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Economic Growth, CO_2 Emissions, and Financial Development in Jordan: Equilibrium and Dynamic Causality Analysis

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Abstract

This article contributes to the existing literature by investigating equilibrium and dynamic causality relationships among economic development, CO_2 emissions, energy consumption, financial development, foreign direct investments inflows, and gross fixed capital formation in the case of kingdom of Jordan over the 1976-2010 period. The ARDL approach has been employed to detect co-integration between the series. The VECM Granger causality is also applied to evaluate causal relationships among the variables. The findings suggest the existence of co-integration between economic growth and its determinants. In addition, CO_2 emissions, foreign direct investments inflows, and gross fixed capital formation have positive and significant impact on economic growth in long-run. Interestingly, the results of this paper indicate that environmental Kuznets curve hypothesis does exist between economic development and CO_2 emission in long-run and short-run.

Keywords: ARDL approach, CO_2 emissions, economic development, EKC hypothesis, Jordan, VECM

1. Introduction

Jordan is one of the smallest economies in Middle East, with a total (GDP) gross domestic product of JD10.5 billion in 2012 and a population of 6.32 million, of which 13.3% live below the poverty line (CD-ROM, 2014). Unlike other neighboring Arab countries, it is a non-oil-producing country with limited natural resources and minerals. Jordan is rapidly growing, both as a result of its population demographic and due to an influx of refugees over the past decades, with an estimated 1.5 million non-Jordanian residents. It is heavily dependent on imports of energy to meet the growing of (EC) energy consumption due to the lack of energy resources. The EC is expected to double from 7.58 (mtoe) million tons of oil equivalents in 2007 to 15.08 mtoe by 2020 (The Jordanian Energy Sector Report, 2012).

The prices of energy have soared recently, which encouraged the Jordanian government to update its energy master plan. The energy sector master plan transforms the existing energy mix from one heavily reliant on oil, and natural resources to a more balanced mix with a higher proportion of energy supplied by nuclear power, oil shale, and renewable sources. In addition, the Jordanian government is currently supporting various policies, initiatives, and programmes aimed at achieving a green economy. These are: the complete removal of subsidies for oil in 2008; the adoption of the renewable energy law and fiscal incentive package on renewable energy and energy efficiency equipment in 2010; and the establishment of the Eco-cities forum, the Eco-financing seminar and the Zarqa river rehabilitation project (Green Economy Report, 2011).

The issue of relationships between GDP and its determinants including the EC has been diversely investigated (e.g., Alam, Begum, Buysse, & Huylenbroeck, 2012; Alam, Begum, Buysse, & Huylenbroeck, 2011; Altinay & Karagol, 2004; Apergis & Payne, 2010; Asafu-Adjaye, 2000; Bekhet & Othman, 2014; Bekhet & Othman, 2011; Bekhet & Yasmin, 2013; Belloumi, 2009; Boutabba, 2014; Dagher & Yacoubian, 2012; Hamdi, Sbia, & Shahbaz, 2014; Jobert & Karanfil, 2007; Kivyiro & Arminen, 2014; Lean & Smith, 2010; Menyah & Wolde-Rufael, 2010; Mugableh, 2013; Ozturk & Acaravci, 2010; Wang, Zhou, Zhou, & Wang, 2011; Zhang & Cheng, 2009). Thus, the main purpose of current paper is to rebuild the existing literature and examining equilibrium relationships between GDP and its determinants (i.e., (CO_2) carbon dioxide emissions, EC, (FD) financial development, (FDI) foreign direct investment inflows, and (GCF) gross fixed capital formation) for the case of an emerging country in Middle East, Jordan. In addition, different econometrics techniques have been employed to accomplish the objectives of this paper like diagnostic statistics tests, stationary test, (ARDL) autoregressive distributed lag approach, and (VECM) vector error correction model. The structure of the paper is as follows. Section 2 presents model structure and data used. Section 3 provides econometrics methodology. Section 4 offers results discussions, whereas Section 5 presents final remarks.

