2, …, N*)} for different $p, q \in \{1,2,\ldots,n\}$. In other words, it is now possible to construct *N* data triples { (y_i, x_{ip}, x_{iq}); (*i=1, 2, …, N*)} from observation using such $p, q \in \{1,2,\ldots,n\}$ in the form

$$\begin{cases} a_0 + a_1 x_{1p} + a_2 x_{1q} + a_3 x_{1p} x_{1q} + a_4 x_{1p}^2 + a_5 x_{1q}^2 = y_1 \\ a_0 + a_1 x_{2p} + a_2 x_{2q} + a_3 x_{2p} x_{2q} + a_4 x_{2p}^2 + a_5 x_{2q}^2 = y_2 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ a_0 + a_1 x_{Np} + a_2 x_{Nq} + a_3 x_{Np} x_{Nq} + a_4 x_{Np}^2 + a_5 x_{Nq}^2 = y_N \end{cases}$$

Using the quadratic sub-expression in the form of equation (5) for each row of *N* data triples, the following matrix equation can be readily obtained as

$$A\mathbf{a} = Y \qquad (7$$

where $\mathbf{a}$ is the vector of unknown coefficients of the quadratic polynomial in equation (5)

$$\mathbf{a} = \{a_0, a_1, a_2, a_3, a_4, a_5\} \qquad (8)$$

and

$$Y = \{y_1, y_2, y_3, \ldots, y_N\}^T \qquad (9)$$

is the vector of output's value from observation. It can be readily seen that

$$\mathbf{A}=\begin{bmatrix} 1 & x_{1p} & x_{2q} & x_{1p}x_{1q} & x_{1p}^2 & x_{1q}^2 \\ 1 & x_{2p} & x_{2q} & x_{2p}x_{2q} & x_{2p}^2 & x_{2q}^2 \\ : & : & : & :: & : & : \\ 1 & x_{NP} & x_{Nq} & x_{Np}x_{Nq} & x_{Np}^2 & x_{Nq}^2 \end{bmatrix} \quad (10)$$

.

We used the data of central bank of Iran in this paper and we used them in logs because the trend is shown better in logs.

4. RESULTS

4-1) Modeling And Forecasting The Investment:

Table 4-1-1

NO	variables	Title
1	r	Interest rate
2	GDP	Gross domestic production
3	inf	Inflation
4	S	Saving
5	Xo	Oil export
6	Iup	Change of inventories
7	DI	Depreciation of investment
8	OP	Optimism
9	I-1	Investment in 1 term ago

Table4-1-2 output:

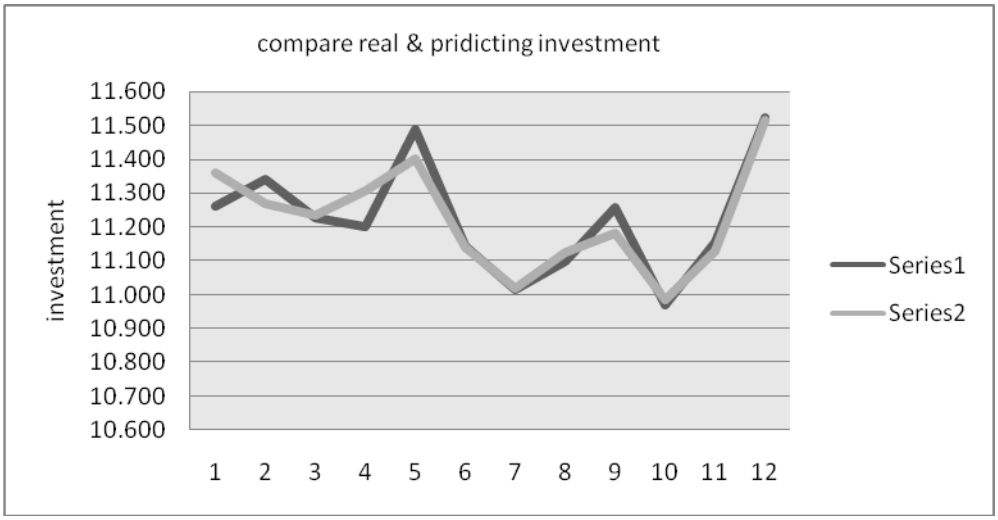
Omitted variables	Inf- S
Variables with double effect	DI- OP

RMSE[1]:3001.087**MAPE[2]:** 0.031211**Thile[3]:**0.149245

Note: Because the interest rate was obligatory during those years then we used the stock of money variety (ΔM) as a proxy for showing the trend of its variety.

