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Forecasting Economic Growth and Movements with Wavelet Transform and ARIMA Model

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Abstract: This study uses historical data and modern statistical models to forecast future Gross Domestic Product (GDP) in Jordan. The Wavelet Transformation model (WT) and Autoregressive Integrated Moving Average (ARIMA) model were applied to the time series data and yielded a best-fitting result of (2,1,1) for estimating GDP between 2022-2031. The study concludes that GDP is expected to increase with a positive growth rate of around 3.22%, and recommends government agencies to monitor GDP, strengthen existing policies, and adopt necessary economic reforms to support growth. Additionally, the private sector is encouraged to enhance production tools to achieve economic growth that benefits all sectors of society.

Keywords: Prediction, WT, ARIMA, GDP, Time Series, Jordan.

1 Introduction

The capacity of the economy to generate products and services at the local as well as global scale serves as a barometer for measuring the development and economic improvement of all nations. No matter what a nation's economy may look like—industrial, commercial, agricultural, or even service-based—the volume of revenue from domestic output is regarded as a sign of economic strength. In order to raise their GDP, all nations adopt various strategies and look for elements that encourage production because doing so will certainly have a positive ripple effect on the economy and the overall well-being of society. When examining the nation's economy over the decades and years, it is seen as its economic profile, which highlights the success factors and the degree of development and growth that have occurred in it over time. This review is essentially done to identify the economy's weaknesses and strengths, which are either increasing or decreasing in importance [46] and [1].

All economies and governments have seen throughout history how GDP is impacted by numerous local or external factors. While countries can control internal variables and use them to their advantage, for the external factors they have no power to alter them; instead, they can only force them to adapt collectively [2] and [62]. The ability of planners to develop plans based on useful realistic numbers, to obtain these realistic figures, and to achieve these objectives, it requires a thorough review of previous results in order to build precise future forecasts, this ability distinguishes random economic planning from rational economic planning. Therefore, predicting future economic effects is now one of the most crucial aspects of effective planning and scheduling of policies [3] and [4]. Modern economies started to review past economic results from previous periods and establish future expectations based on these results. The gross domestic product for all countries turn into main concern in how to measure, develop and increase it so as country rises it to a higher economic level. The effective future financial planning requires considering all economic variables at the local level and at the external level of the state because future financial success requires the ability to increase future resources by taking advantage of past historical financial practices. Therefore, forecasting the macro factors of the economy such as gross domestic income, inflation, interest rates, consumption, investment, tax is one of the reasons for the success of the economy

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since these forecasts is regarded as essentials for decision-making process [3] and [5].

The problem of the study crystallizes in the failure of many of the financial and monetary policies followed by the state in improving the economic level by increasing the gross domestic product due to the weakness in the Orientalism of the financial future for the state; several observation by many researches and international organizations were concentrated on gross national product as the most crucial factor that reflects the economy growth. i.e. [6,7,8,9,10,11,47,62]. since it embraces the total value of economy goods, services, personal consumption, government procurement, in addition to the public and private inventory of country [12,13]. Recently, forecasting of GDP has come to be of great importance to all economies around the world due to the fact that economic growth indicators are vital for the both of government and community, as well as to other countries that are dealt with country economically [13,14]. The lack of attention and interest of policymakers and in modern and advanced scientific mathematical methods in forecasting GDP, that serve policy-making, this study mainly assembled to prove the ability of past financial results in extrapolating future results so that policies are developed and implemented on a clear ground to achieve these future goals. Forecasting future GDP nowadays is realized as the superior measure for the wealth of the nation, thus countries with high GDP are considered rich countries, while countries with low GDP are seen as poor countries and they harness all their resources to rise to wealthy countries.

In view of the importance for measuring and forecasting GDP annually, studies on this subject will be inspired as long as the economy continues since decision-makers must continually be provided with up-to-date numbers and forecasts that serve their decisions concerning the percentage of GDP growth. The current study is motivated by the continuous need for our country as emerging economy to be updated with all information concerning the level of progress in GDP and whether the future expected trend satisfy policy makers expectations. Moreover, the study is regarded to be a complementary one to other similar studies worldwide in follow-up the recent developments in GDP for developed countries. What gives this study originality is its employment for advanced and more accurate data about future trend of GDP by modern mathematical and statistical models; also this study is distinguished by its invented ability to provide more up-to-date information on future GDP position, which is helpful and supportive to the decision-making process for economists whom search to reduces the cases of future economic uncertainties; furthermore, the study can establish an evidence to be a reference for government economic agencies and legislators about the anticipated future development of the country's economy as a whole.

