GDP and Inflation: New Story from a Developing World: Case of Jordan

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Abstract

This research examines the short-run and long-run relationships between inflation and economic growth in Jordan during 1977-2021. A two-variable VAR model with three lags was conducted to systematically capture the dynamics in the two-time series, inflation, and economic growth. The dynamic properties of the VAR (3) were summarized using impulse response functions and variance decompositions. There was no long-run relationship between inflation and economic growth, instead, a potential positive short-run relationship exists. Our findings are aligned with the existing body of literature on the nexus between inflation and economic growth; the results of our study can be utilized formulate macroeconomic policies by promoting economic growth which in return provides a stable economic environment without causing inflationary pressures. It could also be utilized by other countries with similar economic structures. Therefore, it is suggested that the country should maintain a moderate inflation rate for short-run growth.

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1. Introduction

The impact of inflation on economic growth is a subject of an ongoing debate. The relationship between GDP and inflation has been debated extensively in both empirical as well as theoretical researches with hands-on country classifications; both developed and developing countries (Asandului and Lupu, 2015). The purpose of the work is to investigates the presence of any causality among inflation and output growth during the period (1977-2021) in a scarce resource country, such as Jordan, which is also affected by several uplifts of unrest political situations from the surrounding countries in the Middle East and North Africa (MENA) region.

The Hashemite Kingdom of Jordan has been acting as a participating member in the war zone due to the recipients of refugees along with maintaining strong relations with foreign powers. Jordan's previous refugee crises are incomparable with the undergoing Syrian crisis; it is on a global scale the greatest displacement crisis during the past fifty years. This crisis has a large-scale population displacement for the eleventh year in a row, and yet ongoing. The outbreak of the Arab Spring in the MENA region was triggered by collapsing the traditional autocratic regimes in the republics of the region (Salamey, 2017). Jordan's central role in the region makes the analysis of GDP and inflation dynamics there of the utmost importance. Understanding Jordan's economy is crucial due to its pivotal role in shaping the economic structure of the region. Researchers can discover the underlying factors that affect Jordan's economic stability and its effects on neighboring economies by probing the complex relationship between GDP and inflation. As a result, this research is an essential tool for decision-makers, economists, and other stakeholders, empowering them to create effective plans and promote sustainable economic growth in Jordan and the larger region.

Jordan relies on rentierism as a country, lacking substantial productive resources or a significant industrial base. The country depends mainly on two sources of financing: exports of services and workers' transfers associated with the country's human capital, i.e., remittances and foreign aid. For remittances, one needs to realize that they are not only larger than Foreign Direct Investments (FDI), foreign grants and national exports all together, but also the most stable resource for the livelihoods of the receiving households (JSF, 2018). Remittances have registered a considerable contribution to Jordan's GDP, from 2.6% in 1975 to 22.3% in 1996 and 17.3% in 2014, and went down to 11% in 2020 due to Coronavirus consequences "COVID-19" (WBG, 2022). These inflows of remittances have no direct impact on inflation; instead, the indirect spillover effect was due to the increased Jordanian bank deposits as well as the bank deposits in foreign currencies; attributable to the rise of money supply in the country. Due to the high remittances inflow, the households sector in Jordan is not directly linked to the government of Jordan's public spending policies, monetary policy (increasing or lowering the interest rate, for example), or fiscal policy intervention (financial support for certain groups in society).

GDP and inflation are two key monetary pointers that are significant for figuring

out the general soundness of an economy. In Jordan, these variables are especially significant because of multiple factors, the kingdom is considered an upper-middle-income country that has been experiencing several economic growth activities, furthermore, the nation has established itself as the Middle East's anchor for stability from a geopolitical standpoint. For that purpose, a stable economy is essential for a nation's citizens' general welfare. An economy is stable when it has a consistent GDP growth rate and low inflation rate, which enables businesses to run effectively and citizens to afford essentials. Jordan's economy may be able to draw foreign investment and investors are more likely to make investments in nations with stable economic conditions and a welcoming business environment, which can help to spur economic growth and create job opportunities targeting the unemployed population. GDP and inflation data may be used by the Jordanian government to guide decisions about taxation, spending, and monetary policy. For instance, if inflation is high, the government may need to increase interest rates in order to reduce it, which could have an effect on both businesses and households. As for the trade perspective, Jordan's economy is heavily dependent on foreign trade. Jordan can become more competitive in the global market and draw foreign investment and trade partnerships with a high GDP growth rate and low inflation rate, consequently, that creates stronger policy incentives to maintain low inflation levels.

The rest of the paper is structured as follows, part 2 offers a survey of the related economic literature from a global perspective with a careful review of key publications cited. The conducted study organized a comparative table to examine and contrast the controversial and diverging hypotheses from various countries around the world, including but not limited to, the Middle East and Africa. Part 3 outlines the data and the analysis method. Part 4 illustrates the analysis results. Finally, conclusions and test results are included in part 5. Appendix I. offers the supplementary data explanation.

2. Literature Review

The literature on inflation and growth has a long and enduring tradition in economics (Asandului and Lupu, 2015). Extensive theoretical and empirical studies have examined how inflation and economic growth, in both developed and developing nations, are related to one another. This section provides a brief overview of the main studies in this field. According to Valdovinos (2003), the original data illustrates the absence of a clear relationship between inflation and growth over time, after using the Baxter and King filter to extract the long run components of the data, a clear negative relation emerges between the two-time series, of eight different Latin American countries, from 1970 to 2000.