1)Root mean square Error 2)Mean Average Percent Error 3)Thile In Equality CoefficientNote: Thile less than 0.55 means that the model has enough authoritative.

Figure4-1-1



4-2) Modeling And Forecasting The Consumption:

Table4-2-1

No	variables	Title
1	T	Tax
2	C-1	Consumption in 1 term ago
3	C-2	Consumption in 2 terms ago
4	GDP	Gross domestic production
5	W	Wealth

Table4-2-2 **Out put:**

Omitted variables	GDP
Variables with double effect	T- C-1 - W

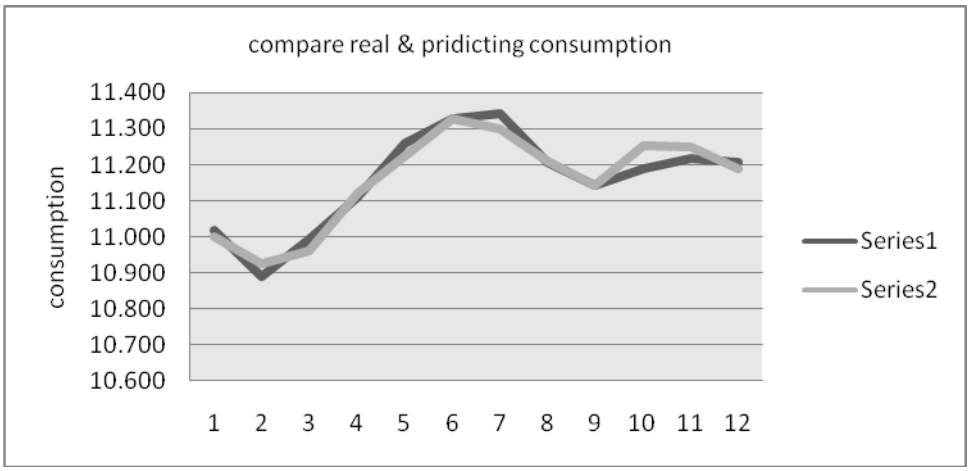
RMSE:0.035446

MAPE: 0.002443

Thile:0.836256

Note : Because of lacking in wealth statistics we used the amount of consumption of durable goods as a proxy for

Figure 4-2-1



4-3) Modeling And Forecasting The Government Deficit Spending:

Table4-3-1

NO	Variables	Title
1	OG	Operating cost of government
2	CG	Current cost government
3	TI	Tax income

4	OI	Oil income
5	OTI	Others incomes
6	GDP	Gross domestic production
7	PL	Private section liquidity
8	I	Investment
9	C	Consumption

Table 4-3-2 **Out put:**

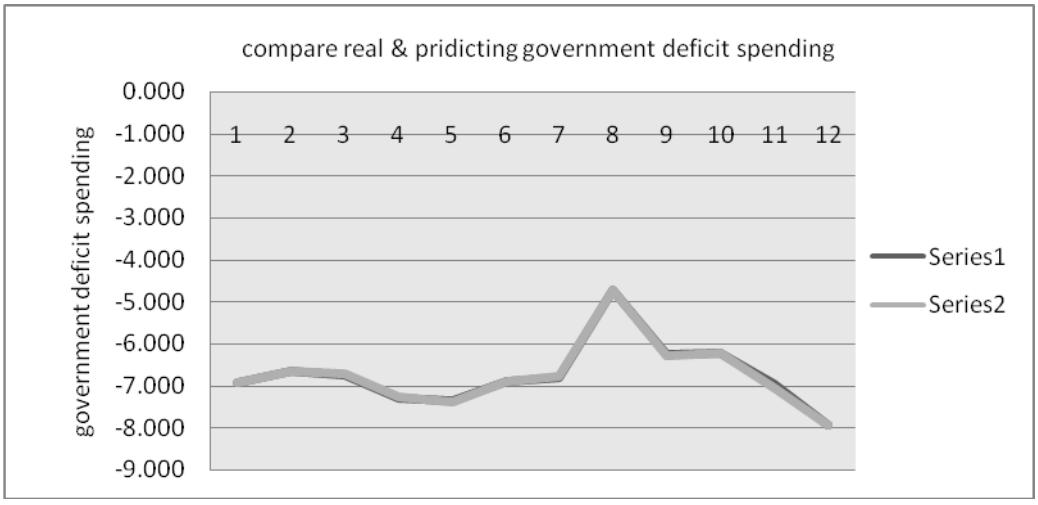
Omitted variables	CG- TI- I
Variables with double effect	OG- OTI

