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Forecasting The Budget Deficit In Jordan Over The Period (2006-2025): Univariate ARIMA Model

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ABSTRACT

This paper examines the behavior of forecasts for the budget deficit in Jordan over the coming twenty years (2006-2025). To achieve the objective, the available historical data for the Jordanian budget deficit over the period (1964-2003) was manipulated by an Autoregressive Integrated Moving Average (ARIMA) model. Different diagnostic tests also were performed to reach the final results. The empirical results have shown that the Jordanian budget will keep suffering from an increasing deficit over the coming twenty years, which may worsen the crisis of public debt in Jordan.

Keywords: Public Pudget, Jordanian Economy, ARIMA Model.

1. INTRODUCTION

Since the early 1960s, the government spending was considered the major implement for driving the Jordanian economy for different reasons. First reason, the political instability in the Middle East discouraged the private sector to invest in Jordan. Second reason, the main Jordanian industries such as: Potash and Phosphate, required a huge amounts of investments, that the Jordanian private sector was not able to afford. And third reason, the Arab-Isreali wars enforced the Jordanian government to spend a huge amounts on defense. This had put a heavy burden on the Jordanian public budget. Starting from the mid 1980s, this burden has become heavier because the receipts of external aids and the Jordanian workers' remittances declined sharply. Thus, Jordan witnessed a severe economic crisis, which encouraged the Jordanian government to reach an agreement with the International Monetary Fund (IMF) for a structural reform program that calls for a reduction in government spending and an increase in tax revenue (Shotar and Barghothi, 2000) for the purpose of decreasing the budget deficit. Thus, the Jordanian public budget achieved this goal by gaining a budget surplus over the period (1990-1996). After that the budget had started to suffer from deficits. So, this paper tries to forecast the behavior of the budget deficit in Jordan over the coming twenty years, where forecasting is considered an important part of econometric analysis, and for decision-makers probably the most important.

A very popular method of forecasting stationary time series is the Autoregressive Integrated Moving Average (ARIMA) method, popularly known as the Box-Jenkins methodology.

The rest of the paper is organized as following: The next section shows the importance of the study. Section 3 describes methodology and data. Section 4 presents the empirical results. Finally, section 5 concludes.

2. IMPORTANCE OF THE STUDY

The importance of this study comes up through two aspects; first aspect, the technique of forecasting used here is not conventional. Second aspect, to the knowledge of the researcher, this is the first time in Jordan to run a study for the purpose of forecasting in general, and forecasting the budget deficit in particular, where the previous work in this regard has focused on analyzing the progress of the items of the Jordanian budget.

In fact, the researcher has faced two kinds of obstacles; First obstacle, the nonavailability of monthly data to get more accurate results. Second obstacle, the empirical studies that use univariate ARIMA models are very rare, since we use only one variable in the model. So, the researcher focuses on the theory of this technique rather than mentioning other empirical studies.

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3. METHODOLOGY AND DATA

The single-equation regression models and simultaneous-regression models have their heyday for economic forecasting during the 1960s and 1970s. But later, the glamour about such forecasting subsided owing the oil price shocks of 1973 and 1979 and the Lucas critique. The thrust of this critique is that the parameters estimated from an econometric model are dependent on the policy prevailing at the time the model was estimated, and will change if there is a policy change. In short, the estimated parameters are not invariant in the presence of policy changes. For example, changing the monetary policy from targeting interest rates to monitoring the growth rate of money supply, an econometric model estimated from the past data will have little forecasting value in the new regime (Gujarati, 1995:735). On the other hand, univariate ARIMA methodology does not depend on any policy, since this methodology emphasizes on analyzing the probabilistic or stochastic properties of econometric time series on their own, under the principle "let the data express itself", which implies that any time series in this methodology may express itself by past or lagged values of the series itself and the stochastic disturbance term. This gives ARIMA model an advantage over some other forecasting techniques.