The organization of the paper after the introduction will be as follows: the second part is for the theoretical framework and the literature review of the study, the methodology and methods will be in the third section, the fourth section will be for data, analysis and discussion, and the last part will be for conclusions and recommendations.

2 Theoretical Background and Related Literature

2.1 Gross Domestic Product (GDP)

When we examine the historical development of the GDP scale, we discover that Willian Beatty was responsible for its invention before 1700 AD. This measure was straightforward and developed to combat the greed of land and farm financiers who imposed unfair taxes during the Dutch and English wars between 1654 and 1676. Charles Defenat created this metric in 1695, and Simon Kzench introduced the first modern notion of GDP in 1934. Kzentech stated in a U.S. Congressional Economic Report that this measure can be used to assess the well-being of society. In 1991, the United States of America adopted Kzench's ideas that were embodied in world economics by measuring economic growth in total domestic production rather than total national production. The GDP measure had been adopted as the primary method for gauging economic development in any nation following the Bretton Conference in 1944 [53].

Traditionally, GDP is suggested by many historians, i.e. [3,4,15,16,17,18,47,48] as the representative of the market monetary value for all goods and services produced during a specific period of time, usually a year, this measure is constantly adopted to compare living standards in different countries, as it has been proven that the use of GDP per capita (nominal) does not reflect differences in social welfare between countries and does not accurately measure inflation levels, so GDP at the gross level is more accurate and appropriate than GDP at the individual level. Thus, when the value of the GDP of countries is reported each year, details are made about the contributions of the different sectors of industry, trade or services to this output, which may appear in the annual reports of government agencies per capita at the country level of GDP. The Organization for Economic Cooperation and Development (OECD) defined GDP as a total measure of production that covers the total loads added by the population, institutions, and participants in production and services, with the addition of any taxes and the introduction of any support provided by the government. This is just one example of the many national and international economic institutions that have provided a set of definitions of GDP. The International Monetary Fund noted that the GDP reflects the monetary value of all consumer goods and services purchased by consumers and generated in a particular country throughout a year [8,9,19]. For many years, economists

have used the GDP as the benchmark for global comparisons and as a primary measure of economic advancement, describing it as the most reliable and powerful indication of a nation's progress and development [20,21,22,47,53]. The modernization of the economy, however, resulted in numerous critiques of this indicator, demonstrating that it ignores a number of other factors, including resource investment, environmental effects, and unpaid labor. As a result, critics have proposed alternative economic models to measure economic growth and development, such as the Donut economy, which incorporates additional indicators of economic success, such as the Better Life Index, which is published by the Organization for Economic Cooperation and Development [19]. Theoretically, every notion of GDP that has been developed and every one of its measurements have the same effect on GDP; these measurements can be divided into three categories: The first reflects the value of all finished goods and services generated by society over a specific time period, typically a full year [2,53,62]. The second represents the value of the total increased value of all economic sectors plus taxes, minus any gifts or other forms of financial or in-kind assistance given to the government. Regarding the third, it reflects the entire income from output in the state after deducting wages for employees and production tax it is the total amount of output income in the state, less employee pay and production taxes [14,22]. These three measurements were highlighted as the methods for calculating GDP; the first was categorized as the cost or expenditure method, the second as the production method, and the third as the revenue method [53,63].

2.2 Future Prediction of GDP

The concept of economic forecasting is the creation of methodologies and techniques to predict anticipated future economic results. Economic forecasting can be made at the aggregate level for all elements of the economy combined, such as forecasting GDP or gross national product, or it can be allocated to specific economic factors like inflation, unemployment, or fiscal deficit, and it can be allocated to a specific economic sector such as the financial sector [3,4,17,23,47]. Economic forecasting generally aims to determine the level of economic prosperity or growth of a country or a particular sector. There are many interested in economic forecasting's results such as government agencies, central banks and international funds such as the International Monetary Fund or the Organization for International Cooperation and Economics [8,9,19]. In addition to increasing individual awareness, numerous local and international study centers are also interested in GDP forecasting. Academics and economic scholars are also drawn to this topic of study. Because the indications that arise from these forecasts need to be revised on a regular basis, these projections are typically ongoing and unstoppable.

