A Dynamic Equilibrium Relationship between Foreign Direct Investment, Electrical Power Consumption, and Gross Domestic Product in Jordan

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ABSTRACT

This study's aim is to investigate the empirical relationship between the foreign direct investment (FDI), per capita electrical power consumption, economic growth (proxies by GDP per capita in constant prices), and consumer price index (CPI) in Jordan over the 1976-2011 period. Annual time series data were employed using the Autoregressive distributed lag (ARDL) model to estimate the relationship among the variables. This study is important for different parties like policy makers, domestic and foreign investors, corporations and government. The results suggest the existence of a long-term equilibrium relationship between electric power consumption and the economic growth.

Keywords: Co-integration, Electricity Power Consumption, ARDL, Economic Growth, Causality, Jordan.

INTRODUCTION

Several studies have examined the relationship between electricity power consumption and economic growth, especially in the past four decades started with the study of Kraft and Kraft (1978). Also, there are intensive debates in the literature suggesting a strong relationship between electricity power consumption and economic growth. This implies that an increase in electricity consumption directly impacts economic growth and that economic growth also stimulates further electricity consumption (see, Apergis and Payne, 2011; Lai *et al.*, 2011; Lorde *et al.*, 2010; Morimoto and Hope, 2004; Narayan and Smyth, 2009; Odhiambo, 2009; Yoo, 2006; Wolde-Rufael, 2006). Most of these studies are based on the directions of causal relationship between the electricity consumption and the economic growth that could be classified into three types of bidirectional, unidirectional, and neutrally causality relationship.

Due to the current situation of the Jordanian economy, the author is interested to investigate the dynamic relationship between economic growth and the electricity consumption. Therefore, this paper aims to evaluate this dynamic relationship in developing country like Jordan, a country with limited resources such as oil resources, limited agricultural land, and scarce water. However, despite this ordeal and a troubled regional environment, Jordan keeps a stable economic growth rate compared to other emerging economies in the Arab countries. This is due to the recent extensive economic improvement by the government, resulting in the opening up of key sectors to foreign direct investment and vibrant economic activity beside different developments, innovations and regulations.

This study is important for different parties like policy makers, domestic and foreign investors, corporations and government. However, the importance of this study stems from the reason that electricity bill reflects a notable share in the gross domestic porduct for

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Jordan. Also, the prices of electric bill affected by oil have went up very high, especially during the (2003-20013) period due to different political and economical crisis events in the Arab countries. Thus, the increase in the oil prices has affected on the prices of electricity positively.

Over the past decades the relationship between economic growth and electricity power consumption has been extensively researched in developed countries. Yet, there seems to be no consensus regarding the relationship in developing countries. Furthermore, this study will be the first study that re-examines the relationship between economic growth and electricity power consumption (EPC) particularly in Jordan to fill the gap in the existing literature. Besides, the relationship with FDI, CPI will be investigated.

The current paper adopts one of the contemporaneous time series analysis techniques, the autoregressive distributed lag (ARDL) bound testing approach developed by Pesaran *et al.* (2001). ARDL is a popular and standard technique for examining co-integration among financial variables. Subsequently, we hypothesized a long-run equilibrium relationship between the EPC and economic growth represented by gross domestic product (GDP) per capita with a bidirectional causality relationship between them.

The rest of the paper is organized as follows: The next section sheds light on Jordanian economy and the EPC in Jordan. Section 3 explores the literature review. Section 4 provides data and model specification. Section 5 illustrates methodology. Section 6 reports the empirical results while conclusions, limitation and managerial implications are presented in the last section.

2. An Overview of the Jordanian Economy

Jordan is a middle income country with a population of 6.5 million. Jordan is a small open economy with few natural resources and little manufacturing, but has a large skilled population that works abroad. Jordan has incompetent supplies of water with a large proportion of desert soil and around 4% arable land. However, the main natural resources in Jordan are phosphate and potash. Currently, the main challenges facing Jordan are reducing the budget deficit, reducing foreign grants and dependence, and creating investment incentives to promote job creation. A fundamental percentage of the population, 38% is under the age of fourteen resulting in a rapid increase in the working age population (Amara, 2008).

The electrical power system in Jordan consists of two main generating power stations, 132 Kilovolt and 400 Kilovolt transmission network. This transmission network interconnects the power stations with the load centers and different areas in the kingdom. The system also includes the 230, 400 Kilovolt connect line with Egypt and 400 Kilovolt connect lines with Syria. The electrical networks are serving about 99.9% of the total population in Jordan. Furthermore, there are includes some private power stations, which are coinciding with the rest of the power stations in the integrated network. Also, there are a few private power stations, which are not connected with the interconnected network and serve only their owners (Al-Ghandoor *et al.*, 2011).