RMSE:0.04906065

MAPE:0.00414612

Thile:0.04971526

Figure 4-3-1



4-4) Modeling And Forecasting The Net Export:

Table 4-4-1 **Table 4-4-2Out put:**

No	variables	Title
1	X	Export
2	M	Import
3	OP	Oil price
4	OX	Oil export
5	NOX	Non-oil export
6	R	Exchange rate

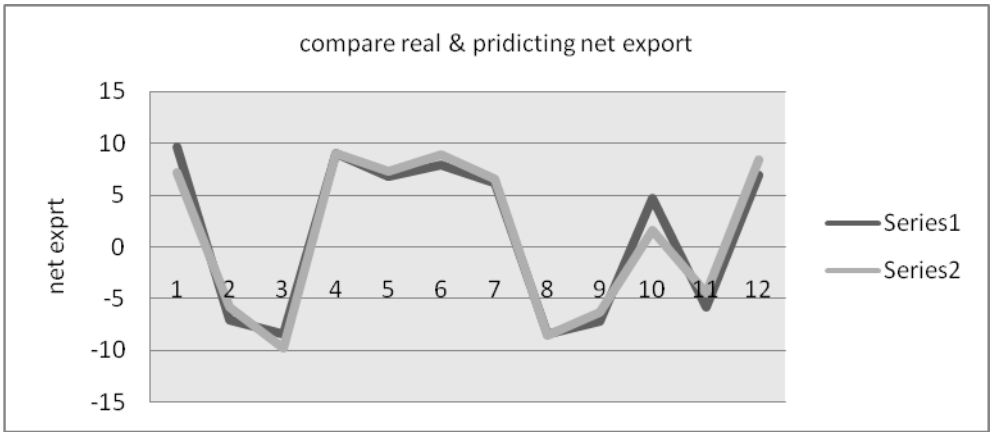
Omitted variables	X -M- OX
Variables with double effect	OP-NOX-

RMSE:1.864567296

MAPE:0.305967277

Thile:0.183045154

Figure 4-4-1



4-5) Modeling And Forecasting The Inflation :

Table 4-5-1 **Table4-5-2** **Out put:**

No	Variables	Title
1	GC	Growth of cost government
2	GL	Growth of liquidity

3	GI	Growth of investment
4	BD	Government deficit spending
5	GDP	Gross domestic production
6	S	Saving
7	V	Money circulation velocity
8	R	Exchange rate

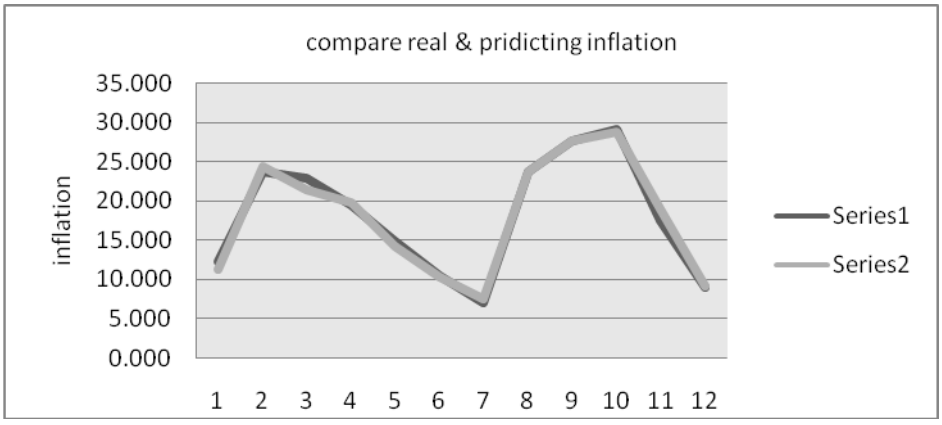
Omitted variables	GC- GL- S -V
Variables with double effect	BD-GDP- GI