During the last five decades, those interested in forecasting such as economic researchers and mathematicians have developed many methods of future economic forecasting, where all these methods have been used in data analysis of economic variables, and a methodology with similar steps has been adopted in most forecasting methods. When the researcher makes a forecast, he begins to determine the scope, which includes identifying the variables and economic topics to be researched based on the needs of the target group that benefit from the forecasts. In the second step, literary sources, studies and points of view that help in interpretation, commentary and comparison of forecasting results are reviewed, in the third step accurate and reliable data are collected about the economic variables targeted for forecasting from databases or from any appropriate sources. In the fourth step, the researcher determines the relationships between the variables studied, such as identifying independent variables and dependent or intermediate variables, but in the fifth step, these relationships are translated into models through mathematical equations that clarify the assumed relationships between the variables, and in the last step, the results are drawn, the results are interpreted and discussed, and comparisons are made to the results [24, 25,26,47,49].

Because its well known that the gross domestic product is made up of a number of elements, including consumer spending, government spending, total investment, and foreign trade, forecasting benefits should be used to support plans and policies relating to these components. In addition, forecasting generally has a number of advantages and benefits that benefit all groups at all levels of the state, society, or even other nations, as well as any groups that gain from the outcomes of economic forecasting [8,9,19]. At the individual level, forecasts can show the stability of the economy, and this encourages members of society to spend their incomes on consumption and reduce savings, which increases productivity to meet society's consumption. Therefore, it is clear that confidence in income stability is a strong indicator of economic stability and this reduces the burden on the government on societal spending [3,27]. The results of economic forecasting also benefit government agencies to develop financial plans and determine their programs better to face any possible economic fluctuations indicated by future forecasts; prediction of future economic numbers are suggested as an appropriate guide for the movement of investment in the country, moreover, forecasts serve government and community in several economic issues such as trade balance, unemployment, taxes and inflation [3,17,19]. Future forecasting benefits companies operating in the country in reducing future uncertainties, which enhances their ability to avoid or reduce risks related to future changes and better control the conduct of their business

by developing appropriate business strategies and making decisions that support the company to achieve its goals by adapting its resources to the future [9,22]. Develop a comprehensive vision of future work, re-evaluate costs and types of future products and services, in addition to building future budgets for sales and profits [8,19].

Many methods of future economic forecasting have been developed over the last fifty years by those with an interest in forecasting, such as economists and mathematicians. All of these methods have been used in the data analysis of economic variables, and the majority of forecasting methodologies have adopted a methodology with similar steps. When a forecast is made, the researcher first establishes the scope, which entails choosing the variables and economic areas that should be investigated in light of the requirements of the target audience that will gain from the forecasts. The second step involves reviewing literary works, studies, and points of view that aid in the interpretation, commentary, and comparison of forecasting results. The third step involves gathering accurate and reliable data about the economic variables targeted for forecasting from databases or other suitable sources. In the fourth step, the researcher establishes the relationships between the variables under study, such as identifying independent and dependent or intermediate variables; however, in the fifth step, these relationships are translated into models through mathematical equations that clarify the assumed relationships between the variables; and in the final step, the results are drawn, the results are interpreted and discussed, and comparisons are made to the results. As accuracy is considered one of the most crucial criteria for the success of the economic forecasting process, a set of statistical tests have also been adopted by researchers to ascertain the level of accuracy of information collection, the accuracy of the tools used to predict, and the accuracy of the results.

In general, the accuracy of the results is affected by the variety of future forecasting methods, this can be utilized in addition to the prediction makers' expertise and knowledge [47,49,54]. The methods and techniques for future economic forecasting vary between qualitative methods and short- or long-term quantitative methods according to the need for these forecasts. Qualitative methods depend on survey methods, opinion polls, interviews, questionnaires or observation method, these methods aim to design relational models for the opinions of experts and specialists in certain economic fields in order to determine future trends in these areas [47]. As for the other type, which is quantitative methods, it depends on real numerical data from the past and uses statistical quantitative models through which the direction of future numbers can be predicted based on historical numbers, and the quantitative method usually depends on time series for multiple periods of time, where they can be examined and predicted using statistical methods such as correlation and simple and multiple regression, and more advanced methods with high accuracy have recently appeared to predict time series data such as Autoregressive Integrated Moving Average (ARIMA) [28,46,47].