Asandului and Lupu (2015) examined three testes, namely; the structural break using Zivot-Andrews test, the stationarity test using ADF, and the Granger causality testing. Test results showed that for the period 1970 to 2013, there was a cointegrating relationship between inflation and economic growth for Romania. According to Hussain and Malik (2011) for the case study of Pakistan during 1960 until 2006, inflation was positively related with economic growth and vice versa.

However, Guerrero (2006) suggested that inflation has an adverse effect on growth that is economically significant and quite robust statistically, in high, middle, and low income countries. Apergis (2004) through univariate GARCH models and a panel set for the International Group of Seven (G7), suggested that inflation affects output growth, while Friedman (1977) hypothesis stated that inflation causes inflation uncertainty. Apergis's analysis provided support to Cukierman and Meltzer (1986) hypothesis.

Another study by Barro (2013) analyzed 100 countries during thirty years (1960-1990) to assess the effects of inflation on the economic performance, results have found causal influences from inflation to growth and investment. Although the negative effects of inflation on growth appear to be minimal, they had significant long-term effects on living standards. Robert and Alexander (1997) found a strong evidence between inflation and real growth after using a small sample of OECD countries. Aydın, et al. (2016) studied five Turkish Republics using panel data, results have reflected a nonlinear relationship between inflation and growth rate, and that illustrated how a high inflation rate can have a considerable influence on economic growth. Koulakiotis, et al. (2012) investigated the causality between inflation and GDP during the period from 1961 to 2008, through panel univariate GARCH models for 14 European countries, at a 5% level of significance, inflation causes GDP, and at a 10% level of significance, GDP causes inflation. There is a bidirectional effect as a result. Hwang and Wu (2011) examined the inflation–growth nexus in China from 1986 to 2006, according to the empirical findings, the inflation threshold effect is highly significant and robust. Ahmed and Mortaza (2005) used annual data set on real GDP and CPI in Bangladesh, for the period of 1980 to 2005, results demonstrated a statistically significant long-run negative relationship between inflation and economic growth.

Chimobi (2010) tested empirically the Nigerian case for the period (1970-2005), results have shown no co-integrating relationship between Inflation and economic growth. Furthermore, the causality relationship using VAR-Granger causality at two different lag periods was tested, and the result have shown the same. Mallik and Chowdhury (2001) have examined the relationship between inflation and GDP growth for 4 South Asian countries from 1961 to 1997, the analysis found that inflation and economic growth are positively related. Moreover, growth is more sensitive to changes in inflation rates than inflation is to changes in growth rates. Hwang (2007) investigated inflation-growth causality using a monthly data of US real growth rates and inflation rates from January 1947 until March 2005. With VARMA-ML-Asymmetric-VGARCH to investigate the causality between inflation and economic growth, results suggested that while one level has a positive effect on both uncertainties, one level has a positive effect on its level and a negative effect on the other level in a much smaller magnitude.

Regarding the case of Jordan, Sweidan (2004) explored the relation between inflation and economic growth to check whether if this relation has a structural breakpoint effect or not. The study demonstrates that the structural breakpoint effect happens when the inflation rate reaches 2%, after which the effect shifts to the

negative. This finding indicates that the monetary policy's room for maneuver will be very small. Additionally, while implementing the new monetary policy, the Jordanian central bank should be mindful of the inflation phenomenon. Almajali and Almubidin (2022) estimated the indirect effects of the Jordanian monetary policy on three economic variables; foreign reserves, output gap, and inflation using the new Keynesian Theory. Results found that the monetary policy implemented by the Central Bank of Jordan has a certain level of effectiveness in influencing inflation and the output gap. However, its impact is found to be somewhat constrained. Additionally, the study highlights that the monetary policy has a significant role in covering the expenses related to the country's most prominent imports by affecting the foreign reserves. Another Jordanian study by Abu Shihab (2014) during early 2000s (2000-2012) examined the Granger causality between economic growth and fiscal policy, in conclusion, results have shown the existence of a causal relationship between the two variables; economic growth can be used to explain the changes which occur to the budget deficit, but not vice versa. Within the same Jordanian nexus, Matar (2016) investigated the empirical relationship between FDI, per capita electrical power consumption, economic growth. The findings indicate the presence of a long-run equilibrium relationship between electricity consumption and economic growth. Furthermore, the study suggests a unidirectional relationship from the real GDP to electrical power consumption.

Another panel data by Gillman and Harris (2010) analyzed 13 transition countries during 13 years; (1990-2003) to study the effect of inflation on economic growth. Results found a strong negative robust effect of inflation on growth. Another time series data analyzed the case of South Africa by Odhiambo M. (2013), where they studied the link between inflation and economic growth and results have indicated a bidirectional causality between the two variables. Within the same context of time-series data, a study from Kuwait by Saaed (2007) for the period of 1985 to 2005 examined the nexus between inflation and economic growth using co-integration and error correction models, results demonstrated the existence of a strong long-run inverse relationship between the two variables. Using time-series data in China during (1979–2014), He and Zou (2016) showed that magnitude of the estimated effect of inflation has a significant positive impact on economic growth.