Figure 1 shows the growth rate of Jordan's GDP which was at 5.5% for the (1976-2011) period. Also, it indicates a gradually upward trend over the targeted period. Despite the global financial crisis affect and other events during this study period, Jordan's GDP reached US $16 billion in 2011. Over the (2000-2009) period, Jordan's economy has slowed down largely due to the global and regional downturn. It was consistent with the global economic slowdown, in 2009 where output growth fell sharply and economic activity is expected to rise modestly (Bekhet and Matar, 2012; IMF, 2010).

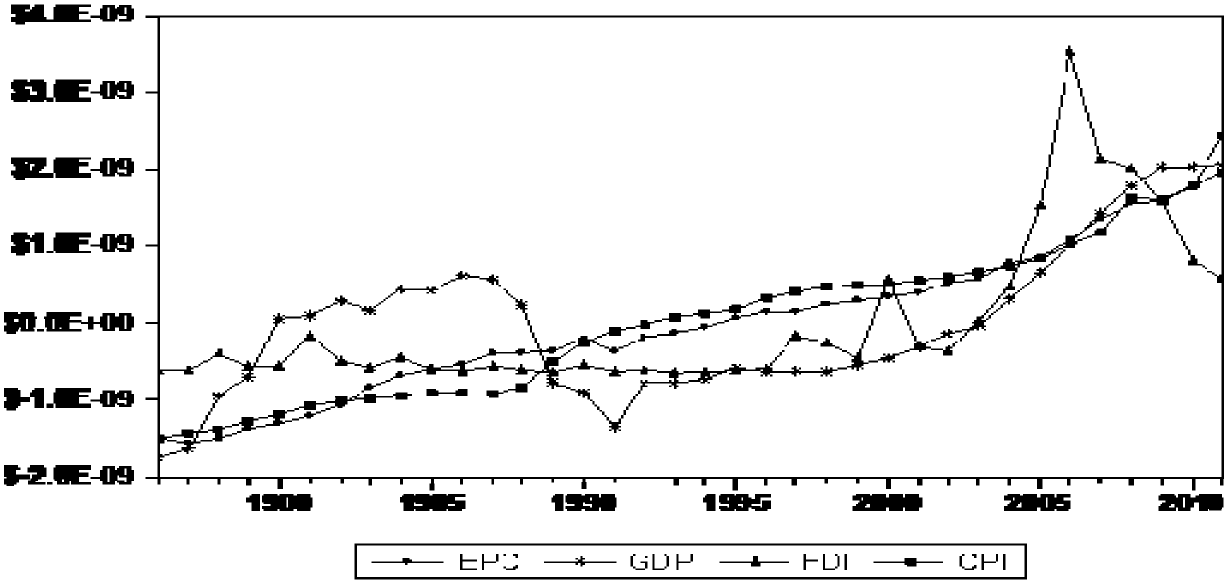

Figure 1: The study variables during the (1976-2011) period

Source 1. World Bank (2013), Jordan data, available at http://data.worldbank.org/country/jordan.

2. Central Bank of Jordan (2013), Statistical Database, Prices, available at http://statisticaldb.cbj.gov.jo/index?action=level2&lang=en&cat_id=19.

In addition, the EPC grew notably during the (1976-2011) period where the average annual growth rate during this period was 4.5%. the greatest amount of EPC was in 2011 with 2610 KW, the greatest consumption came from the household sector that consumed about 41% of total followed by industrial sector which consumed 25% of total, then commercial sector with consumption share of 17% followed by water pumping sector that consumed 14% then by street lighting sector which consumed 3% (see Figure 2).

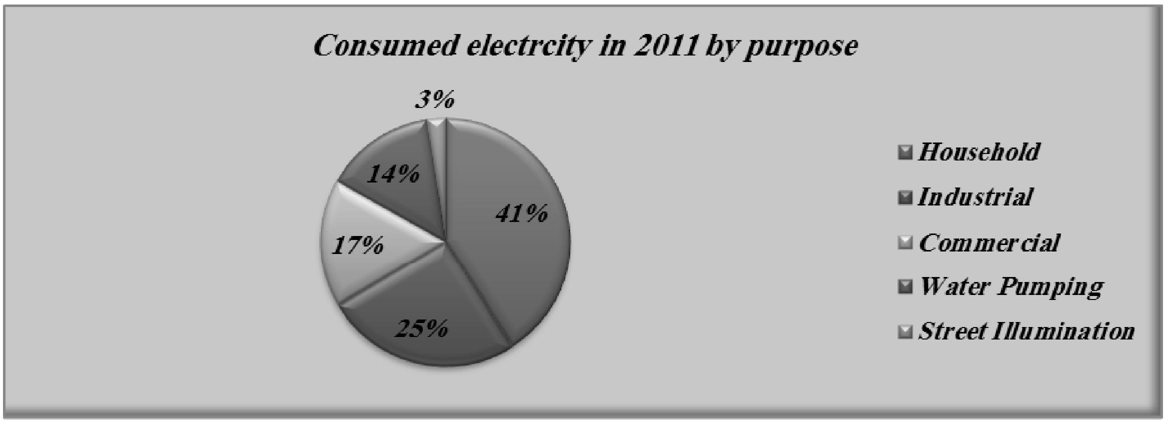

Figure 2: EPC in Jordan in 2011 (by purpose)

