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Research Article

Using Artificial Intelligence Algorithms to Study the Relative Importance of Macroeconomic Variables on Foreign Trade in Iraq

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ABSTRACT

International trade is considered the central link in the complex system of contemporary international economic relations. It links all countries of the world in a unified economic system whose goal is to address economic problems at the international level through developing productive capacity, expanding employment opportunities, and enhancing the flow of production factors between countries to achieve economic growth. Our study aimed to clarify the considerable impact of some macroeconomic variables (exchange rate, gross domestic product, public spending, foreign direct investment) on foreign trade in Iraq and to determine the degree of relative importance of the macroeconomic variables affecting foreign trade in Iraq. The study followed the descriptive analytical approach by collecting data related to the study for the period from 2003 to 2020 and then analyzing the data obtained through artificial neural networks.

Keywords: Artificial Neural Network; Macroeconomic Variable; Gross Domestic Product; Foreign Direct Investment; Descriptive Analytical Approach.

1. INTRODUCTION

For any country, whether developing or developed, isolating itself from the outside world is impossible because the country's production materials may not be available or there may be a surplus at the level of its economic activity. Thus, they resort to exchanging trade with countries. This exchange is called foreign trade, which is considered the main artery that connects countries to each other; through foreign trade, integration and economic rapprochement among countries emerges (Abdelkarim and Ahmed, 2022).

Foreign trade is one of the oldest and most advanced models of relations among countries. It is one of the main components of global economic relations because it integrates the countries of the world into a single international economic system. Recently, the world has witnessed a series of rapid and radical developments that have clearly contributed to changing the characteristics of the political climate and the economic environment, which may be reflected in economic performance, especially foreign trade (Mhmood et al., 2021).

The importance of foreign trade for developing countries, including Iraq, is demonstrated by the inability of the production system to meet the requirements of individuals, such as consumer goods and investment goods, due to the imbalance occurring in its economic structure as a whole. Similar to other developing countries, Iraq suffers from a deficit in the availability of financial resources that it uses to finance its production and investment programs

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(Al-Masoudi, 2021). Despite the Iraqi economy's financial and human resources and capabilities, it suffers from the weak contribution of Iraqi economic sectors to foreign trade due to its dependence on oil exports (Sabar and Saeed, 2021). This dependence results in great interest in the foreign trade sector because of what this vital and important sector provides for the development of various economies. Here, we attempt to clarify through our research the considerable effect that some macroeconomic variables (exchange rate, gross domestic product (GDP), public spending, and foreign direct investment) have on foreign trade in Iraq, including the degree of significance of each of the chosen variables and the role it plays in enlarging or contracting the foreign trade sector, so that we may take advantage of the results in the future when developing and creating the necessary plans.

2. RELATED WORKS

- Zitouni, A.; Beddiar, A. 2022. The effect of the macroeconomic variables on the Algerian foreign trade volume during the period (1990–2019) using ARDL model. This study used annual data from 1990 to 2019 using the autoregressive lag (ARDL) model to examine the effects of macroeconomic variables on Algeria's international trade volume. The study concluded that the stock of foreign direct investment has a major long-term effect on the volume of foreign trade and that the volume of foreign trade in Algeria and the dinar's long-term exchange rate against the dollar have no link. The amount of national revenue and international commerce in Algeria also have a long-term link; however, no such association exists between the volume of public expenditures and foreign trade in Algeria.

- Mhmood, M.; Hassan, F.; Shihab, K. 2021. Measuring and analyzing the impact of some macroeconomics variables on the foreign trade in China during the period between 2000 to 2019. The goal of the study was to examine how various macroeconomic factors in China (e.g., GDP, inflation rate, economic growth rate, and dollar exchange rate) affect international trade, which is measured by exports and imports, between 2000 and 2019, by adopting econometric analysis. Stepwise multiple linear regression analysis was used. The research reached several results, including the presence of an effect of the variables of domestic capital investment and foreign investment on the development of foreign trade movement, the absence of an effect of exchange rate, inflation rate, and economic growth on the development of foreign trade, and the presence of an effect of the GDP variable in the development of foreign trade movement. If the variables proposed in the research are adopted independently and its effect on China's imports and exports is clear, investment in the domestic capital and the movement of foreign trade in China and in its GDP increases; that is, foreign investment is relatively stable. A decline occurred in the economic growth rate relative to the GDP for the period 2000–2019, as well as in the exchange rate of the dollar against the Chinese yuan.