2.3 Formal Studies on Autoregressive Integrated Moving Average (ARIMA)

[47] pointed out the criticism of many statistical methods for their inaccuracy in predicting the future is accurate and appropriate for time series has encouraged many mathematicians and statisticians to search for highly accurate statistical methods in forecasting, including Autoregressive Integrated Moving Average (ARIMA). This method has been adopted by many researchers, i.e. [3,4,7,10,11,25,29,30,46] when predicting the direction of GDP due to the urgent need for high-accuracy figures that can be used as a basis for understanding the evolution of GDP and its fluctuations, and since GDP appears in numbers for several years as a time series, ARIMA has proven highly effective in predicting its future accuracy.

GDP is usually volatile in nature, but its temporal results may appear in several directions, it may be in a trend upward or downward or stable, and the ARIMA model can accurately predict these three cases, whether they are annual, quarterly, monthly or even on daily basis. There are many statistical forms of ARIMA but in this study, the methodology of [47] and later developed by [31,32] will be employed to reach an accurate forecast about the GDP in Jordan.

It is noteworthy that many researchers such as [2,3,4, 23] after multiple experience in using several statistical measures to measure economic growth, suggested that ARIMA found one of the best statistical measures capable for predicting future growth with high accuracy and with a slight deviation from the expected, and the researchers also showed that the moving average depends on partial autocorrelation and autocorrelation functions; moreover, the [48] framework was suggested as the best automatic algorithm that was also applied by the deployed both of [33] and [61] whom focused on time series data as the major determinant for estimation the ARIMA parameters. Some researchers, like [34] also employed time series that were extracted from the financial markets and created a multi-factor dynamic proposed system (VAR) to measure growth in GDP; similarly, [35] also succeeded in using ARIMA model to estimate GDP in china environment after predicting china GDP from 2007 to 2011 relying on data on GDP from 1978 to 2006. Equal results were found on ARIMA accuracy by [38] when they used data from 1952 to 2007 and revealed that ARIMA predicted future GDP with variance of only 5% between actual GDP and predicted GDP. Similar results were also achieved by [20,21,22,36,37].

2.4 Economic Environment in Jordan

Jordan is classified economically as a developing country, and its geographical location imposed on it the status of unstable countries due to the political conditions surrounding it and because of the ongoing regional conflicts in the Middle East, which made it economically affected by these political, economic and social tensions that occur in the region [9,55,56]. Despite the continuous attempts and efforts by the Jordanian government and the investment sectors, Jordan has suffered since independence in the forties of the last century with fluctuating in economic results such as prices of goods and services, production and various resources [8]. Jordan has for several decades developed economic strategies and plans aimed at increasing economic growth, and many of these policies have succeeded in improving the economic level in the country, and Jordan has established several economic partnerships with Western countries such as the United States of America, the United Kingdom and many European countries, and has also created economic links and partnerships with neighboring countries in the Middle East, North African countries and East Asian countries, as these links contributed to improving the balance of payments and led to acceptable economic growth despite the scarcity of economic resources in Jordan [9].

During the last two decades, the Jordanian government has made fundamental changes to the composition of the Jordanian economy in order to increase openness to global markets and began to liberalize markets and follow the open economy approach, where the government has taken a set of economic measures aimed at raising the level of the economy and increasing its productivity, as it has privatized many sectors such as the industrial and health sectors, energy and communications sectors, and promoted private education and health by encouraging private schools, universities and private hospitals [9]. The official authorities also conducted a comprehensive review of legal and economic legislation, as they amended the Tax Law and the Social Security Law, made amendments to commercial laws and regulations, and established private investment zones and industrial cities in all big cities of the country [8,57]. However, despite all the economic measures taken by the official authorities, the Jordanian economy continued to suffer, as it faced many crises and external influences such as the first and second Gulf wars, the Iraq crisis and the war in Syria, where these influences led to a rise in production inputs, a decrease in exports, an increase in the cost of living and a rise in energy prices, which affected the Jordanian economy by appearing very slow [9]. Despite some assistance and support provided by Western countries and Gulf countries through grants and aid, the Jordanian economy as a developing country lacking basic resources and wealth has remained at a modest growth level [59].

In order to improve the GDP, many international institutions and organizations, especially the World Bank and International Monetary Fund provided advice and recommendations to carry out many economic reforms by changing economic policies, raising government intervention in many internal economic activities such as energy, water and electricity prices, and raising the sales tax [60]. the results of the statistics of the GDP that shown in figure 1 show that the average growth was 7.6% from 1965 to 2021, and the results that appear indicate that there is a decrease in the growth rate, as the rate of Growth 3.6% in the last 10 years and 2.5% in the last five years; this decrease in the last two years might be justified by the pandemic of Covid-19 [8,9].