Source: Department of Statistics, Jordan (2013), available at http://www.dos.gov.jo/dos_home_a/main/jorfig/2011/14.pdf

During the (2007-2008) period many privatization operations were executed in the electricity sector which resulted in partial privatization for the sector. However, the price index for mineral fuels and lubricants category increased by 32% due to the increase in the prices of oil. Therefore, the fuel and electricity category price index has increased by 49%. Theoretically, the EPC is considered a dependent variable of other related independent variables such as GDP per capita that affect the consumption of electricity variable positively besides, the Price of electricity variable that affect the consumption of electricity variable negatively.

It is generally obvious in Figure 1 that both the FDI and consumer price index for Jordan's economy are gradually raising with growth rate of 9.8%; 5%, respectively. Recently, the FDI fell down to the lowest amount in 2011, while in the contrary the CPI increases to the highest amount in the same year due to the different political and economical events that faced the world economies and particularly the Jordan's economy.

3. Literature Review

In the current paper, we categorize the literature based on the direction of the causality test into three folds (bidirectional, unidirectional and neutral directional relationships between variables):

First, bidirectional causality relationship between EPC and economic growth was found in different countries. In UK for example, Narayan and Prasad (2008) found that there is strong bidirectional causality relationship between Electrical consumption and real GDP. Besides, the same result was suggested for ASEAN 4 and Korea by Yoo and Kim (2006) and Yoo (2005) respectively. In India suggested by Chen *et al.* (2007); in Hong Kong by Ho and Siu (2007); in China by Yuan, *et al.* (2008). Furthermore, Lorde *et al.* (2010); Yoo and Kwak (2010); Dagher and Yacoubian (2012); and Shahbaz and Lean (2012) found the same result in Barbados; Vanzuela; Lebanon; and Pakistan. On their panel study consist of 65 countries, Omri and Kahouli (2014) found bidirectional causal relationships between economic growth, FDI, and energy consumption for the high and middle-income countries.

Second, for several countries there is a unidirectional causality running between EPC and economic growth. Some results the causal relationship run from EPC to GDP For example, Aqeel and Butt (2001); Altinay and Karagol (2005); Lee and Chang (2005); Narayan and Singh (2007); Odhiambo (2009) in Pakistan; Turkey; Taiwan; Fiji; and Tanzania, respectively. The same result was found in China by Shiu and Lam (2004); Yuan *et al.* (2007), and in Malaysia by Tang (2008); Bekhet and Othman (2011). In contrast, the causal relationship run from the GDP to the EPC in the following studies by Fatai, *et al.* (2004); Morimoto and Hope, (2004); Jumbe , (2004); Narayan and Smyth, (2005a); Squalli, (2007); Mozumder and Marathe, (2007); and Ghosh, (2009) in Australia; Sri Lanka; Malawi; Australia; Algeria; Bangladesh; India, respectively. Recently, Sbia, *et al.* (2014) found a unidirectional causality relationship running from economic growth to energy consumption in UAE. Shahbaz et al. (2014) explored a unidirectional causality relationship between financial development and trade openness in Bangladesh.

Third, we can accept the neutrality hypothesis if there is no causality relationship running in any direction. This result was found by Thoma (2004) in USA; Chen, *et al.* (2007) in China, Taiwan, and Thailand. Besides, Narayan and Prasad (2008) found a neutral (no causal) relationship between EPC and GDP in USA, Canada, Belgium, Denmark, Austria, France, Germany, Greece, Ireland, Japan, Luxembourg, New Zealand, Mexico, Poland, Norway, Turkey, Sweden, Switzerland, and Spain. Tang *et al.* (2014) in Malaysia. In Saudi Arabia, Samargandi *et al.* (2014) found that financial development has insignificant impact on economic growth and oil-sector growth. Wolde-Rufael (2014) found that there is no evidence of causality relationship between electricity consumption and economic growth in Macedonia, Albania, Moldova, Poland, Serbia, Romania, Slovenia and Slovak Republic. Furthermore, Table 1 summarized various studies in different countries examine the relationship between the energy consumption (EC), EPC, and different variables (see Table 1):