- Khudair, M.; Abdullah, A. 2018. The impact of some macroeconomic variables on foreign trade in Iraq for the period (2001–2016). Using the ARDL self-regression model, the research aimed to quantify and assess the effect of a few macroeconomic variables on Iraq's foreign trade from 2001 to 2016. The findings demonstrated that the value of international trade is considerably affected by the exchange rate. This result indicates that the value of foreign trade increases by 35.11 million dollars at a significant level of 8% for every unit increase in the exchange rate by approximately 0.54 million dollars at a significant level of 1% for the GDP in a unit and within a year and by 1% at a significant level for public spending, which has the opposite relationship to the value of foreign trade over the course of the year. Moreover, an inverse relationship between public spending and foreign trade exists, meaning that a rise in public spending causes a decrease in foreign trade of 0.151 million dollars for every unit increase in the value of public spending. This relationship is not statistically significant; however, interest in foreign direct investment raises the value of foreign trade by 13.519 million dollars annually and at a significant level of 1%.
- Ibrahim, U. T. (2023). The impact of exchange rate fluctuations on the per capita share of foreign trade in Iraq for the period (2004–2022). The study aimed to know the effect and type of relationship between exchange rates and the per capita share of foreign trade and to clarify the extent to which the exchange rate affects the per capita share of foreign trade. A Markov model was used, and the switching system method was relied upon to estimate the regression equation using the (EViews 12) program to determine the impact of exchange rate changes on per capita foreign trade. The study concluded that increasing exchange rates by 1% in times of prosperity or rise leads to an increase in the per capita share of foreign trade by 0.87%. Increasing exchange rates by 1% in times of recession or state austerity leads to a decrease in exchange prices. Per capita foreign trade (3.4%)

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- Barzanji, K.; Ahmed, A. 2023.The impact of the change in the exchange rate of the US dollar on foreign trade in the Kurdistan region of Iraq 2016–2022. The study aimed to analyze the impact of changing the US dollar's exchange rate for international trade in Iraq's Kurdistan Region. Special data for the exchange rate for the period 2016–2020 was used in the analysis. The study used the descriptive analytical approach to examine the causal relationship between international commerce in the Kurdistan Region of Iraq and the US dollar exchange rate. The study reached several results, the most important of which are the existence of a causal relationship in both directions, that is, between exports and the US dollar exchange rate, between imports and the US dollar exchange rate, between the trade balance and the US dollar exchange rate, between imports and exports, and between the trade balance and exports.

The present study is similar to previous studies in studying the impact of some macroeconomic variables on foreign trade, while it differs from previous studies in its use of artificial neural networks in studying the impact of economic variables on foreign trade, whereas previous studies used statistical and measurement methods.

3. CONCEPTUAL FRAMEWORK OF THE STUDY VARIABLES

- GDP: The GDP is an indicator of the value of services and goods that were produced within a certain geographical area. It is not a measure of the overall well-being of individuals or the country as a whole. However, it can help in making informed economic decisions by linking the various aspects of the economy to the labor market and the supply of work (Khudair, 2012).
- Foreign trade: It is the circulation of capital, goods, and services across international borders or territories. It constitutes a large proportion of the GDP in most countries (Popkova, et al., 2017).
- Exchange rate: It is the trade of one unit of a foreign currency for one unit of the local currency. The relationship between imports and exports is reflected in the exchange rate, which serves as a bridge between the domestic and international economies. The rate of exchange between local and international money units is known as the exchange rate. (Mohsen, 2018).
- Public expenditure: It is the axis upon which the analysis and determination of levels of aggregate demand in the economy are based. Therefore, it is the motivating and balancing variable at the same time for the macroeconomic management model; thus, it is the most important factor. It has an impact on determining the trends and on the national economy (Ben Inaya, 2005).
- Foreign direct investment: It refers to investment that is made outside its home country, whether directly or not, whether it is owned by a state, a company, or several companies, as investments flow from one state to another in search of the greatest return and lower risks according to the investment climate and political and economic risks (Baadash, 2008).

4. PROPOSED METHODOLOGY

4.1 Study Problem

The problem focuses on the weak contribution of the Iraqi economic sectors to foreign trade and their dependence on a single product (oil) and the extent of the possibility of the studied economic variables in achieving export-oriented production. The problem can be formulated with the question of how the studied macroeconomic variables affect the volume of foreign trade in Iraq.