RMSE: 0.831603237

MAPE:0.031580411

Thile:0.110999545

Figure 4-5-1



4-6) Modeling And Forecasting The Interest rate:

Table 4-6-1

No	Variables	Title
1	GMS	Growth stock of money
2	Inf	Inflation
3	GDP	Gross domestic production
4	S	Saving

Table 4-6-2 **Out put:**

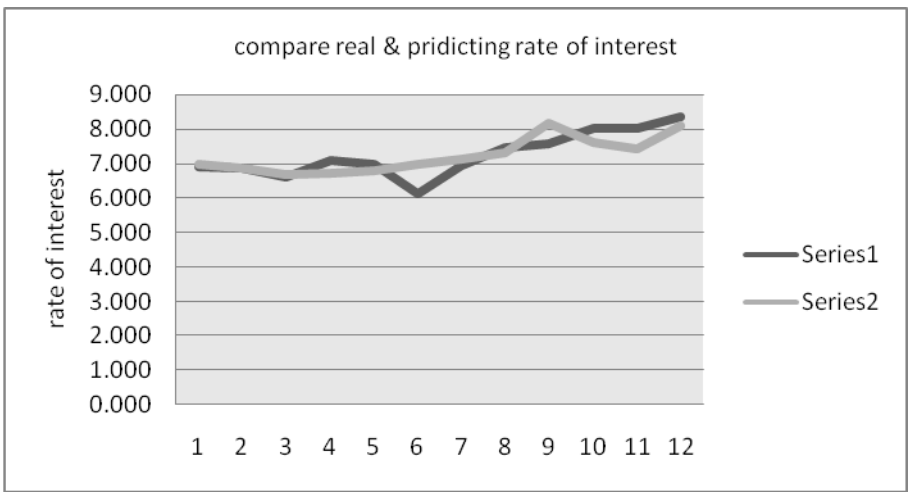
Omitted variables	S
Variables with double effects	GM- Inf – GDP

RMSE:0.480781594

MAPE: 0.057655409

Thile: 0.520665095

Figure 4-6-1



4-7)Modeling And Forecasting The Gross Domestic Production

Table 4-7-1Table 4-7-2 **Out put:**

No	Variables	Title
1	C	consumption
2	I	investment
3	G	Government cost
4	X	Export
5	M	Import
6	OP	Oil price
7	S	Saving
8	T	Tax

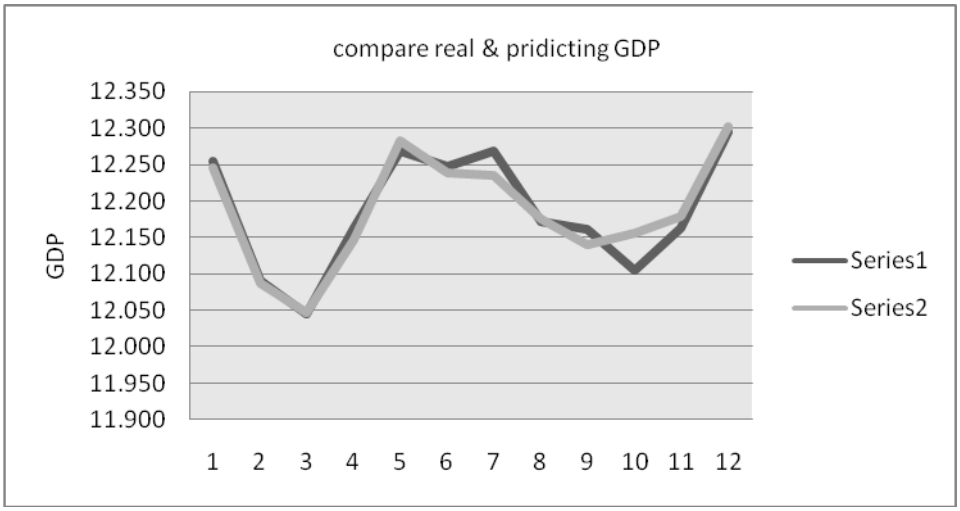
Omitted variables	OP- T
Variables with double effect	C- M-