Table 1
Summary of electricity consumption nexus economic growth literature

Author	**Country**	**Variables**	**Methodology**	**Causality results**
Ghosh (2002)	India	EPC per capita and RGDP per capita	VAR	Y ⟶ EPC
Wolde-Rufael (2006)	17 African countries	EPC per capita and RGDP per capita	ARDL and Granger Causality	Y ⟶ EPC
Yoo and Kim (2006)	Indonesia	EPC, ELP and RGDP	VAR and Granger Causality	Y ⟶ EPC Y ⟶ ELP
Soytas and Sari (2007)	Turkey	MI, EC, manufacturing real fixed investment and ME.	VECM	IELC ⟶ MVA
Huang, *et al.* (2008)	82 countries	GDP and EC	VAR	Bi-directional positive feedback relationship between GDP and EC
Sari, *et al.* (2008)	USA	Disaggregate energy variables, IP, and L	ARDL	Co-integration among EC, L and IP
Hu and Lin (2008)	Taiwan	EPC and RGDP	VECM	Y⟶EPC
Abosedra, *et al.* (2009)	Lebanon	EPC growth, real import growth, L, and relative humidity	VAR and Granger Causality	ELC ⟶ IMP
Odhiambo (2010)	Sub-Saharan African countries	EC per capita, RGDP per capita, and CPI	ARDL and Granger Causality	EC ⟶ Y (South Africa and Kenya) Y⟶EPC in Congo
Wolde-Rufael (2010)	India	Nuclear EC, RGDP per capita, real GFCF, and L	ARDL and Granger Causality	NEC ⟶ Y

Tsani (2010)	Greece	EC and RGDP	Granger-Causality and Toda and Yamamoto (1995)	EC ⟶ Y
Apergis and Payne (2011)	88 Countries	EPC, RGDP, RGFCF, and L	VAR Panel and Granger Causality	EPC ⟷ Y (high income and upper-middle income country panels) EPC ⟶ Y (Lower-middle income country panel and the low income countries).
Lai, *et al.* (2011)	China	EPC and GDP	VAR and Granger-Causality	A long-run equilibrium relationship between EC and GDP
Pirlogea and Cicea (2012)	Romania, Spain, and European Union	EC and GDP per capita	Granger Causality	EC ⟶ Y in Romania
Sebri and Abid (2012)	Tunis	EPC per capita, EC per capita, oil consumption per capita, TO, and AVA per capita.	Granger Causality	Trade openness and both aggregated and disaggregated energy consumption Granger cause AVA.
Islam, *et al.* (2013)	Malaysia	EC, RGDP, population, and FD	VECM and Granger Causality	Co-integration between FD, EC, aggregate production, and population in Malaysia. Also, EC is influenced by GDP and FD, both in the short and the long-run
Hamdi, *et al.* (2014).	Bahrain	EC, FDI, K and GDP.	ARDL	EPC ⟷ Y

Sbia, *et al.* (2014)	UAE	CO_2, TO, FDI, clean energy, and GDPL	ARDL	Y ⟶ EC

Notes: 1. ⟶, ⟷, —, , denotes, unidirectional causality, bidirectional causality, and neutral, respectively.

2. Abbreviations defined as follows: EPC=electricity consumption; EC=energy consumption; ELP= electricity production; NEC; nuclear energy consumption; FD= financial development; IELC=industrial electricity consumption; consumption; AVA = agricultural value added; MVA= manufacturing value added; IMP = imports; Y = real or nominal GDP or GNP; IP = industrial production; J-J = Johansen-Juselius; ARDL = Autoregressive distributed lags; VAR = Vector autoregressive; VECM = Vector error correction model.

4. Methodology and Data

Yearly time series data for the (1976 – 2011) period were used. The data for all variables are obtained from the (World Bank development indicators, 2013) except for CPI obtained from the central bank of Jordan. To avoid the hestroscedasticity problem, all variables have been transformed into natural logarithmic by using SPSS (20), Microfit version 5.0, and E-views 7.2 packages. The functional form of EPC as a function of all factors influence the EPC in Jordan assumed as in Equation 1.

$$lEPC_t = f(lGDP_t, lFDI_t, lCPI_t) \quad (1)$$

Where, l denotes the natural logarithmic; EPC represents the electricity power consumption per capita measures in kilowatt hour (kw/h); GDP per capita in constant price US $ 2000 is proxy for the growth in real gross domestic product (economic growth); FDI is the net foreign direct investment in constant US $ 2000, the relationship between FDI and EPC was investigated by Tang (2009) and Bekhet and Othman (2011); CPI is the consumer price index represent the inflation rate in Jordan.

Several studies were using Engle and Granger (1987) and Johansen and Juselius (1990) techniques to test the co-integration between EPC and economic growth. These techniques require that all variables (regressors) in the system must be stationary and with equal order of integration. Pesaran, *et al.* (2001) has developed a model to introduce a surrogate co-integration technique known as ARDL bound testing approach.