In three Asian countries for the period (1980-2010), Jayathileke and Rathnayake (2013) showed that there is a long-run negative and significant relationship between economic growth and inflation. In Vietnam, Dinh (2020) investigated the impact of inflation rate on economic growth using time-series data from 1996 to 2018, the author found the best-fit model for the Vietnamese case and results showed that the inflation rate is positively related to economic growth. Ekinci, et al. (2020) examined 24 countries to understand the nexus between price stability and economic growth, threshold dynamic panel data model was used in the analysis by applying inflation targeting. The results of the conducted study have shown that the relationship between inflation and economic growth is nonlinear. Mollick, et al. (2011) examined the effects of inflation during the what sol-called "globalization years" of (1986–2004) using a panel data, results have shown that inflation effect

in emerging markets is less than the static models case, these results have been reported in the long-run. Paul, et al. (1997) examined the nexus between inflation and economic growth using 70 countries data during the period (1960-1989) using the Granger causality methodology, results were varied and mixed; non-uniform, no-causality, unidirectional causality, and bidirectional causality. To examine the threshold inflation rate which affects the economic growth, Ajide and Lawanson (2011) observed that after using the causality test between inflation and real GDP growth, there was neither bidirectional nor unidirectional causality, in addition, the nexus between the two variables was rather considered independent relationship.

In a similar direction, Hasanov and Omay (2011) tested 10 CEE countries for causal relationships, in some of the countries, results suggested that output growth rate minimizes market volatility, whereas inflation rate causes variability for both inflation rate as well as output growth rate; while one level has a positive effect on both uncertainties, one level has a positive effect on its level and a negative effect on the other level in a much smaller magnitude. Manamperi (2014) tested the nexus between inflation and economic growth for both, long-run and short-run, in the BRICS countries during 30 years (1980-2012), results showing the relationship between inflation and economic growth varied from long-run to short-run, from positive to negative, and even no relationship, depending on the studied countries. In Bangladesh, during (1978-2010) Hossain, et al. (2012) examined the long-run relationship between inflation and economic growth, results found that inflation has certainly an impact on economic growth. Behera (2014) investigated the impact of inflation on economic growth in 6 South Asian Countries during (1980-2012), the countries results' have shown no long-run relation between inflation and economic growth except for Malaysia where cointegration results showed an existing relationship in the long-run.

Gregorio (1993) investigated the relationship between inflation and growth in 12 Latin American countries for the period (1950-1985) have shown that inflation was indeed detrimental to growth, and the relationship was rather negative. Within the same Latin American context, Valdovinos (2003) used 8 different countries durian (1970-2000), a strong negative relationship appeared in the data. Baltar (2015) studied the case of Brazil and suggested examining the relationship between economic growth and inflation using a specific model "the cost-based price approach". A high level of inflation is one of the factors that can hinder a nation's economic growth; it leads to a continuous increase in the prices of essential goods and services, which are fundamental needs of society. On the other side of the continent, Bittencourt, et al. (2015) studied 15 SSA countries during (1980-2009), results have suggested that inflation had indeed a detrimental effect to growth. Jung and Marshall (1986) used a data set for a diverse array of countries to examine the nexus between inflation and economic growth, the results were tested using the Granger causality method. The results were indicative between both views, the distortionist, and the structuralist, furthermore, one has discussed that inflation can lower real growth, while the other has the tendency to increase real growth. Table 1. reflects a synthesis of the various economic perspectives on the topic.

Table 1: Findings summary of the various economic studies on Inflation and Economic Growth

Authors	Countries	Time Period	Methodology	Findings
Asandului and Lupu (2015)	Romania	1970-2013	Structural break, Stationarity, Granger causality	Cointegrating relationship between inflation and economic growth for Romania
Almajali and Almubidin (2022)	Jordan	Quarterly data 2000-2019	Simultaneous equations methodology and GMM	Monetary policy has a certain level of effectiveness in influencing inflation and the output gap
Abu Shihab (2014)	Jordan	2000-2012	Granger causality	Causal relationship between economic growth and fiscal policy
Matar (2016)	Jordan	1976-2011	Time series using ARDL	Long-run equilibrium relationship between electricity consumption and economic growth
Valdovinos (2003)	Eight Latin American countries	1970-2000	Baxter and King filter	Clear negative relation between inflation and economic growth over time
Hussain and Malik (2011)	Pakistan	1960-2006	2SLS technique	Positive relationship between inflation and economic growth and vice versa in the case of Pakistan
Guerrero (2006)	Rich, middle-income, and poor countries	1949-2002	OLS	Inflation has an adverse effect on growth that is economically significant and quite robust statistically
Apergis (2004)	International Group of Seven (G7)	1960–2000	Univariate GARCH models, panel set	Inflation affects output growth, supporting Cukierman and Meltzer's hypothesis.
Friedman (1977)	France, Italy, Sweden, US, UK, Canada, Germany, and Japan	1966-1970 and 1970-1975	The "natural-rate", "accelerationist" or "expectations-adjusted Phillips curve" hypothesis	Inflation causes inflation uncertainty, not directly related to the relationship between inflation and economic growth
Barro (2013)	100 countries	1960-1990	Panel data	Causal influences from inflation to growth and investment, with small adverse influence on growth and substantial long-term effects on standards of living
Robert and Alexander (1997)	OECD countries	1966-1988	pooled time series and cross-section fashion	Strong evidence between inflation and real growth