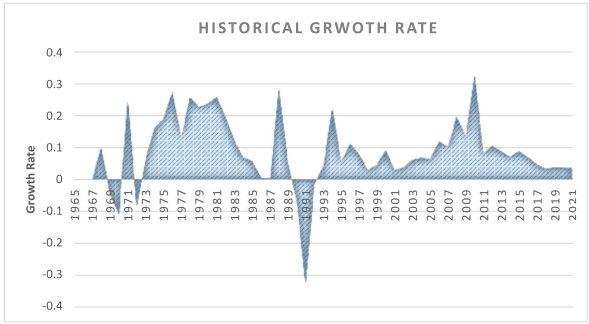

Fig. 1: GDP Annual Growth Rate

3 3. Methodology of The Study

The methodology for the study is shown in Figure 2. It consists of a number of steps, beginning with the collection of time series data on GDP that will be used for forecasting, followed by an explanation of the methodology using the appropriate mathematical models (Wavelet Transform formula) and, finally, the analysis of the data using statistical software to determine the best ARIMA model for prediction.

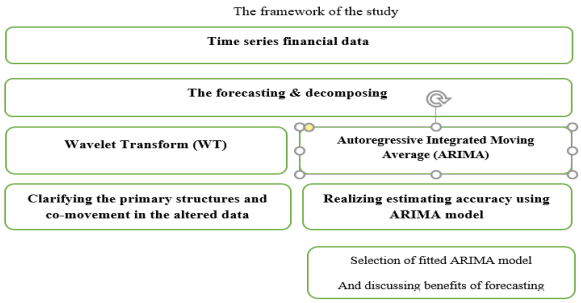

Fig. 2: framework of the study

3.1 ARIMA model

ARIMA model is an auto regression (AR) model and viewed as a process applied on lagged values of time series data, this model is equated as follows:

$$Yt = \alpha_0 + \alpha_1 Yt - 1 + \alpha_2 Yt - 2 + ... + \alpha_p Yt - p \quad (1)$$

The moving average (MA) of the framework is correlated if AR have other mechanisms that generates Y value; but it must contain past values with its error terms. The MA (q) is assembled as:

$$\varepsilon t = \beta_1 \varepsilon t + \beta_2 \varepsilon t - 2 + \beta_3 \varepsilon t - 3 + ... + \beta q Y \varepsilon t - q \quad (2)$$

This model has inaccuracies resulted from white noise; this is donated to as ARMA (p, q) process when Y retains both of AR and MA qualities. The methodology of [45,50] is followed which basically derived from (Box-Jenkins model) in order to label and predict the proper statistical model that can be applied to represent how the sampled data were formed. However, because of the non-stationary nature of time series numbers, a differences of time series will result in a stationary time series data thus, the model assumes that if the selected data was stabilized after multiplication with (d), we donate (I) to the date series. Therefore, the initial time series is ARIMA but only if ARMA (p, q) was functioned to the series of data that is I(d), (p,d,q). Moreover, this equation for ARIMA model assumes the use of correlogram in order to identify the values for p, q that used in AR and MA. The framework also assumes that the ordering for the moving average q, ACF stops or dies down beyond lagging q at the same time the autoregressive for the order of p, and PACF also stop or dies down post the lagging of p for the AR (p) methods. [49] noted that this model diagnose is mostly applied basing on Mean Absolute Percent Error ((MAPE) and also applied by Root Mean Square Error (RMSE) by value of (MAPE).

3.2 Wavelet Transform Equation

In order to realise the accurate estimation for future data, the initial observation of time series data is changed to time scale domain by application of a mathematical model known as Wavelet Transform (WT). Since the majority of financial data are non-stationary, the model works extremely well with this type of data. Discrete Wavelet Transform (DWT) and continuous Wavelet Transform are two sub-types of WT (CWT) as pointed out by Several researches such as [39,40,41,49,51]. The properties of each of these functions are the same across all applications. The WT's equation for each function will be described in this paper. These suggestions are equally originated by the work of [42,52].