The general univariate ARIMA(p,d,q) process for any time series X takes the form:

$\Phi(L)X_t = \delta + \theta(L)\,\varepsilon_t$

Where;

$\Phi(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \ldots\ldots\ldots\ldots - \alpha_p L^p$

$\theta(L) = 1 - \beta_1 L - \beta_2 L^2 - \ldots\ldots\ldots\ldots - \beta_q L^q$

δ :is the constant term.

d :is the degree of homogeneity for the series X.

ε: is the disturbance random term.

P and q are the orders of the autoregressive part and the moving average part in the model, respectively.

The measurement of fiscal or budget deficit must be specified over three dimensions: First, the deficit has to be defined for a public sector of a given coverage. Second, the coverage or size of the public sector and its composition must be delineated and third, the time horizon relevant for assessing the magnitude of the deficit must be identified (Blejer and Cheasty, 1991). Anyway, in this paper, the definition of fiscal deficit (or budget deficit) is taken as it is defined by the Jordanian government, which equals to total government revenues and receipts minus total government expenditures.

The model of this study is based on a yearly data, starting from 1964 till 2003. All the data is taken from the monthly and yearly statistical bulletins of the Central Bank of Jordan.

4. EMPIRICAL RESULTS

Given the series Budget Deficit (BD). The first problem is to determine the degree of homogeneity (d); that is the number of times that the series must be differenced to produce a stationary series (Pindyck and Rubinfeld, 1991, P492). The failure to properly transform nonstationary data into stationary data can result in model misspecification, thus leading to incorrect inferences (Alkhatib, 2004). Performing the three most popular tests for unit root or stationarity; Dickey-Fuller test (DF), Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP) for the series under consideration (BD), gave the results reported in table (1).

Table 1: Variable: Budget Deficit (BD).

Unit Root Test	Computed Value	Critical Value at 5% level
Dickey-Fuller	-2.81	-2.94
Augmented Dickey-Fuller	-2.71	-2.94
Phillips-Perron	-2.83	-2.94

Note: One lag is found to be enough for the residuals to have no significant autocorrelation.

Since the computed values in the three tests (in absolute value) are smaller than the critical values (in absolute value) at 5% level of significance, we can conclude that the variable under consideration (BD) is not stationary, and we need to make it stationary in order to be able to use it in an ARIMA model. One way to make the given series stationary is by taking the first difference of that series; i.e. BD^* where $BD^*_t = \Delta BD_t = BD_t - BD_{t-1}$. The results of the same previous three unit root tests for the first difference of the variable under consideration are shown in table (2). It is very clear from table (2) that BD^* is stationary, which implies that the BD series is integrated of order one, i.e. I(1).

Table 2: Variable: First Difference of Budget Deficit (BD^*).

Unit Root Test	Computed Value	Critical Value at 5% level
Dickey-Fuller	-6.44	-2.94
Augmented Dickey-Fuller	-5.09	-2.94
Phillips-Perron	-6.53	-2.94

Note: One lag is found to be enough for the residuals to have no significant autocorrelation.

Table 3: Estimation of Univariate ARIMA Model: (Dependent Variable: BD^*).

Variable	Coefficient	Std. Error	t-Statistic	Probability
C	-0.638	0.42	-1.53	0.1300
AR(1)	-0.693	0.18	-3.77	0.0006
AR(2)	0.313	0.19	1.69	0.1000
MA(1)	-1.446	0.21	-6.75	0.0000