ARDL approach has many advantages over the previous co-integration techniques. First, it has more proper considerations than the Johansen and Juselius and Engle-Granger techniques for testing the co-integration among variables in small sample size (Ghatak and Siddiki, 2001). Comparatively, the Johansen co-integration techniques need large data sample for validity. Second, no need to examine the non-stationary property and order of integration, this means that we can apply ARDL whether underlying regressors are purely I(0) or purely I(1), while other co-integration techniques require all the regressors to be integrated of the same order (Pesaran *et al.*, 2001). Third, the ARDL application allows the variables may have different optimal lags, while it is impossible with conventional co-integration procedures (Ozturk and Acaravci, 2011). Finally, the ARDL model has become increasingly popular in recent years (Jayaraman and Choong, 2009).

Basing on these advantages of ARDL model this paper will employ bound test for testing co-integration among the variables in the current study. To examine the co-integration among variables in equation (1), the ECM representation of the ARDL approach is formulated for each variable as in (Equation 2) matrix style:

$$\begin{bmatrix} \Delta lEPC_t \\ \Delta lGDP_t \\ \Delta lFDI_t \\ \Delta LCPI_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} + \begin{bmatrix} \mu_{11} & \mu_{12} & \mu_{13} & \mu_{14} \\ \mu_{21} & \mu_{22} & \mu_{23} & \mu_{24} \\ \mu_{31} & \mu_{32} & \mu_{33} & \mu_{34} \\ \mu_{41} & \mu_{42} & \mu_{43} & \mu_{44} \end{bmatrix} \begin{bmatrix} \Delta lEPC_{t-i} \\ \Delta lGDP_{t-i} \\ \Delta lFDI_{t-i} \\ \Delta lCPI_{t-i} \end{bmatrix} + \begin{bmatrix} \varphi_{11} & \varphi_{12} & \varphi_{13} & \varphi_{14} \\ \varphi_{21} & \varphi_{22} & \varphi_{23} & \varphi_{24} \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & \varphi_{34} \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} \end{bmatrix} \begin{bmatrix} lEPC_{t-1} \\ lGDP_{t-1} \\ lFDI_{t-1} \\ lCPI_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (2)$$

Where: $\beta_1,\dots,\beta_4$: are the constant terms, $\mu_{11},\dots,\mu_{44}$ represent the short-run coefficients; while $\varphi_{11},\dots,\varphi_{44}$ represent the long-run coefficients; and $\varepsilon_{t1},\dots,\varepsilon_{t4}$: are white noise error terms. For testing the existence of short-run relationship among the above variables (Equations 2-5) we can formulate the H_0 and H_1 hypotheses as the following:

H_0 : No short – run relationship	H_1 : Short – run relationship
$\mu_{11} = \mu_{12} = \mu_{13} = \mu_{14} = 0$	$\mu_{11} \neq \mu_{12} \neq \mu_{13} \neq \mu_{14} \neq 0$
$\mu_{21} = \mu_{22} = \mu_{23} = \mu_{24} = 0$	$\mu_{21} \neq \mu_{22} \neq \mu_{23} \neq \mu_{24} \neq 0$
$\mu_{31} = \mu_{32} = \mu_{33} = \mu_{34} = 0$	$\mu_{31} \neq \mu_{32} \neq \mu_{33} \neq \mu_{34} \neq 0$
$\mu_{41} = \mu_{42} = \mu_{43} = \mu_{44} = 0$	$\mu_{41} \neq \mu_{42} \neq \mu_{43} \neq \mu_{44} \neq 0$

However, for testing the existence of long-run relationship, the H_0 and H_1 hypotheses have been formulated as the following:

H_0 : No long–run relationship	H_1 : A long–run relationship
$\varphi_{11} = \varphi_{12} = \varphi_{13} = \varphi_{14} = 0$	$\varphi_{11} \neq \varphi_{12} \neq \varphi_{13} \neq \varphi_{14} \neq 0$
$\varphi_{21} = \varphi_{22} = \varphi_{23} = \varphi_{24} = 0$	$\varphi_{21} \neq \varphi_{22} \neq \varphi_{23} \neq \varphi_{24} \neq 0$
$\varphi_{31} = \varphi_{32} = \varphi_{33} = \varphi_{34} = 0$	$\varphi_{31} \neq \varphi_{32} \neq \varphi_{33} \neq \varphi_{34} \neq 0$
$\varphi_{41} = \varphi_{42} = \varphi_{43} = \varphi_{44} = 0$	$\varphi_{41} \neq \varphi_{42} \neq \varphi_{43} \neq \varphi_{44} \neq 0$

The decision to reject or accept H_0 (no co-integration among the variables) is based on the following procedures by using F-statistic (F_s) (Pesaran *et al.*, 2001):

If $F_s >$ Upper bound then reject H_0 and the variables are co-integrated.