The wavelets methods and assumptions are structured on Fourier enquiry, this theory adopts the fact that any function is the total value for both of sine and cosine scores. The WT is generally the function of time represented by t which follows a simple law, identified as wavelet admissibility state [52]:

$$C_\varphi = \int_0^\infty (\frac{|\varphi f|}{f}) df < \infty \quad (3)$$

The QF is donated to the transformation of Fourier function for frequencies of (f, for Q(t)). The WT is donated to method mean that might be applicable to several applications; for instance, the analyzing image and the signals processes. This method was formalized to overcome the complications allied to Fourier transformations in the case of confronting non stationary data signals that could confined in interval of time or space and frequencies. The most common forms of WT are function-family; the wavelet father type represents the smooth and low frequencies fragments for particular signals; on the hand the mother wavelet type define the details for high frequented parts; the formula in equation 3 demonstrate the two types of wavelet propositions, where, j= 1,2,3……..., j for the J-level [52]:

$$\Phi j,k = 2^{-\frac{j}{2}} \phi(t - \frac{2^j k}{2^j}) \quad (4)$$

Where J denotes the maximum scale sustainable by the number of data points and the two types of wavelets stated above, namely father wavelets and mother wavelets and satisfies:

$$\int \phi(t) dt = 1 and \int \varphi(t) td = 0 \quad (5)$$

time series data, i.e., function f(t), is an input represented by wavelet analysis, and can be built up as a sequence of projections onto father and mother wavelets indexed by both k, k = 0, 1, 2,... and byS=2j, j=1,2,3,. . .J.

Referring to formula 4 the f (t) function is donated to the input of wavelet analysis, that is used to be constructed up for the sequence of both mother and mother of wavelet index, that represented by k, when k= 0,1,2……. and defined by S in equation 5 when S=2j, j 1,2,3…. j. The analysis for the reality of desecrated sample of data involves generating lattice in order to conduct the necessary calculations. Scientifically its more suitable to apply a dyadic development as represented in formula 4, this expansion is assembled in equation 6 as:

$$S_{J,K} = \int \phi(t) dt = 1 (and) d_{J,K} = \int \varphi(t) td = 0 \quad (6)$$

The orthogonal for wavelet framework is an estimation for f (t) as:

$$F(t) = \sum S_{J,K}\Phi_{J,K}(t) + \sum d_{J,K} \varphi_{J,K}(t) + \sum d_{J-1,K}\varphi_{J-1,K}(t) \ldots + \sum d_{1,K}\varphi_{1,K}(t)\cdots \quad (7)$$

$$S_J(t) = \sum S_{J,K}\Phi_{J,K}(t) \quad (8)$$

$$D_J(t) = \sum d_{J,K}\Phi_{J,K}(t) \quad (9)$$

The coefficients for the estimations of WT series is equated in equation 6, particularly for the discrete signal; the Sj (t) and Dj (t) are representative for both of smooth and details [43]. In the case that data pattern is found highly irregular, the wavelet should repeatedly apply in order to decrease the errors for the root mean (RMSE) among the signal prior and post transforming; thus, any noise obtained from the original series can be discharged, consequently we intended to apply WT for two times on the data.

3.3 Accuracy of Mathematical Model

As the aim of the study is to obtain the best estimation results; therefore, before starting discussion for comparison of framework a discussion will be firstly undertaken on the criteria's that were applied to warranty the fair comparison. The three selected criteria for accuracy are Mean square error (MSE), Root mean square error (RMSE) in addition to the Mean absolute error; these categories were formally experimented by several historians and found fit to equate performance differences among models [42,44,62].

4 Results

4.1 Data description

The study's data set included Jordan's gross domestic product (GDP), which was taken from the Central Bank of Jordan's (CBJ) annual reports and the general department of statistics. The data set, which was chosen as a time series, encompassed the years 1965 to 2021. The data were examined using Matlab and Mini-tab statistical software, which is recommended as the best suitable software for using ARIMA, in order to estimate the future GDP. The research hypothesis, dependent and independent variables, as well as the anticipated statistical tests, are all shown in Table 1.

As the figure screen has a non-linear route, the results for the Histogram, Accumulated Histogram, and Descriptive Statistics for the Study Time Series are shown in Figure 2. Because the data is non-stationary in nature, it is classified as random data that varies from year to year.