2. Model Structure and Data Used

The cure objective of this paper is to investigate equilibrium and causality relationships between GDP and its determinants including CO_2 emissions, EC, FD, FDI, and GCF using annual time-series data for the 1976-2010 period. The empirical model is structured as in Eq. (1).

$$LGDP_t = \beta_0 + \beta_1 LCO_{2t} + \beta_2 LEC_t + \beta_3 LFD_t + \beta_4 LFDI_t + \beta_5 LGCF_t + \varepsilon_t \quad (1)$$

where, L denotes the natural logarithmic form to remove non linearity in parameters; t represents the discrete time period; β_0 is the intercept term; β_i (i= 1, …, 5) represent the slope parameters of $LGDP_t$'s determinants; and ε_t signifies the error term. However, the GDP (constant billions, Jordanian Dinar, JD) represents the indicator of economic growth. The CO_2 emissions (metric tons per capita) demonstrate the main component of greenhouse gases in Jordan. The EC (Kg of oil equivalent per capita) represents the energy sector indicator. The FDI (% of GDP) is the flows of foreign capital into the Jordanian economy. The FD (domestic credit provided by financial sector, % of GDP) is a measurement of financial development. The GCF (% of GDP) represents a measure of gross net investment, acquisitions less disposals, in fixed capital assets by enterprises, government, and households within the Jordanian domestic economy during an accounting period of time. The time-series data has been obtained from the World Bank, World Development Indicators Databases (CD-ROM, 2014).

3. Econometrics Methodology

The present paper employs four steps of econometrics methodology to achieve research objectives. Initially, the descriptive statistics tests have been utilized to check if the (ε_t)s error terms are $((\varepsilon_t)s \sim N(0, \sigma^2))$ normally distributed with zero mean and constant variance. Ng-Perron (2001) unit root test has been used in the second step to determine the integration levels of variables. Also, the current paper employs the ARDL approach to test the (H_0) null hypothesis of no co-integration and estimate equilibrium relationships. This approach is suitable with small sample size and can be employed if the variables are having mixed order of integration (Bekhet & Al-Smadi, 2015; Bekhet & Mugableh, 2013; Mugableh, 2015; Narayan, 2005; Pesaran, Shin, & Smith, 2001). If the calculated F-statistics value is greater than the (I (1)) upper critical F-statistics value, then the H_0 of no co-integration would be rejected. In contrast, if the calculated F-statistics value is lesser than the (I (0)) lower critical F-statistics value, then the H_0 of no co-integration would be accepted. The ARDL approach is modelled as in Eq. (2).

$$\begin{aligned}\Delta LGDP_t = {} & \alpha_0 + \alpha_{1t} LGDP_{t-1} + \alpha_{2t} LCO_{2t-1} + \alpha_{3t} LEC_{t-1} + \alpha_{4t} LFD_{t-1} + \alpha_{5t} LFDI_{t-1} + \alpha_{6t} LGCF_{t-1} \\ & + \sum_{s=1}^{h} \alpha_{7s} \Delta LGDP_{t-s} + \sum_{s=0}^{h} \alpha_{8s} \Delta LCO_{2t-s} + \sum_{s=0}^{h} \alpha_{9s} \Delta LEC_{t-s} \\ & + \sum_{s=0}^{h} \alpha_{10s} \Delta LFD_{t-s} + \sum_{s=0}^{h} \alpha_{11s} \Delta LFDI_{t-s} + \sum_{s=0}^{h} \alpha_{12s} \Delta LGCF_{t-s} + \varepsilon_t \end{aligned} \quad (2)$$

where, Δ is the first difference operator; α_0 denotes the intercept term; α_{it} (i= 1,…. 6) represent long-run coefficient for testing the H_0 of no co-integration. If $\alpha_{it} \neq 0$, then the H_0 of no co-integration would be rejected, implying that the variables are shared long-run relationships among each other. α_{is} (i= 7,…. 12) signify short-run coefficients; h denotes the lag length that is obtained using the Akaike information criterion; and ε_t is the error term. If the co-integration exists between variables, then the causality in long-run and short-run should be evaluated. The VECM Granger causality has been developed as in Eq. (3) to determine the directions of causality.