Aydın, et al. (2016)	5 Turkish Republics	1992-2013	Panel data	Nonlinear relationship between inflation and growth rate, with high inflation rate having a considerable influence on economic growth
Koulakiotis, et al. (2012)	14 European countries	1961-2008	Panel univariate GARCH models	Bidirectional effect between inflation and GDP, with inflation causing GDP at 5% significance level and GDP causing inflation at 10% significance level
Hwang and Wu (2011)	China	1986-2006	ARDL	Highly significant and robust inflation threshold effect on the inflation-growth nexus in China
Chimobi (2010)	Nigeria	1970-2005	VAR-Granger causality	No co-integrating relationship between inflation and economic growth.
Mallik and Chowdhury (2001)	South Asian countries	1961-1997	Time series analysis	Inflation and economic growth are positively related. Sensitivity of inflation to changes in growth rates is larger than that of growth to changes in inflation rates.
Hwang (2007)	United States	1947- 2005	VARMA-ML-Asymmetric-VGARCH	Bidirectional causality between inflation and economic growth.
Sweidan (2004)	Jordan	1970-2003	Structural breakpoint analysis	Negative effect of inflation on economic growth after inflation rate equal to 2%.
Gillman and Harris (2010)	13 transition countries	1990-2003	Panel data analysis	Strong negative robust effect of inflation on growth.
OdhiambyM. (2013)	South Africa	1980-2011	Time series analysis	Bidirectional causality between inflation and economic growth.
Saaed (2007)	Kuwait	1985-2005	Co-integration and error correction models	Strong long-run inverse relationship between inflation and economic growth.
He and Zou (2016)	China	1979-2014	Time series analysis	Significant positive impact of inflation on economic growth.
Jayathileke and Rathnayake (2013)	Asian countries	1980-2010	Time series analysis	Negative and significant long-run relationship between economic growth and inflation
Dinh (2020)	Vietnam	1996-2018	Time series analysis	Positive relationship between inflation rate and economic growth

Ekinci, et al. (2020)	24 countries	1997- 2018	Threshold dynamic panel data model	Nonlinear relationship between inflation and economic growth
Mollick, et al. (2011)	Emerging markets	1986-2004	Panel data analysis	Inflation effect in emerging markets is less than the static models case in the long-run
Paul, et al. (1997)	70 countries	1960-1989	Granger causality methodology	Mixed and varied results, including no-causality, unidirectional causality, and bidirectional causality
Ajide and Lawanson (2011)	Nigeria	1970-2003	Causality test	Independent relationship between inflation and real GDP growth
Hasanov and Omay (2011)	10 CEE countries	1998- 2008	Causality test	Inflation rate causes variability for both inflation rate and output growth rate, while output growth rate minimizes market volatility
Manamperi (2014)	BRICS countries	1980-2012	Long-run and short-run analysis	Relationship between inflation and economic growth varied from long-run to short-run, from positive to negative, and even no relationship
Hossain, et al. (2012)	Bangladesh	1978-2010	Time series analysis	Inflation has a negative impact on economic growth
Behera (2014)	6 South Asian countries	1980-2012	Cointegration analysis	No long-run relationship between inflation and economic growth except for Malaysia
Gregorio (1993)	12 Latin American countries	1950-1985	2 models that demonstrate various ways in which inflation influences growth were presented	Negative relationship between inflation and growth
Baltar (2015)	Brazil	1994- 2013	Cost-based price approach	Confirms the relationship postulates in the article
Bittencourt, et al. (2015)	15 SSA countries	1980-2009	Panel data analysis	Inflation had a detrimental effect on growth
Jung and Marshall (1986)	Diverse array of countries	1960-1980	Granger causality methodology	Indicative results for both the distortionist and the structuralist views of inflation's effect on growth

In conclusion, and with the previous findings', the hypotheses are considered controversial and indecisive. Results varied; some found a robust evidence that inflation was positively related with economic growth while other researches documented a little support and even a negative one. Accordingly, some can give spurious results if a certain variable was excluded in the empirical analysis. For that reason, the dynamic causality between economic growth, and inflation will be presented in this research paper for the case of Jordan. Chronology of significant events occurred during the studied time period and have affected the country's GDP. Starting from the Gulf War (1990-1991), 2003 Iraqi War, passing by the Global Financial Crisis (2008-2009), 2010 Arab Spring, the 2011 Syrian Civil War and the refugees crisis, and lately, the COVID-19 economic challenge.