Table 1: Data analysis Matrix

	Fitted ARIMA Model
Research hypothesis	Modelling and prediction of GDP
Dependent variable	GDP
Independent variable	Time (year)
statistics	His, Acc.His, des.stat, WT, ARIMA

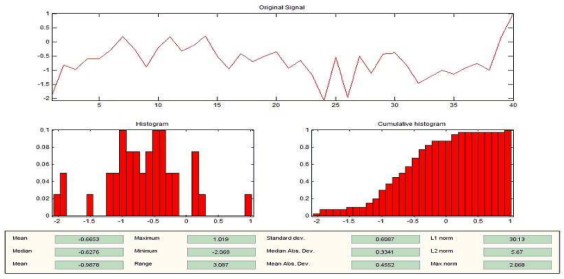

Fig. 3: Data Description of GDP

4.2 Decomposition of Time Series Data

There are a Consensus among analysts that time series data consists of three elements; trend, noise and seasonality [3,4,17,23,25,46]. Thus decomposition aims to separate these three elements in order to read and explain the results properly. The trend component show the volatility of data in states of increase and decrease; whilst the seasonal component aims to decrease the volatility of data by repeating processing of data to the time series, as for the third element Noise its aimed to reduce the noise state of data through randomization [21, 22].

The results in figure 4 the decomposition of data using WT, but pre proceeding in sample decomposition its worthy to point out that the sampled time series has been reformed by the log function since high volatility is noticed in time series. As shown in the figure the decomposition represented of: a1 as the approximated coefficients that assemble for the appropriate estimation; d1, illustrates the volatility or fluctuation of data; accordingly, the mathematical equation can be assembled as S= a1 + d1, where S donated to the original data.

When screening the results displayed in figure 4, we see that the timing plots for GDP exhibit random fluctuations. This result indicates that the data are non-stationary in nature and volatile across the analyzed time, and as a result, are not constant in terms of mean or variance. The spectral analysis of WT must be used when the data are in a non-stationary state since they typically exhibit a seasonal tendency. Since the primary characteristics and volatility of time series data are clarified by d1, the non-stationary nature of time series allows the transformation process of data from random trend to linear trend. There are several oscillations that are mixed in with the GDP results across the study period, as the findings of d1 in the figure also demonstrate.

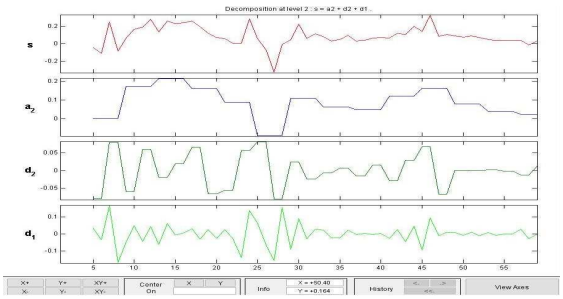

Fig. 4: Data Description of GDP

Once the decomposition steps applied on time series data, an ARIMA methodology is applied to allocate the suitable model for predicting Jordanian GDP, the results are shown in table 3.

Table 2: ARIMA forecasting models

	Fitted ARIMA Model
Model	(2,1,1)
MASE	0.3708
RMSE	0.0699

Table 2 show the models of ARIMA that detected by means of MASE and RMSE; by performing Gaussian MLE criterion, both of ARIMA models parameters were predicted; grounding on ARIMA frameworks the best fitted models that selected is those with the lowest score of MASE which is (0.6878) and the lowest value of RMSE that is (0.0699) with the most fitted ARIMA with value of (2,1,1). Based on articulated ARIMA fitted model, the results in figure 5 that show the GDP trend from 1965 to 3031, the figure suggests that the Jordanian economic growth represented by GDP is estimated to be upward sloping trend; this results is supportive to economy by such optimistic results. As the figure illustrate that the upcoming ten years in Jordanian economy tend to be compensational for the previous declined years.

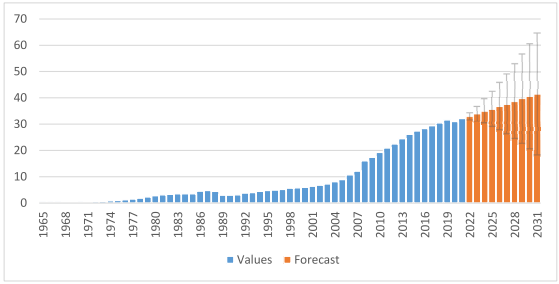

Fig. 5: GDP original and forcasted

5 Conclusion

The study was driven by the need to forecast the future trend of the GDP in Jordan by utilizing time series data from earlier periods and incorporating them into high-precision mathematical prediction models to forecast GDP growth in the future. Time series data on GDP covering the years 1965 to 2021 were gathered from databases at the Central Bank of Jordan and the Department of Statistics. These time series data will be used as a foundation to forecast GDP growth over the following 10 years, from 2022 to 2031. The study adopted the model WT in the first stage to build data and identify oscillations and outliers. In the second stage, the ARIMA model was employed, which was agreed upon by most researchers as one of the best models for predicting future data, as it was used to predict GDP. The study used the quantitative research approach, which depends on the analysis of real data derived from the market.