4.2 Importance of the research

The research aims to clarify the relative importance of macroeconomic variables on foreign trade in Iraq and to analyze the various macroeconomic factors that affect foreign trade and their relationship with each other. It was conducted to determine if these factors can help improve the flow of foreign trade. The research also aims to identify the degree to which these factors can influence the trade activity of other countries.

4.3 Study methodology

To achieve the objectives of the study, we collected data related to the study variables from the Iraqi Statistical Collection and the World Bank and analyzed them using artificial neural networks as one of the artificial intelligence algorithms. SPSS was used to obtain the results. Artificial neural networks, which are considered one of the modern techniques through which the impact of variables and their relative importance can be studied, were used. In addition, artificial neural networks can address the problem of nonlinearity that plagues economic models relying on statistical and economic methods in analyzing and interpreting the relationship of variables(Aljubayli, 2022). Furthermore, it can predict time series better than other artificial intelligence algorithms.

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4.4 Artificial neural networks

The idea behind artificial neural networks, one of the most remarkable artificial intelligence techniques, is to use computers to simulate the human brain's capacity to recognize patterns and distinguish between objects. This method is performed by simulating the brain's self-learning process, which builds on previous experiences to produce the best results in the future (Abiodun, et al., 2018).

4.5 Learning an artificial neural network

Learning an artificial neural network is the process by which a neural network changes itself while being trained to provide the desired results. In other words, it is the process of learning, where the neural network looks for information from a sample dataset. The network then modifies connection weights based on incoming inputs until the outputs it is aiming for are reached (Raza and Khosravi, 2015).

5. RESULTS AND DISCUSSION

The research aims to clarify the relative importance of macroeconomic variables on foreign trade in Iraq on the basis of the annual time series data for the period 2003–2020, as shown in Table 1.

TABLE I. GDP DURING THE PERIOD 2003–2020

Year	Foreign trade	Exchange rate	GDP	Public spending	Foreign direct investment
2003	13036.8	1936	64736.5	16659.62	1000
2004	23705.9	1453	99796.3	31521	300
2005	47229.4	1469	104188	30831	515.3
2006	50563	1467	114771.6	37494	383
2007	60319.8	1255	116352.7	39309	971.8
2008	98808.6	1193	125926.3	67277	1855.7
2009	77008.4	1170	130181.8	55589	1598.3
2010	95679	1170	138516.7	70094	1396.2
2011	127484	1170	148969.8	78758	2082
2012	153215	1166	169730.9	105139	3400
2013	149117	1166	180885.9	119128	5131.4
2014	132116	1166	182152.1	83556	4781.8
2015	101320	1167	190895.4	70397	3468
2016	85120	1182	211893.9	67067	3951
2017	91600	1190	221665.8	75490	2838
2018	122132	1190	268918.9	80873	2851
2019	104004	1190	277884.9	111728	2117
2020	63291	1190	198774.3	76083	16172.2

Source: Iraqi Statistical Group 2020–2021 https://cosit.gov.iq/ar/https://data.albankaldawli.org/

5.1. Proposed Artificial Neural Network Model:

This model predicts the size of the impact or importance of macroeconomic variables (exchange rate, GDP, public expenditure, and foreign direct investment) on foreign trade through artificial neural networks according to the following stages:

- **Description of the artificial neural network model and division of the study sample**: Given that the quality of the model depends on the consistency of the results between the test sample and the training sample, segmenting the study sample is regarded as one of the most crucial steps in developing the artificial neural network model. At this point, the study sample was split up, as shown in Table 2:

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TABLE II. DIVISION OF THE STUDY SAMPLE

Case Processing Summary			
		N	*Percent*
Sample	Training	13	72.2%
	Testing	5	27.8%
Valid		18	100.0%
Excluded		0	
Total		18	

Table 2 shows that the training sample includes 72.2% of data, and the test sample includes 27.8% of data.

- **Building the database**: To prevent any distortion in the distribution of the data that could result in heterogeneity of the input values and a large average square error, the data have been converted to standard values instead of their natural values.
- **Determining the criteria and structure of the study model**: The model's inputs, outputs, number of hidden layers, and nodes were all established at this stage. Layers were separated into the following: The study's variables, represented by four nodes in the first layer's inputs, are the study's independent variables (exchange rate, GDP, public spending, and foreign direct investment). Each layer in the hidden layer has a single node. One node was placed in the output layer to represent foreign trade in accordance with Table 3.