$$\begin{bmatrix} \Delta LGDP_t \\ \Delta LCO_{2t} \\ \Delta LEC_t \\ \Delta LFD_t \\ \Delta LFDI_t \\ \Delta LGCF_t \end{bmatrix} = \begin{bmatrix} \alpha_{1t} \\ \alpha_{2t} \\ \alpha_{3t} \\ \alpha_{4t} \\ \alpha_{5t} \\ \alpha_{6t} \end{bmatrix} + \sum_{s=0}^{h} \begin{bmatrix} \delta_{11s} & \delta_{12s} & \delta_{13s} & \delta_{14s} & \delta_{15s} & \delta_{16s} \\ \delta_{21s} & \delta_{22s} & \delta_{23s} & \delta_{24s} & \delta_{25s} & \delta_{26s} \\ \delta_{31s} & \delta_{32s} & \delta_{33s} & \delta_{34s} & \delta_{35s} & \delta_{36s} \\ \delta_{41s} & \delta_{42s} & \delta_{43s} & \delta_{44s} & \delta_{45s} & \delta_{46s} \\ \delta_{51s} & \delta_{52s} & \delta_{53s} & \delta_{54s} & \delta_{55s} & \delta_{56s} \\ \delta_{61s} & \delta_{62s} & \delta_{63s} & \delta_{64s} & \delta_{65s} & \delta_{66s} \end{bmatrix} [1 - L] \begin{bmatrix} LGDP \\ LCO_2 \\ LEC \\ LFD \\ LFDI \\ LGCF \end{bmatrix}_{t-s} + \begin{bmatrix} \lambda_{1t} \\ \lambda_{2t} \\ \lambda_{3t} \\ \lambda_{4t} \\ \lambda_{5t} \\ \lambda_{6t} \end{bmatrix} [Ec]_{t-1} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \end{bmatrix} \quad (3)$$

here, 1-L is the backshift operator; α_{it} (i = 1, …, 6) denote the intercept terms; δ_{ijs} (i, j = 1, …, 6) signify the coefficients to test the H_0 of no Granger causality directions in short-run; λ_{it} (i= 1,…. 6) represent the coefficients of (Ec_{t-1})s error correction terms. These coefficients are employed to test the H_0 of no Granger bidirectional causality in long-run. Engle and Granger (1987) argued that the differenced vector autoregressive model is not sufficient to examine the causality directions in short-run, especially if co-integration exists. Therefore, the inclusion of (Ec_{t-1})s is necessary to evaluate the bidirectional causality in long-run.

4. Results Discussions

4.1 Descriptive Statistics Tests

Table 1 shows the results of descriptive statistics tests. The H_0 of non-normality has been rejected implying that the (ε_t)s ~ $N(0, \sigma^2)$. That is, the p-values of Jarque-Berra are greater than 10%. In addition, the correlation matrix results show that the variables are linearly correlated between each other.

Table 1. Descriptive statistics tests results

	$LGDP_t$	LCO_{2t}	LEC_t	LFD_t	$LFDI_t$	$LGCF_t$
Mean	4.79	3.07	979.19	84.41	4.03	28.87
Median	4.15	3.23	1004.5	83.50	1.27	29.89
Maximum	9.99	3.89	1273.5	114.7	23.5	46.03
Minimum	1.61	1.57	508.84	39.93	0.03	19.83
σ	2.27	0.60	194.56	19.74	5.62	6.616
Skewness	0.85	-1.3	-0.923	-0.40	1.85	0.483
Kurtosis	2.85	3.81	3.6549	2.71	5.87	2.591
Jarque-Berra	4.21	10.5	5.6000	1.05	31.9	1.605
p-values	0.12	0.10	0.11	0.60	0.62	0.44
$LGDP_t$	*1.00*					
LCO_{2t}	*0.74*	*1.00*				
LEC_t	*0.82*	*0.87*	*1.00*			
LFD_t	*0.65*	*0.84*	*0.88*	*1.00*		
$LFDI_t$	*0.75*	*0.51*	*0.60*	*0.47*	*1.00*	
$LGCF_t$	*-0.34*	*-0.46*	*-0.40*	*-0.44*	*-0.06*	*1.00*

Note. σ denotes the standard deviation.