3. Analysis Method

The purpose of this study was to examine the short and long-run relationship between inflation and economic growth (measured as GDP growth) in Jordan for the period 1977 to 2021. The stationarity of each series was checked using the Augmented Dickey–Fuller (ADF) test and the Phillips and Perron (PP) test. As the series were stationary at I (0), a two-variable vector autoregressive (VAR) model with k lags (Sims, 1980) was conducted to systematically capture the dynamics in the two-time series, inflation and economic growth. The VAR can be represented using the following two equations:

$$y_t = \beta_{y0} + \beta_{yy1}y_{t-1} + \cdots + \beta_{yyk}y_{t-k} + \beta_{yx1}x_{t-1} + \cdots + \beta_{yxk}x_{t-k} + v_t^y \qquad (1)$$

$$x_t = \beta_{x0} + \beta_{xy1}y_{t-1} + \cdots + \beta_{xyk}y_{t-k} + \beta_{xx1}x_{t-1} + \cdots + \beta_{xxk}x_{t-k} + v_t^x \qquad (2)$$

Where y = inflation, x = GDP growth, t = time, and β_y0 and β_x0 represent intercepts. β_yyk represents the coefficient of y in the equation for y at lag k, β_yxk represents the coefficient of x in the equation for y at lag k, β_xyk represents the coefficient of y in the equation for x at lag k, β_xxk represents the coefficient of x in the equation for x at lag k. v_t^y and v_t^x are error terms (serially uncorrelated or independent) normally distributed with mean zero and time invariant covariance matrix Σ.

The information criteria include Akaike's information criterion (AIC), the corrected Akaike's information criterion (AICC), the final prediction error criterion (FPE), the Hannan-Quinn criterion (HQC), and the Schwarz Bayesian criterion (SBC, also referred to as BIC) were used to determine the optimum lag k for the VAR. The dynamic properties of the VAR(k) were summarized using the following two types of structural analysis, including impulse response functions and variance decompositions. Granger causality test was not used to further assess the VAR as the both data series were I(0), which implying there was no long-run relationship between the two series.

To ensure the validity of the VAR models, Durbin-Watson test statistics were used

to test the null hypothesis that the residuals were uncorrelated. The Jarque-Bera normality test statistics and quantile-quantile (QQ) plots were used to determine if the residuals were normally distributed. The F statistics and their p-values for autoregressive conditional heteroskedasticity (ARCH), a method that explicitly models the change in variance over time in a time series, were used to test the null hypothesis that the residuals have equal covariances. The residuals were found to be uncorrelated and normally distributed with equal covariances (See Appendix I). All analyses were performed using SAS version 9.1.4 (Cary, NC). For any tests, a p-value < 0.05 indicated significance.

4. Analysis Result

Figure 1 shows the plot of the two-time series, inflation and GDP growth, in Jordan for the period 1977 to 2021. There was no obvious time trend for both time series. The average GDP growth was 4.65% (SD = 5.30), with a maximum of 20.80% and a minimum of -10.73% (Table 2). The average inflation was 4.97% (SD = 5.21), with a maximum of 25.71% and a minimum of -0.88% (Table 2.).
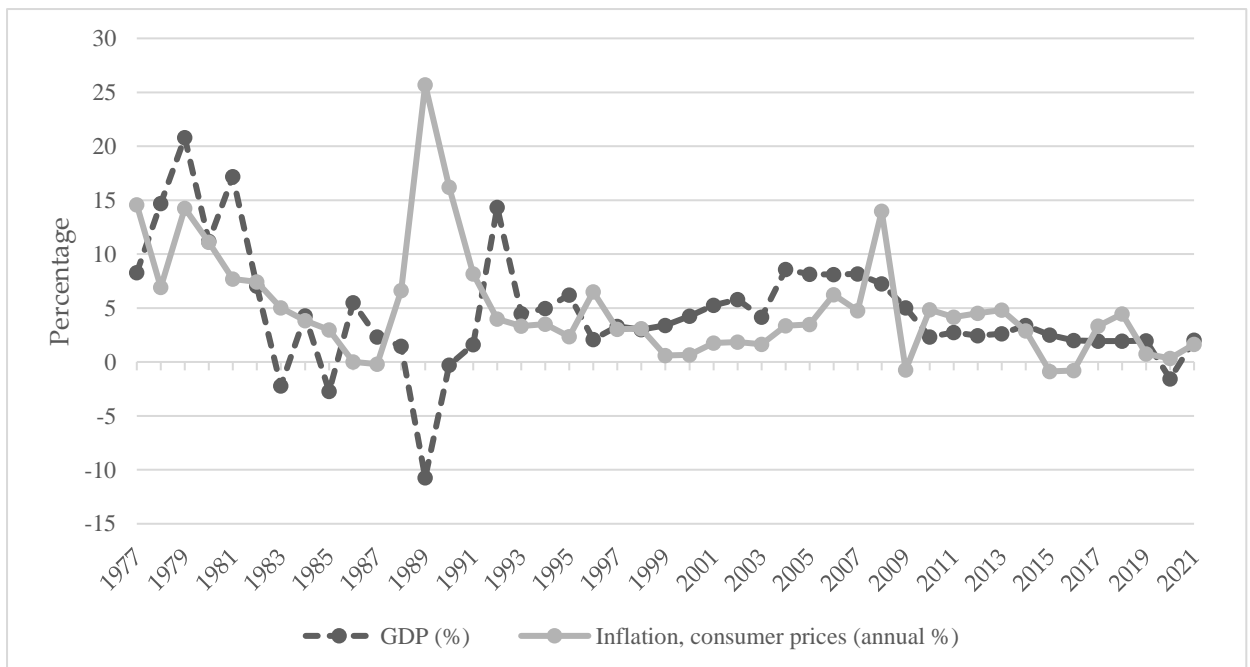
Source: The World Bank Data.