If $F_s <$ Lower bound then accepts H_0 and the variables are not co-integrated.

But if $F_s \geq$ Lower bound and $\leq$ Upper bound then the decision is inconclusive.

The Granger Causality test is used to test the short-term causality between dependent and independent variables. Grange Causality test shows the presence of bidirectional or unidirectional causality relationship, whether one variable causes the other variable or not. It can be formulated as in Equations (3) and (4):

$$\Delta x_t = \gamma_0 + \sum_{i=1}^{n} \beta_1 \Delta x_{t-1} + \sum_{i=1}^{n} \beta_2 \Delta x_{t-2} + ... + \sum_{i=1}^{n} \beta_i \Delta x_{t-i} + \sum_{j=1}^{m} \alpha_1 \Delta y_{t-1} + \sum_{j=1}^{m} \alpha_2 \Delta y_{t-2} + ... + \sum_{j=1}^{m} \alpha_j \Delta y_{t-j} + \varepsilon_t \quad (3)$$

$$\Delta y_t = \delta_0 + \sum_{j=1}^{m} \beta_1 \Delta y_{t-1} + \sum_{j=1}^{m} \beta_2 \Delta y_{t-2} + ... + \sum_{j=1}^{m} \beta_i \Delta y_{t-j} + \sum_{i=1}^{n} \alpha_1 \Delta x_{t-1} + \sum_{i=1}^{n} \alpha_2 \Delta x_{t-2} + ... + \sum_{i=1}^{n} \alpha_j \Delta x_{t-i} + v_t \quad (4)$$

Theoretically, it is possible that one variable Granger causes the other; whilst in actual evidence no causal relationship can be detected between two variables (Huang, et al., 2000). Eventually, the word (causality) according to Granger-causality does not mean that movements of one variable cause movements of another, it means that only a correlation between the current value of one variable and the past values of others (Brooks, 2008).

5. Results Analysis

Table 2 shows the Augmented Dicky-Fuller (ADF) test of stationary for all variables, both in levels and in first-differences. The results exist that we cannot reject the null hypothesis of unit roots for all variables in level forms except for *lEPC* that is stationary at level *I(0)*. However, the null hypothesis is rejected when the ADF test applied to the first differences of each variable (see Appendix A). This means that the variables of the study are stationary of level and order one *I(1)* and *I(0)*. Thus, the most appropriate model in this case is the bound testing approach. Since all variables are stationary, it is appropriate to test whether the variables are co-integrated or not.

Very important step before testing the existence of co-integration between the selective variables, choosing the optimal lag length is based on the most popular criterions of selecting lags length like Schwarz Bayesian information criterion (SBC), Akaike information Criteria (AIC), Hannan-Quinn Criterion (HQ), Final Prediction Error (FPE), and Log-Likelihood Ration (LR) in vector autoregressive (VAR) model. To compute the F-statistic for co-integration test, we consider lag 1, based on the minimum values of FPE, AIC, SBC and HQ criteria (Table 3, Appendix B). The bound testing of co-integration is presented in Table 4 to show the results of testing the long-run equilibrium relationships among the variables.

Table 4 shows that the computed *F*-statistic for the *lEPC* and *lGDP* model is higher than the upper bound value. Therefore, the null hypothesis of no co-integration among the variables cannot be accepted. On the other hand, when the process was repeated for the rest of models, the computed *F*-statistics is less than the upper and lower bound at all level of significance (see Appendix C). Thus, we cannot reject the H_0 of no co-integration. Clearly, there is two co-integration relationship indicates there is compelling long-run co-integration relationships among the variables when the regressions are normalized on *lEPC* and *lGDP* co-integration relationship among the variables in Jordan. Besides, all the regressors can be treated as long-run forcing variables for the per capita consumption of electricity.

Thereafter, the *lEPC* model is shown in Table 5 Appendix D. The coefficients are significant for all variables (GDP, FDI, and CPI) at the 1% and 10% level of significance which signals a positive impact on EPC in the long-run. In addition, Table 6 (Appendix E) represents the results of the short-run dynamics equilibrium relationship between the EPC and the regressors. The error correction terms (Ect_{t-1}) indicates the speed adjustment back to equilibrium in the dynamic model. When Ect_{t-1} is significant with a negative sign in the short-run model confirms the existence of a long-run equilibrium relationship among the variables (Nayaran and Smyth, 2005b). The magnitudes of the coefficients of Ect_{t-1} denote the speed of adjustment in correcting any disequilibrium and then the economy can return to its equilibrium (Pesaran and Pesaran, 2009).