After gathering the study's original time series-based data and testing them using the study model, it was discovered that the data were non-stationary by nature; as a result, they were transformed into stationary data to better suit the study. During the process of model development, the initial data is found to be non-stationary and is then modified to become stationary. The ARIMA (2,1,1) model, which has the lowest BIC values of all the early ARIMA models, is chosen for analysis and GDP forecast. The findings demonstrate that for the appropriate framework, the fitted model's effect R square value is high (95%) and its mean absolute percent error is quite small. As a result, the estimation's accuracy was high. Therefore, it has been determined that during the next ten years, Jordan's GDP will continue to rise at a level consistent with its recent development trend; the anticipated average growth rate would be close to 3.22%.

5.1 Implications, limitations and future research

The present study is acknowledged by its contribution to previous research regarding the use modern estimation mathematical model in forecasting the expected future enhancement in economic growth represented by GDP; the little research on this issue specifically in emerging countries was a motivating factor to conduct this analysis. The study brought more insight and shed more light on how to policy makers can utilize the results of such forecasting's in formulating plans, polices and strategies on a clear sight for future upcoming results. The study also concentrated in to the ability for adaptation of policy makers and government agencies to future trend of GDP; moreover, the results directed to interested parties on how to overcome any probable risks attained from future economic situation, for example governments might seek for local or external support for funding economy.

The study linked the past results with future results which is crucial for decision makers to point out any past

deficiencies in monetary or financial results and correct them in future action; such practices guide the policy makers on the country level or on corporate level for more efficacy in utilizing available resources that participates in production or service. Promoting the tools and techniques of measurement is also an implication for researchers, analysts which enables them to obtain accurate, appropriate and transparent numbers for both past and future results. The results achieved from such foresting's increases the level of cooperation between all country sectors whether private or public institutions enhance any future unsatisfied expected future results.

The outcomes of our research offers some implications that are helpful for applying forecasting in different settings. The desire to obtain reliable relevant financial information mandates government to plan and execute based on this forecasting's. Therefore, adopting such methods in planning helps government in general and public in particular. Furthermore, the modern forecasting techniques empower policymakers in convincing official and public with their strategies and plans. The provision of new planning methods without benefit from such methods regarded as a weakness point in countries that hardly seek to enhance their economic position. The emergence of forecasting methods also can be used as controls for effective use of resources in order to achieve the desired goals. The real value of forecasting methods will not be achieved unless the ideal employment of these methods by competent persons whom have the required knowledge in utilizing future trends in present actions.

Without a doubt, it has become known to everyone that government cannot continue with traditional planning old systems, in an accelerated world and an economic environment with high competition that has exceeded the borders of countries, it has become necessary for government and even companies in private sectors have to insert these forecasting methods into financial culture. This activity will result in unlimited transparent and reliable information useful for making economic decisions; hence, if government and companies want to maintain their growth and continuity, they are obliged to provide efficient, effective and figures to all interested parties. Therefore, it is recommended that the officials and government agencies to continue monitoring the gross domestic product, strengthen existing policies, plans, and laws, and adopt the necessary economic reforms to support the anticipated economic growth. It also needed to encourage the private sector to enhance and develop all production tools to assist the government in achieving distinguished economic growth whose consequences are mirrored in all sectors of society.

In scientific research, there is no study without limitations, similar to other studies conducted on this topic this study faced several limitations, including the time period on which the study was conducted, as this study covered a forcasted period of 10 years; for some professionals and researchers the period is too short and that this study may need longer periods of time. Also, one of the limitations is related to the type of forecasting method (ARIMA), some could argue that other methods are more efficient in the field of forecasting such as (SARIMA, ARIMAX) or artificial neural networks (ANNs) and recurrent neural networks (RNNs). The third limitation is related to the selected variables for the study; most of forecasting research focused on GDP, but still there are many indicators for economic growth such as Consumer Price Index (CPI), or unemployment figures, analysts might claim that these indicators are better than GDP. Future research on this topic can develop the study through the use longer time periods for forecasting example more than 10 years, also future researchers can use other growth indicators such as (CPI) or unemployment; also future researcher can employ another types of forecasting methods other than ARIMA.'

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