Source: E-views software package (version. 8.1).

4.2 Unit Root and Co-integration Tests

The Augmented Dickey-Fuller (A.D-F) and Phillips-Perron (P-P) unit root tests have not been employed in this paper due to their low prediction power. However, the Ng-Perron unit root test is suitable for small sample size and provides efficient results regarding integration levels of variables. The results of Ng-Perron unit root test are reported in Appendix A. The outcomes show that all variables are stationary at the first difference, I (1), with intercept and time trend (i.e., $\Delta LGDP_t$, ΔLCO_{2t}, ΔLEC_t, ΔLFD_t, $\Delta LFDI_t$, $\Delta LGCF_t$). This lead us to apply the ARDL approach to examine co-integration and equilibrium relationships. In addition, the VECM Granger causality would be employed to evaluate causality directions in long-run and short-run.

Table 2. Co-integration test results

Function	Computed F-statistics value	Tabulated F-statistics values					
		1%		5%		10%	
		I(1)	I(0)	I(1)	I(0)	I(1)	I(0)
$LGDP_t = \boldsymbol{f}(LCO_{2t}, LEC_t, LFD_t, LFDI_t, LGCF_t)$.	6.42*	5.33	3.71	3.96	2.69	3.39	2.25

Note. (1) The tabulated F-statistics values were retrieved from Narayan (2005, Case II: restricted intercept and no trend, p. 1987).

(2) * denotes the significance at 1% level.

Source: The computed F-statistic value was obtained from Micro-Fit software package (version 5.1).

The results reported in Table 2 reveal that the computed F-statistic value (6.42) is more than the tabulated F-statistic value (5.33) at upper integration level, I(1), and 1% significance level. Thus, the long-run relationship is found between $LGDP_t$ and its determinants. These results are in line with the findings obtained for Bahrain (Hamdi et al., 2014) and Saudi Arabia (Alshehry & Belloumi, 2015).

4.3 Equilibrium and Dynamic Causality Analysis

After confirming the co-integration among variables, the equilibrium relationships have been tested by applying the ARDL approach. In addition, Bekhet and Al-Smadi (2014), Bekhet and Matar (2013), Bekhet and Mugableh (2012), and Granger (1969) mentioned that if the variables are co-integrated then the causality should be found at least from one direction in both long-run and short-run. Table 3 shows long-run relationships analysis results when the $\Delta LGDP_t$ is dependent variable. The LCO_{2t-1} adds in $\Delta LGDP_t$ and it is statistically significant at 10% level. A 1% increase in the LCO_{2t-1} is linked with 2.95% $\Delta LGDP_t$ in long-run. Keeping other things are constant, a 1% increase in $LFDI_{t-1}$ adds in $\Delta LGDP_t$ by 0.31%. $LGCF_{t-1}$ is significant at the 5% level and positively associated with the $\Delta LGDP_t$.

Table 3. Long-run relationships analysis results

Variables	Coefficients	Standard errors	t-ratio[p-value]	Significance levels
Intercept term	34.64	10.6	3.28[0.004]	1%
LCO_{2t-1}	2.95	1.60	1.85[0.079]	10%
LEC_{t-1}	-2.16	1.97	-1.1[0.286]	Insignificant.
LFD_{t-1}	-0.87	0.62	-1.4[0.177]	Insignificant.
$LFDI_{t-1}$	0.31	0.08	4.07[0.001]	1%
$LGCF_{t-1}$	0.99	0.44	2.28[0.033]	5%

Source: Micro-Fit software package (version 5.1).

The short-run relationships results analysis is illustrated in Table 4. The $\Delta LGDP_t$ is negatively influenced by ΔLCO_{2t-1}, ΔLFD_{t-1}, and $\Delta LFDI_{t-1}$. The impact of $\Delta LFDI_t$ and $\Delta LGCF_t$ on $\Delta LGDP_t$ are positive and significant at the 1% and 5% levels, respectively. The diagnostic tests are detailed in Table 4 in lower segment. The results show that the short-run model seems to pass serial correlation, non-normality, and Heteroscedasticity.