The Ect_{t-1} coefficient is found to be negative and significant [-0.258, 0.001] which is highly significant at 1% level with correct sign. This implies a highly speed adjustment back from short-run disequilibrium to the long-run equilibrium, where 21% of disequilibrium from previous year can return to long-run equilibrium in the current year. Also, a significant Ect_{t-1} indicates causality from *lGDP*, *lFDI*, and *lCPI* to *lECP*. Within an error correction model, causality may arise from two channels. Furthermore, the regressions for the underlying ARDL model passed the diagnostic tests of serial correlation, functional form, hetroscedasitcity, and normality tests. Also, the results of *lELC* model reveal evidence that the model is correctly specified.

To check the direction of causality relationship among the variables, we need to run the Granger causality relationship between all variables. As seen, the directional causality among all variables is included in Table 7 at the 1, 5, and 10% levels of significance. The results of the Granger test suggested three unidirectional causality relationships among the variables. These results imply that LEPC is affected by GDP and FDI variables on hand and the GDP is affected by the FDI on the other hand (see Appendix F).

Finally, to check the estimated ARDL model stability of the long-run coefficients with the short-run dynamics between *EPC* and its determinants, we apply the cumulative sum of recursive residuals CUSUM and the cumulative sum of squares CUSUMQ (Brown *et al.*, 1975; Pesaran and Pesaran, 1997; and Bahmani-Oskooee and Bohl, 2000). If the plot of CUSUM and CUSUMSQ statistic stays within 5% range of significance level (within the two straight lines) the null hypothesis that all coefficients in the error correction model are stable and cannot be rejected (Bahamni-Oskooee and Ng, 2002). If either of the lines is crossed, the null hypothesis of coefficient constancy can be rejected at the 5% level of significance. Figure 3 reveals that the plot of both CUSUM and CUSUMQ statistics stays within the critical boundaries support the stability of the long-run coefficient of the *EPC* function (see Appendix G). Subsequently, the results are consistent with the earlier findings (for example, Fatai, *et al.*, 2004; Ghosh, 2009; Jumbe, 2004; Morimoto and Hope, 2004; Mozumder, 2007; Narayan and Smith, 2005b; Squalli, 2007; Tang, *et al.*, 2014; Yoo and Kim, 2006).

6. Conclusion

The paper analyzed the relationship between FDI, EPC and economic growth. It has used the ARDL time series approach for the (1976-2011) period to test the co-integration among the variables. The empirical results provided strong evidence against the null hypotheses of unit roots in most of the series under investigation. The results of ARDL approach showed the existence of long-run equilibrium relationship between the EPC and variables of real GDP per capita, FDI, and consumer price index in Jordan. Furthermore, the multivariate granger causality test suggests a unidirectional relationship run from the real GDP to the EPC; this implies that the reduction of the per capita EPC will not impact the future economic growth in Jordan. On the other vein, a unidirectional causal relationship runs from FDI to EPC, which indicates the FDI in Jordan may cause more consumption of electricity. Besides, the CUSUM and CUSUMQ stability tests also reveal that the coefficients of the error correction model are stable.

7. Policy Implications

The implication of the main finding that GDP granger causes EPC indicates that the high rate of economic growth will lead to high growth in EPC. Thus, it is difficult to meet EPC demand if the government wants to sustain the current growth prosperity. The

Jordanian government should utilize the potential of renewable or alternative energy for electricity generation, such as the solar energy as this will apart from decreasing Jordan's certainty imported fuels; activate Jordanian economic growth, the electrical power generation from nuclear power, and controlling current account deficits. In addition, managing the policies of energy growth is vital in order to ensure sufficient electricity supply to support the Jordanian economic development.

In the current study, we add to the existing literature by employing the most popular approach in examining co-integration between the EPC and GDP in Jordan and fill the gap in the literature. In addition, studying the relationship between the EPC and GDP can shed some light on the energy response to economic factors in Jordan since the prices of electricity start rise in recent couple years. This study is very important for different parties like, policymakers, energy sectors, and academic researchers. The policymakers will need to pay more attention to the increase in the rate of consumption by the population; this will help to reduce the imports of oil as the main source of electricity running. Finally, for further studies, we suggest more factors that may cause the obvious structural breaks on EPC such as (consumer price index, trade openness, financial development, pollutions, and political events).

Appendices

Appendix A:

Table 2

ADF Tests

Variables	*ADF-Level*	*P-value*	*Variables*	*ADF-1st Difference*	*P-value*	*Order of Integration*
lEPC	-3.4763**	0.0149	*ΔlnEPC*	-5.1414***	0.0002	*I (0)*
lGDP	-1.7637	0.3912	*ΔlnGDP*	-4.3996***	0.0014	*I (1)*
lFDI	-1.7020	0.4215	*ΔlFDI*	-8.2970***	0.0000	*I (1)*
lCPI	-1.4363	0.5530	*ΔlCPI*	-3.5237**	0.0005	*I (1)*

Note: ***, **, * denotes significant level of 1%, 5%, 10% respectively.
Source: output of E.Views Package, version 7.