Figure 1: GDP growth and inflation

Table 2: Descriptive statistics

	M	SD	Min	Max
GDP growth (%)	4.65	5.30	-10.73	20.80
Inflation (%)	4.97	5.21	-0.88	25.71

To test if there was a unit root in the two-time series, Augmented Dickey–Fuller tests and Phillips and Perron tests for up to 4 lagged differences were utilized (Table 3). The p-values of the tau test statistics for the ADF and PP tests in all the autoregressive models were less than 0.05, and the null hypothesis (the series is nonstationary, i.e., there is a unit root) was rejected at the 5% level. Both time series, GDP growth and inflation, were stationary, i.e., I (0).

Table 3: Assessment of stationarity

	Lags	Augmented Dickey–Fuller		Phillips and Perron	
		Tau	p	Tau	p
GDP growth	0	-3.65	0.0083	-3.65	0.0083
	1	-3.41	0.0186	-3.53	0.0115
	2	-4.05	0.0028	-3.63	0.0088
	3	-3.43	0.0151	-3.61	0.0092
	4	-3.74	0.0068	-3.57	0.0103
Inflation	0	-4.07	0.0025	-4.07	0.0025
	1	-3.30	0.0207	-4.09	0.0024
	2	-3.73	0.0068	-4.09	0.0024
	3	-3.16	0.0299	-4.02	0.0030
	4	-2.70	0.0424	-3.96	0.0035

As the series were stationary at I(0), based on information criteria such as AIC, AICC, FPEC, HQC, and BIC (Table 4), a two-variable VAR(3) was conducted to systematically capture the dynamics in the two time series, inflation and GDP growth.

Table 4: Information criteria to determine the optimum lag k for the VAR

	k = 1	*k* = 2	*k* = 3	*k* = 4	*k* = 5
AICC	367.12	366.63	361.21	380.97	421.51
HQC	367.78	362.52	346.54	345.44	434.92
AIC	361.83	354.08	328.65	332.34	335.71
BIC	377.89	376.97	365.25	368.32	370.88
FPEC	440.30	444.50	349.54	393.08	443.82

Note. Bold text indicated smallest number for the information criteria. Optimum lag k = 3 was selected as the model had the smallest information criteria based on AICC, AIC, BIC, and FPEC.

According to the parameter estimates of the VAR(3), (Table 4), the two univariate regression equations systematically capturing the dynamics in inflation and economic growth can be written as:

$GDP_t = 0.8411 + 0.2452*GDP_{t-1} - 0.0184*Inflation_{t-1} + 0.3449*GDP_{t-2} + 0.2463*Inflation_{t-2} - 0.2112*GDP_{t-3} + 0.0548*Inflation_{t-3} + v_t^{GDP}$,

$Inflation_t = 2.3518 + 0.0794*GDP_{t-1} + 0.5305*Inflation_{t-1} + 0.410*GDP_{t-2} - 0.0506*Inflation_{t-2} + 0.250*GDP_{t-3} - 0.1568*Inflation_{t-3} + v_t^{Inflation}$.

It appeared that current GDP growth was statistically significantly positively associated with lagged 2 GDP growth ($\beta = 0.3449$, $p = 0.0270$), and not associated with other lagged GDP growth and any lagged inflation.
It appeared that current inflation was statistically significantly positively associated with lagged 1 inflation ($\beta = 0.5305$, $p = 0.0027$), and not associated with other lagged inflation and any GDP growth.

Table 5: Parameter estimates of VAR (3)

	Variable	β	SE	t	p
GDP	Constant	0.8411	1.1182	0.75	0.4570
	GDP_{t-1}	0.2452	0.1539	1.59	0.1201
	$Inflation_{t-1}$	-0.0184	0.1401	-0.13	0.8965
	GDP_{t-2}	0.3449	0.1494	2.31	0.0270*
	$Inflation_{t-2}$	0.2463	0.1570	1.57	0.1257
	GDP_{t-3}	-0.2112	0.1427	-1.48	0.1480
	$Inflation_{t-3}$	0.0548	0.1475	0.37	0.7124
Inflation	Constant	2.3518	1.3089	1.80	0.0810
	GDP_{t-1}	0.0794	0.1801	0.44	0.3320
	$Inflation_{t-1}$	0.5305	0.1640	3.23	0.0027*
	GDP_{t-2}	0.0410	0.1749	0.23	0.8163
	$Inflation_{t-2}$	-0.0506	0.1838	-0.28	0.7849
	GDP_{t-3}	0.0250	0.1671	0.15	0.8821
	$Inflation_{t-3}$	-0.1568	0.1726	-0.91	0.3701