Table 4. Short-run relationships analysis results

Variables	Coefficients	Standard errors	t-ratio[p-value]	Significance levels
Intercept term	5.58	2.17	3.58[0.021]	5%
ΔLCO_{2t}	0.002	0.24	0.01[0.991]	Insignificant.
ΔLCO_{2t-1}	-0.39	0.19	-2.1[0.051]	10%
ΔLEC_t	-0.35	0.29	-1.2[0.245]	Insignificant.
ΔLFD_t	-0.12	0.12	-1.0[0.323]	Insignificant.
ΔLFD_{t-1}	-0.22	0.10	-2.3[0.034]	5%
$\Delta LFDI_t$	0.02	0.01	2.83[0.010]	1%
$\Delta LFDI_{t-1}$	-0.02	0.01	-2.02[0.06]	10%
$\Delta LGCF_t$	0.16	0.06	2.48[0.017]	5%

Diagnostic tests:

Serial correlation, CHSQ: 1.18(0.28); Functional form, QHSQ: 4.69(0.10); Normality, QHSQ: 2.33(0.31); Heteroscedasticity, QHSQ: 1.95(0.16).

Source: Micro-Fit software package (version 5.1).

Table 5 illustrates the results of the VECM Granger causality test. There is a unidirectional Granger causality in short-run from ΔLEC_t to $\Delta LGDP_t$. The unidirectional Granger causality from energy consumption to economic growth is similar to the finding obtained for South Africa (Menyah & Wolde-Rufael, 2010). Therefore, the non-neutrality hypothesis is existed in Jordan because economic development is highly dependent on energy consumption. Turning to the long-run causality results, Table 5 indicates long-run bidirectional Granger causality between $\Delta LGDP_t$ and its determinants. These results are in line with the findings obtained for India (Boutabba, 2014). The long-run bidirectional Granger causality between financial development and economic development confirms the existence of supply and leading hypotheses in Jordan. Financial development is an important driver of economic growth through the allocation of resources, capital accumulation, and technological innovation.

Table 5. VECM Granger causality analyses results

Variables	Sources of causation Short-run					
	$\Delta LGDP_t$	ΔLCO_{2t}	ΔLEC_t	ΔLFD_t	$\Delta LFDI_t$	$\Delta LGCF_t$
$\Delta LGDP_t$	-	4.2(0.01)*	0.1(0.9)	1.9(0.14)	4.7(0.01)*	1.3(0.23)
ΔLCO_{2t}	4.9(0.00)*	-	3.9(0.02)**	1.6(0.16)	3.5(0.03)**	3.1(0.04)**
ΔLEC_t	5.2(0.00)*	0.20(0.8)	-	1.2(0.25)	1.1(0.27)	0.9(0.33)
ΔLFD_t	4.3(0.01)*	0.30(0.9)	2.8(0.05)**	-	2.6(0.06)***	1.5(0.18)
$\Delta LFDI_t$	3.3(0.03)**	1.2(0.25)	5.5(0.00)*	1.4(0.21)	-	5.7(0.00)*
$\Delta LGCF_t$	0.8(0.35)	0.7(0.37)	0.6(0.39)	0.4(0.41)	5.7(0.00)*	-
	Long-run					
(Ec_{t-1})s	-0.2(0.00)*	-0.6(0.00)*	-0.7(0.00)*	-1.6(0.00)*	-2.7(0.01)*	-2.2(0.01)*

Note. (1) $^{*, **}$ indicate the significance at 1% and 5% levels, respectively. (2) A summary of VECM Granger causality analyses results is provided in Appendix B.

Source: E-views software package (version. 8.1).