R^2= 0.55 AIC= 10.9691

Adjusted-R^2= 0.50 SIC= 11.14331

D-W= 2.32 F-Statistic= 13.2, P(F-Statistic)= 0.000008

The next step is to find an ARIMA (p,d,q) model that fits the series BD very well. One way for doing that, is by utilizing the correlograms of the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). Since in practice we don't observe the theoretical ACFs and PACFs, we count on their sample counterparts. For example, Sample Autocorrelation Function (SACF) and Sample Partial Autocorrelation Function (SPACF) of BD^*. Unfortunately, the ACF and PACF of BD^* don't show any typical pattern to conclude values for p and q. So, the researcher resorted to estimate a collection of ARIMA(p,d,q) models for different values for p and q, and d is already determined to be 1. This collection of models included ARIMA(1,1,0), ARIMA(2,1,0) ARIMA(3,1,0) ARIMA(4,1,0) ARIMA(5,1,0) ARIMA(0,1,1) ARIMA(0,1,2) ARIMA(0,1,3) ARIMA(0,1,4) ARIMA(0,1,5) ARIMA(1,1,1) ARIMA(1,1,2) ARIMA(1,1,3) ARIMA(1,1,4) ARIMA(1,1,5) ARIMA(2,1,1) ARIMA(2,1,2) ARIMA(2,1,3) ARIMA(2,1,4) ARIMA(2,1,5) ARIMA(3,1,1) ARIMA(3,1,2) ARIMA(3,1,3) ARIMA(3,1,4) ARIMA(3,1,5) ARIMA(4,1,1) ARIMA(4,1,2) ARIMA(4,1,3) ARIMA(4,1,4) ARIMA(4,1,5) ARIMA(5,1,1) ARIMA(5,1,2) ARIMA(5,1,3) ARIMA(5,1,4) and ARIMA(5,1,5), then to choose one of these competing models that minimizes Akaike Information Criterion (AIC) and Schwarz Criterion (SIC). Unfortunately, the five models that have the minimum values of AIC and SIC were found to violate a very strict assumption in choosing the best model, that is the error terms ε_t of ARIMA model must satisfy the standard assumption that $\varepsilon_t \sim NID(0,\sigma^2)$. For example, the error terms are assumed to have constant mean zero and constant variance, and they are uncorrelated and normally distributed. The sixth lowest values for AIC and SIC were found to match the model ARIMA(2,1,1) and its error terms are white noise according to the Jarque-Berra (JB) test for normality of residuals, the JB value of (0.763031) with probability (0.682826) indicates that we can't reject the normality assumption of the residuals. The ARCH LM test for autocorrelation in the error variance in the chosen model was conducted and showed that χ^2 =2.193 with p-value (0.1386), which suggests that the error variance is serially uncorrelated. For example, residuals don't contain significant ARCH effects. The researcher has tried to compare the chosen model ARIMA (2,1,1) with some other models that satisfy the normality assumption in their residuals, such as: ARIMA(2,1,0), ARIMA (0,1,1) and ARIMA(1,1,1). The log-likelihood values and the LR-test have found that our model ARIMA (2,1,1) is preferred above the other models.

The results of estimation of the univariate ARIMA (2,1,1) model is shown in Table (3).

The coefficients of AR(1) and MA(1) are very highly significant, whereas, the coefficient of AR(2) is marginally significant. R^2 and Adjusted-R^2 are not high enough and this is a normal conclusion for differenced variables, since differencing may result in a loss of information about the long-run relationship among variables (Pindyck and Rubinfeld, 1991). The value of Durbin-Watson indicates that there is no positive or negative first order serial correlation. The F-statistic value is very highly significant.

The modified Box-Pierce (Ljung-Box) chisquare statistic at different lags (12,24,36) seems to show that we can not reject the hypotheses that this model fits the data since the P-values are greater than 10% as shown in table (4).

Table 4: Box-Pierce (Ljung-Box) Chisquare Statistic.

Lags	χ^2	Degrees of Freedom	P-Value
12	12.7	9	0.176588
24	14.9	21	0.827933
36	16.0	33	0.994430

Thus, our model would take the form;

$$BD^*_t = -0.638 - 0.693BD^*_{t-1} + 0.313BD^*_{t-2} + \varepsilon_t - 1.446\,\varepsilon_{t-1}$$

Which can be rewritten as:-

$$\Phi(L)\,BD^*_t = \delta + \theta(L)\,\varepsilon_t$$

Where;

$$\Phi(L)=1+0.693L-0.313L^2 \text{ and } \theta(L)=1-0.1446L$$

Once the differenced series BD^* (=ΔBD) has been forecasted, a forecast can be obtained for the original series BD, simply by applying the summation operation to ΔBD that is, by summing ΔBD once. The K-period forecast of fBD_T would be given by:-

$$fBD_T(K)= BD_T + fBD^*_T(1) + fBD^*_T(2) + fBD^*_T(3) + \dots\dots\dots + fBD^*_T(K)$$

Table 5: Forecasting the Budget Deficit (ƒBD).