TABLE III. : NETWORK STRUCTURE

<table>
<tr><td rowspan="6">Layer of Input</td><td rowspan="4">Covariates</td><td>1</td><td>Exchange rate</td></tr>
<tr><td>2</td><td>GDP</td></tr>
<tr><td>3</td><td>Public spending</td></tr>
<tr><td>4</td><td>Foreign direct investment</td></tr>
<tr><td colspan="2">No. of Units</td><td>4</td></tr>
<tr><td colspan="2">Method of Rescaling for Covariates</td><td>Standardized</td></tr>
<tr><td rowspan="3">Hidden Layer(s)</td><td colspan="2">Quantity of hidden layers</td><td>1</td></tr>
<tr><td colspan="2">Unit Count in the Hidden Layer 1[a]</td><td>2</td></tr>
<tr><td colspan="2">Function of Activation</td><td>Tangent Hyperbolic</td></tr>
<tr><td rowspan="5">Output Layer</td><td>Variables That Depend</td><td>1</td><td>Foreign trade</td></tr>
<tr><td colspan="2">Unit Count</td><td>1</td></tr>
<tr><td colspan="2">Method of Rescaling for Scale Dependents</td><td>Standardized</td></tr>
<tr><td colspan="2">Function of Activation</td><td>Identity</td></tr>
<tr><td colspan="2">Function Error</td><td>The sum Squares</td></tr>
</table>

The network is trained several times to arrive at the appropriate model that provides accurate predictions. Table 4 shows foreign trade forecasting using artificial neural networks.

TABLE IV. TABLE (3): PREDICTION RESULTS USING NEURAL NETWORKS

Foreign trade	**Year**	**Foreign trade**	**Year**
142345	2012	9603	**2003**
144351	2013	43545	**2004**
126583	2014	40383	**2005**
103842	2015	40847	**2006**
87759	2016	56811	**2007**
106888	2017	100455	**2008**
101228	2018	76973	**2009**
118521	2019	110642	**2010**
71455	2020	126412	**2011**

Relative importance of the study variables (factors affecting): Table 5 and Figure 1 show the relative importance of macroeconomic variables (exchange rate, GDP, public spending, and foreign direct investment) on foreign trade.

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TABLE V. RELATIVE IMPORTANCE OF THE STUDY VARIABLES

	Importance	Normalized Importance
Exchange rate	.288	62.0%
GDP	.122	26.3%
Public expenditure	.463	100.0%
Foreign direct investment	.127	27.4%

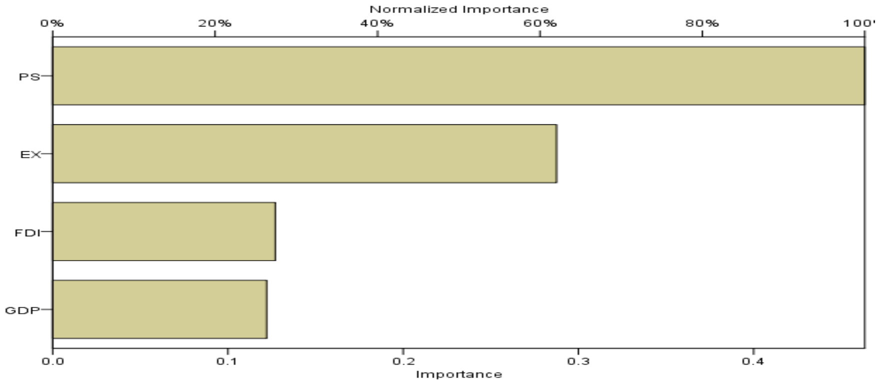

Fig. 1. Relative importance of the study variables

Table 5 reveals the following:

- The factor that gained the greatest importance, which was estimated at 100%, was "public expenditure".
- The variable "exchange rate" came in second place because it was crucial to the study sample by a percentage of 62%.
- In the last two ranks came the "gross domestic product" with a percentage of 26.3% and "foreign direct investment" with a percentage of 27.4%.

6. CONCLUSIONS

The analysis of Iraqi international trade dynamics using artificial neural networks offers a contemporary method of comprehending the intricate relationships between macroeconomic variables. Using state-of-the-art artificial intelligence techniques such as neural networks, the research provides key insights into the effects of variables such as GDP, currency rates, public spending, and foreign direct investment on international trade. This innovative method allows policymakers to make data-driven decisions, enhance economic policies, and strengthen trade strategies for sustainable growth and economic diversification. By utilizing the predictive capabilities of artificial intelligence, Iraq may be better prepared to overcome challenges, grasp opportunities, and solidify its place in the international market through well-informed and proactive actions.

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