Note. * Indicated significance at the 0.05 level

The dynamic properties of the VAR (3) were further summarized impulse response functions and variance decompositions. The simple impulse response functions were used to quantify the impulse responses to shocks from either variable (inflation and GDP growth) over a 30-year period (Figure 1). A unit shock in GDP growth 1) increased GDP growth by a maximum of 0.40 in the short-run and became ineffective in the long-run, and 2) increased inflation by a maximum of 0.12 in t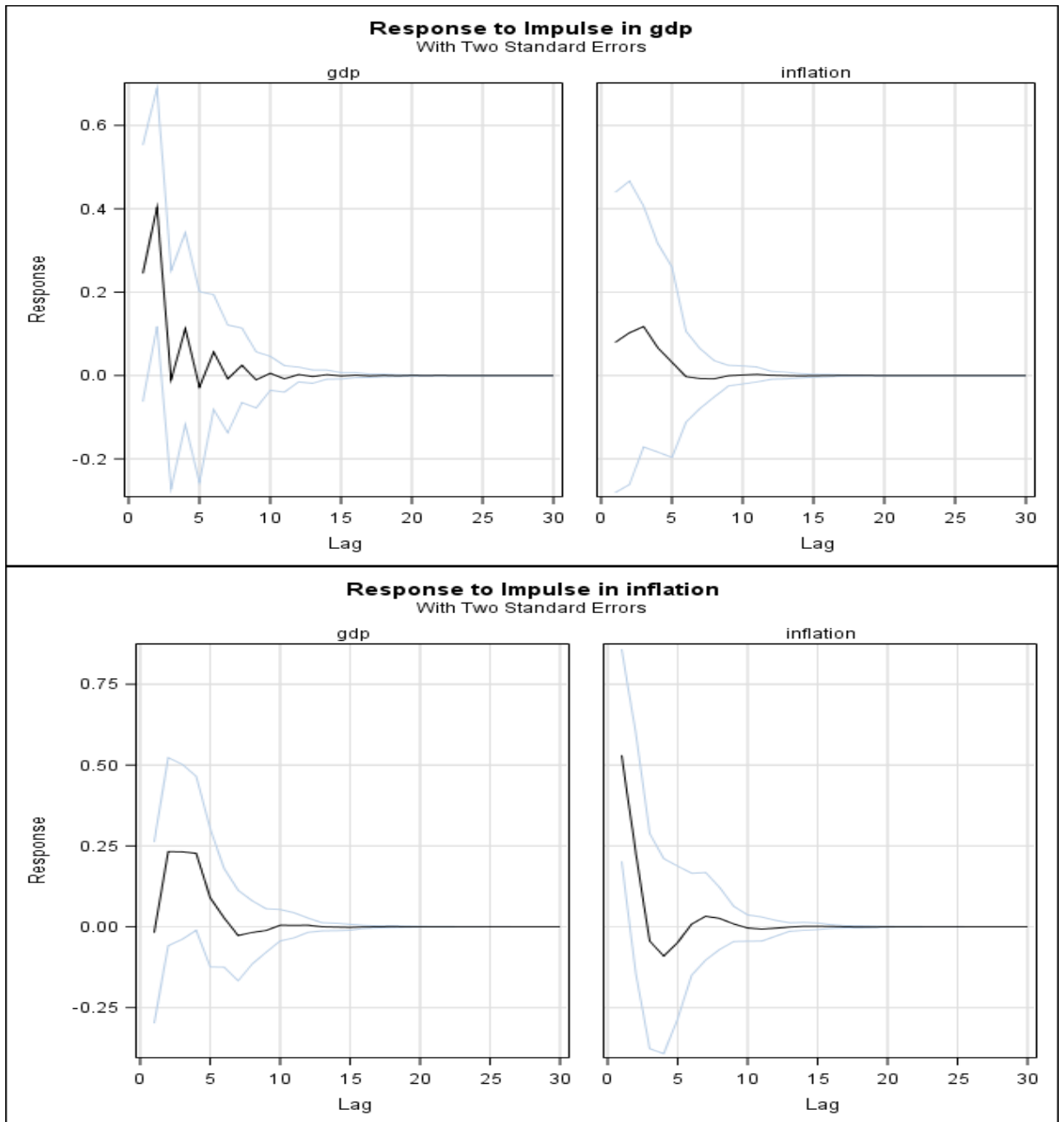he short-run and became ineffective in the long-run. A unit shock in inflation 1) increased GDP growth by a maximum of 0.23 in the short-run and became

ineffective in the long-run, and 2) increased inflation by a maximum of 0.53 in the short-run and became ineffective in the long-run.

Figure 2: Plots of impulse responses

Note. The two left-sided figures ("Response to impulse in gdp") show the responses of GDP growth and inflation to a forecast error impulse in GDP growth with two standard errors. The two right-sided figures ("Response to impulse in inflation") show the responses of GDP growth and inflation to a forecast error impulse in inflation with two standard errors.

Variance decompositions were used to quantify how important each of the shocks is as a component of the overall variance of each of the variables over time (Table 6). 85.82-99.96% of the 1-to-8-step-ahead prediction error covariances of GDP growth was accounted for by its own innovations and 0.04-14.18% was accounted for by the inflation innovations. 83.59-85.72% of the 1-to-8-step-ahead prediction error covariances of inflation was accounted for by its own innovations and 14.28-16.41% was accounted for by the GDP growth innovations.