Year	Forecast (JD Million)	Lower limit (95% Limit)	Upper limit (95% Limit)
2006	-117.531	-367.108	132.046
2007	-100.827	-387.771	186.117
2008	-132.770	-452.194	186.654
2009	-116.117	-465.518	233.284
2010	-148.012	-524.544	228.519
2011	-131.407	-533.681	270.868
2012	-163.255	-589.307	262.797
2013	-146.697	-595.661	302.267
2014	-178.497	-648.885	291.890
2015	-161.986	-653.222	329.249
2016	-193.740	-704.630	317.150
2017	-177.276	-707.423	352.872
2018	-208.983	-757.392	339.427
2019	-192.565	-758.958	373.827
2020	-224.225	-807.747	359.296
2021	-207.855	-808.308	392.598
2022	-239.468	-856.105	377.169
2023	-223.145	-855.828	409.539
2024	-254.711	-902.774	393.352
2025	-289.325	-960.112	398.876

Table 6: Annual Growth Rates of BD.

Period	Growth Rate (%)	Realized or Forecasted?
1964-1975	-10.6	Realized
1975-1985	-17.8	Realized
1985-1995	9.0	Realized
1995-2004	5.3	Realized
2006-2015	6.5	Forecasted
2015-2025	16.7	Forecasted

Note: Positive numbers for growth rates mean deficit, whereas negative ones mean surplus.

Where;

ƒBD: is the forecast of BD.

ƒBD^*: is the forecast of ΔBD.

The results of forecasting of BD over the period (2006-2025) is given in table (5).

Table (5) shows that the budget deficit will grow up over time, the forecasted one in year 2006 is (-117.531) JD million, and (-289.325) JD million in 2025 with an approximate annual growth rate (6.3%). The realized and forecasted growth rates over different sub-periods are reported in table (6).

The expected increases in the Jordanian budget deficit must be financed in different ways; One of them, is through getting more domestic and external loans, which may worsen the crisis of public debt in Jordan (Al-Fanik, 2005). It is worthy to mention that the sharp increases in the oil prices during the last two years, may increase the expected or forecasted Jordanian budget deficit.

5. FINAL REMARKS

This study has forecasted the budget deficit in Jordan over the coming twenty years (2006-2025). The available historical data for the Jordanian budget deficit over the period (1964-2003) was handled by a time series technique; Autoregressive Integrated Moving Average (ARIMA) model. Different diagnostic tests also were performed to reach the final results. The empirical results have shown that the Jordanian budget will keep suffering from an increasing deficit over the coming twenty years, which will be inconsistent with the structural reform program. This increase in the budget deficit may raise the public debt; external and domestic.

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التنبؤ بعجز الموازنة العامة في الأردن خلال الفترة الزمنية (2006-2025): نموذج ARIMA

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ملخـص

تهدف هذه الدراسة، بشكل أساسي، إلى الكشف عن عجز الموازنة العامة الأردنية المتوقع خلال العشرين سنة القادمة (2006-2025). ولتحقيق هذا الهدف تم تطبيق نموذج (ARIMA) أحادي المتغير على البيانات التاريخية السنوية المتوفرة عن عجز الموازنة العامة خلال الفترة (1964-2003). كما تم أيضا اجراء بعض الاختبارات التشخيصية اللازمة للتحقق من مدى دقة النتائج.

بينّت النتائج التطبيقية للدراسة أن الموازنة العامة في الأردن ستعاني من عجز متنامٍ خلال العشرين السنة القادمة، مما قد يفاقم أزمة المديونية الداخلية والخارجية في الأردن، وهذا لا يتفق مع ما تتوقعه الحكومة الأردنية من برامج التصحيح الاقتصادي المتلاحقة.

الكلمات الدالة: موازنة عامة، الاقتصاد الأردني، نموذج ARIMA.

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