5. Final Remarks

The current article analyses dynamic relationships between economic growth and it determinants in the kingdom of Jordan over the 1976-2010 period. The Ng-Perron unit root test is applied to determine the integration levels of variables. The results show that the variables are stationary at I(1), which confirm the use of ARDL and VEC models. The findings suggest the existence of co-integration between economic growth and its determinants. The carbon dioxide emissions, foreign direct investments inflows, and gross fixed capital formation add in economic growth in long-run. The findings show that carbon dioxide emissions are positively associated with economic growth in long-run, whereas they negatively linked to economic growth in short-run. Hence, the EKC (environmental Kuznets curve) hypothesis does exist between economic development and CO_2 emission in both long-run and short-run. This hypothesis argues the relationship between economic development and CO_2 emissions. Specifically, the emissions of greenhouse gases levels increase as a country develops but decrease when a certain level of economic development is achieved (i.e., an inverted-U shape curve). These results are in line with the findings obtained for Malaysia (Azlina et al., 2014; Lau et al., 2014). The causality analysis reveals bidirectional between economic development and its determinants in long-run as the coefficients of (Ec_{t-1})s are significant with negative signs.

The bidirectional Granger causality between energy consumption and economic growth suggests the implementation of energy exploration policies to sustain economic development in long-run. In addition, the bidirectional Granger causality between carbon dioxide emissions and economic growth recommends the Jordanian policy makers to update energy master plans to achieve the green economy. The increases of foreign direct investment flows into Jordan would firstly create employment and secondly increase energy consumption. Thus, economic growth would be increased. In this manner, the Jordanian policy makers ought to focus on establishing industrial projects and improving the total factor productivity strategy. However, financial development does lead economic growth in both long-run and short-run. This implies that loans used by both consumers and investors add to economic growth. Consequently, the Jordanian policy makers are proposed to promote financial development by increasing the levels of performing loans. An interesting future research could investigate the determinants of economic growth by using a heterogeneous panel cross sectional data for a pooling of Arab countries in the Middle East.

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Appendix A. Unit Root Test Results

Variables	Ng-Perron test statistics	Ng-Perron asymptotic critical values at 10% level
$\Delta LGDP_t$	7.19*	6.67
ΔLCO_{2t}	8.20*	6.67
ΔLEC_t	6.90*	6.67
ΔLFD_t	9.08*	6.67
$\Delta LFDI_t$	6.98*	6.67
$\Delta LGCF_t$	7.52*	6.67

Note. * denotes the significance at 10% level.

Source: E-views software package (version. 8.1).

Appendix B. Summary of VECM Granger Causality Analyses Results

Status	Sort of causality	Period of causality
$\Delta LEC_t \rightarrow \Delta LGDP_t$	Unidirectional.	Short-run.
$\Delta LFD_t \rightarrow \Delta LGDP_t$	Unidirectional.	Short-run.
$\Delta LCO_{2t} \rightarrow \Delta LEC_t$	Unidirectional.	Short-run.
$\Delta LFD_t \rightarrow \Delta LEC_t$	Unidirectional.	Short-run.
$\Delta LFDI_t \rightarrow \Delta LEC_t$	Unidirectional.	Short-run.
$\Delta LCO_{2t} \rightarrow \Delta LFDI_t$	Unidirectional.	Short-run.
$\Delta LFD_t \rightarrow \Delta LFDI_t$	Unidirectional.	Short-run.
$\Delta LGCF_t \rightarrow \Delta LFDI_t$	Unidirectional.	Short-run.
$\Delta LCO_{2t} \rightarrow \Delta LGFC_t$	Unidirectional.	Short-run.
$\Delta LFDI_t \rightarrow \Delta LGCF_t$	Unidirectional.	Short-run.
$\Delta LGDP_t \leftrightarrow \Delta LCO_{2t}$	Bidirectional.	Short-run.
$\Delta LGDP_t \leftrightarrow \Delta LFDI_t$	Bidirectional.	Short-run.
$\Delta LGDP_t \leftrightarrow \Delta LCO_{2t}$	Bidirectional.	Long-run.
$\Delta LGDP_t \leftrightarrow \Delta LEC_t$	Bidirectional.	Long-run.
$\Delta LGDP_t \leftrightarrow \Delta LFD_t$	Bidirectional.	Long-run.
$\Delta LGDP_t \leftrightarrow \Delta LFDI_t$	Bidirectional.	Long-run.
$\Delta LGDP_t \leftrightarrow \Delta LGCF_t$	Bidirectional.	Long-run.

Source: E-views software package (version. 8.1).