RMSE: 0.029113635

MAPE:0.001984881

Thile: 0.375750855

Figure 4-7-1



5. DISCUSSION

5-1) During the war, depreciation of investment was caused by a double effect : the war and its destruction in the country . The kind of people's view about future is very important at each period of life for their investments. In each period that people don‘t have the optimistic view to future, they prefer to keep their money instead of investing them or they invest their money in foreign countries. In this model in view of the fact that people hadn‘t optimistic view to future and the augmentation of risk during the war the amount of investment decreased.

5-2) one of the most important variables that had double effect on consumption is tax. In those years government faced spending deficit so it got the more tax and it ,consequently, influenced people‘s consumption by reducing the disposable personal income. (the kind of their consumption was different from present condition ; the consumption in luxury goods decreased; we can say that the level of people expectancy was low in comparison with present condition) .And because of the rule consumption stickiness the amount of consumption follow consumption in some terms specially 1-term ago . In large supply, the consumption of staple goods increased with the view of restitution of some destruction of war, for example the needs for drugs and same services were augmented fast.

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5-3) Iran was at war with Iraq , so it had the urgent needs for armament .and the destruction of war was very large so it caused the augmentation portion of government cost ,especially in constructional cost (in striking that Iran could reduce their costs after each year during the war ,about 5 percent).

5-4) In the 8-year war between Iran and Iraq about 30countries imposed sanction on Iran .This problem had a large effect on Iran's foreign trade (**1**. Reduced U.S. and Non-U.S. export financing (no U.S. export financing from the U.S. Export-Import bank since 1990 **2**. Reduced IMF/World bank Financing 8 project dropped, valued $1 billion **3**. Reduced Tourism Receipts **4**. Impact on Iranian Economic Policies (high profile project with Japan and Europe that may not be always in Iran's best interest) 5. Non-participation of U.S. entities in Iran-Related Business and…)

The needs for some staple goods increased so in those days more import became necessity .In those years because of bad situation in Iran people invest their money in foreign countries so we saw the excess demand for foreign money that resulted in the augmentation of exchange rate that had negative effects on net export again. Because of those reasons, Iran experienced negative net export (NX) in all of that 8-years.

5-5) The augmentation of prices during the war was especially in demand-pull inflation because of the special situation in those years and this excess demand moved the AD-curve upper and brought with itself higher prices and we can see that after the war inflation increased again because the government was bigger than before the war and if government and his activities become larger one of its result is more inflation.

5-6) Often, when a country is at the war, it is its government which determines the nominal interest rate but it is different from the real interest rate. The real interest rate in those years was more than the nominal interest rate .The variables that affected it were growth stock of money-GDP and inflation that growth stock of money has the direct effect by move the LM-curve and GDP and inflation have indirect effects.

5-7) At the war, Iran's GDP reduced because the investment reduced. Import increased, export reduced, consumption increased and at last government cost increased (it didn't had the positive effect on augmentation for GDP because this augmentation on government cost was most in armament same services and the government provided most of those by import that the import has the negative effect on GDP). We can see its reduction in statistics too.

6. CONCLUSION

The results indicate that some variables have double effect on the indices and some of them have little effect on indices. Sometimes we can omit their effect in special period of time and the variables have not the same effect on the other variables at different situations .According to our models we can predict the amount of those variables in the same situation and that investment reduced , export was less than import therefore net export was negative, consumption in staple goods and real interest rate increased and nominal interest rate decreased, country faced government`s spending deficit and at last GDP decreased.

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