Table 6: Proportions of decomposition of prediction error covariances of two variables

		Proportions of prediction error covariances by variable	
Variable	Lead	GDP growth	Inflation
GDP growth	1	1	0
	2	0.9996	0.0004
	3	0.9488	0.0512
	4	0.9041	0.0959
	5	0.8644	0.1356
	6	0.8590	0.1410
	7	0.8587	0.1413
	8	0.8582	0.1418
Inflation	1	0.1641	0.8359
	2	0.1478	0.8522
	3	0.1428	0.8572
	4	0.1518	0.8482
	5	0.1565	0.8435
	6	0.1577	0.8423
	7	0.1577	0.8423
	8	0.1578	0.8422

5. Conclusion

This study conducted a two-variable VAR model with three lags to examine both, the short-run and long-run relationships between inflation and economic growth (measured as GDP growth) in Jordan during the period (1977-2021). The dynamic properties of the VAR (3) were summarized using impulse response functions and variance decompositions. Although there was no long-run relationship between inflation and economic growth, there may be a positive short-run relationship between inflation and economic growth in Jordan from 1977 to 2021.

The evidence on the Jordanian case shows that the level of economic activity and price increase does not interplay; reflecting the current monetary policy, which might deter achieving SDG goal eight in enhancing economic growth and employment for all.

The presented work proves that countries-practically developing countries-

economic structure, employment availability, and government resources differ from developed countries. That is in tandem with what (Paul, et al., 1997) found in some African, developing Asian countries, and some Latin American countries, where no causal relationship between inflation and GDP was found. Most developing countries have no trade-off (zero opportunity cost) between inflation and economic growth. This study contributes to the existing literature by providing empirical evidence on the relationship between inflation and economic growth in Jordan.

Based on that finding, Jordan can improve its performance by enacting more efficient monetary policies to deal with the problem of a lack of interaction between economic activity and price growth. This can aid in achieving SDG Goal 8, which is to improve economic growth and employment opportunities for all. Theoretically speaking, Jordan has the ability to boost economic activity, control price stability, and foster an environment that will lead to sustained economic growth and more job opportunities by reviewing and improving their monetary policy framework. Within the same framework, the country can benefit from concentrating on enhancing its economic foundation, expanding employment opportunities, and maximizing government resources in order to better meet the unique needs and characteristics of developing nations.

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Appendix I. Supplementary Data

Durbin-Watson test statistics were used to test the null hypothesis that the residuals were uncorrelated (Brooks, 2014). The Durbin-Watson test statistics were 2.0360 and 2.0212 for GDP growth and inflation (Table A1), respectively, which indicated that the residuals for the VAR were uncorrelated.

The Jarque-Bera normality test statistics and quantile-quantile (QQ) plots were used to determine if the residuals were normally distributed. The results of the Jarque-Bera normality tests suggested that the residuals may not be normally distributed ($p < 0.0001$, Table A1). However, the QQ plots (Figure A1) indicated that the residuals may be normally distributed as most of the data points in the QQ plots were close to the 45-degree straight line. Thus, as Jarque-Bera normality tests may be conservative, it is concluded that the residuals were normally distributed based on the results of the QQ plots.

The *F* statistics and their *p*-values for autoregressive conditional heteroskedasticity (ARCH), a method that explicitly models the change in variance over time in a time series, were used to test the null hypothesis that the residuals have equal covariances. As the p-values of the F statistics for autoregressive conditional heteroskedasticity ($p = 0.5603$ GDP growth and $p = 0.8058$ for inflation) were greater than 0.05, it concludes that the residuals have equal covariances.

Table (A1): Univariate model white noise diagnostics

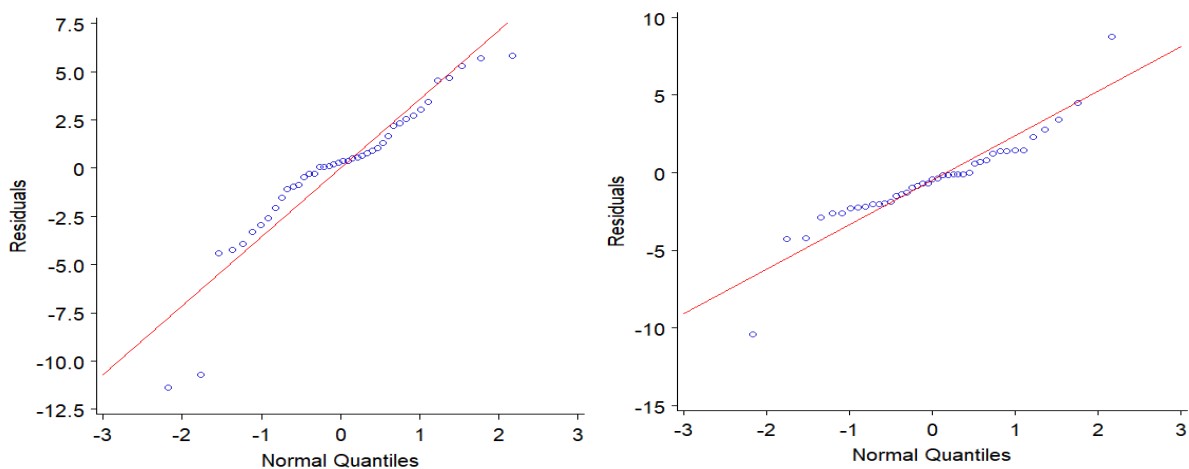|	**Durbin-Watson**	**Jarque-Bera normality test**		**ARCH**	
		χ^2	*p*	*F*	*P*
GDP growth	2.0360	19.91	< 0.001	0.35	0.5603
Inflation	2.0212	24.00	< 0.001	0.06	0.8058

Figure (A1): QQ plots for GDP growth (left) and inflation (right)