Appendix B:

Table 3

Lag length selection criterion for co-integration

Lag	*Log L*	*LR*	*FPE*	*AIC*	*SBC*	*HQ*
0	-23.7726	-	6.02	1.633	1.813	1.694
1	142.822	284.190	8.63*	-7.224*	-6.326*	-6.918*
2	156.002	19.3826	1.06	-7.058	-5.442	-6.507

Note: 1. * indicates lag order selected by the criterion.
2. LR: sequential modified LR test statistic (each test at 5% level of significance).
Source: output of E.Views Package, version 7.2.

Appendix C:

Table 4

Results of *F*-statistic in bound test of co-integration

Models	*F-statistic*	*Lower-upper bound at 10%*	*Lower-upper bound at 5%*	*Lower-upper bound at 1%*	*Decision*
$F_{EPC}(lEPC / lGDP, lnFDI, lCPI)$	7.237***	2.711-3.800	3.219-4.378	4.385-5.615	Co-integration
$F_{GDP}(lGDP / lEPC, lFDI, lCPI)$	4.5505**	2.711-3.800	3.219-4.378	4.385-5.615	Co-integration
$F_{FDI}(lFDI / lEPC, lGDP, lCPI)$	1.8178	2.711-3.800	3.219-4.378	4.385-5.615	No co-integration
$F_{FD}(lnFD / lnEPC, lnGDP, lnX)$	2.4865	2.711-3.800	3.219-4.378	4.385-5.615	No co-integration

Notes: 1. the critical value bounds are from Table F in Pesaran and Pesaran (2009, p. 544), Oxford with an intercept and no trend.

2. *,**,***, significant at 10%, 5%, 1% respectively.

Source: Output of Microfit Package, version 5.0.

Appendix D:

Table 5

ARDL results

Panel 1 : analysis for long-run coefficient for ARDL (1,0,0,0) model				
Dependent variable = lEPC				
Variables	***Coefficients***	***t-statistic***	***p-value***	***Standard Error***
Constant	- 7.5651***	2.9515	0.006	2.5631
$lGDP_t$	1.6198***	3.9837	0.000	0.4066
$lFDI_t$	0.7262*	1.8241	0.078	0.1172
$lCPI_t$	0.8959***	7.6429	0.000	2.5631

Panel 2: Diagnostic tests of the underlying ARDL model				
Test statistics	***Statistic value***	***p-value***	***DW-test***	***R^2-adjusted***
Serial correlation	0.1151	0.734	1.7722	0.9904
Hetroscedasticity	11.236	0.535		
Normality	4.3173	0.461		
Functional Form	2.6703	0.102		

Note: ***, **, * denotes 1%, 5% and 10%. level of significance, respectively. Functional form denotes Ramsey RESET using the square of the fitted values.

Source: Output of Microfit Package, version 5.0.

Appendix E:

Table 6

The analysis of error-correction model and short run relationship

Panel 1 : Error-Correction Representation for the Selected ARDL (1,0,0,0) Model				
Dependent variable = $\Delta lnEPC$				
Variables	***Coefficients***	***t-statistic***	***p-value***	***Standard Error***
$\Delta lGDP_t$	0.4184***	4.2605	0.000	0.0982
$\Delta lFDI_t$	- 0.0187	1.5773	0.125	0.0118
$\Delta lCPI_t$	0.2314***	2.6539	0.013	0.0872
ECT_{t-1}	- 0.2583***	3.5564	0.001	0.0726
Panel 2: Diagnostic tests				
F-statistic	7.0163***	Schwarz Bayesian Criterion	44.5248	
DW-test	1.7722	Akaike Info. Criterion	48.4132	
RSS	53.4132	Mean of Dependent Variable	0.07424	

Note: ***, **, * denotes 1%, 5% and 10%. Level of significance, respectively.
Source: Output of Microfit Package, version 5.0.

Appendix F:

Table 7
Multivariate Granger causality test

Dep.	Short-run Causality				Long-run Causality	Direction of
Variables	***$\Delta lEPC_{t-1}$***	***$\Delta lGDP_{t-1}$***	***$\Delta lFDI_{t-1}$***	***$\Delta lCPI_{t-1}$***	***ECT_{t-1}***	Causality
$\Delta lEPC_t$	-	0.4651	0.7807	0.2485	- 0.2583***	*lnGDP ⟶ lEPC*
$\Delta lGDP_t$	8.463***	-	0.0035	0.0970	-0.1389*	*lFDI ⟶ lEPC*
$\Delta lFDI_t$	2.909***	6.095***	-	0.2533	-0.1326	*lFDI ⟶ lGDP*
$\Delta lCPI_t$	1.594	0.0584	1.8797	-	-0.0449	

Note: The (⟶) represents the unidirectional Granger causality.
Source: EViews7.2 ® Output.

Appendix G:

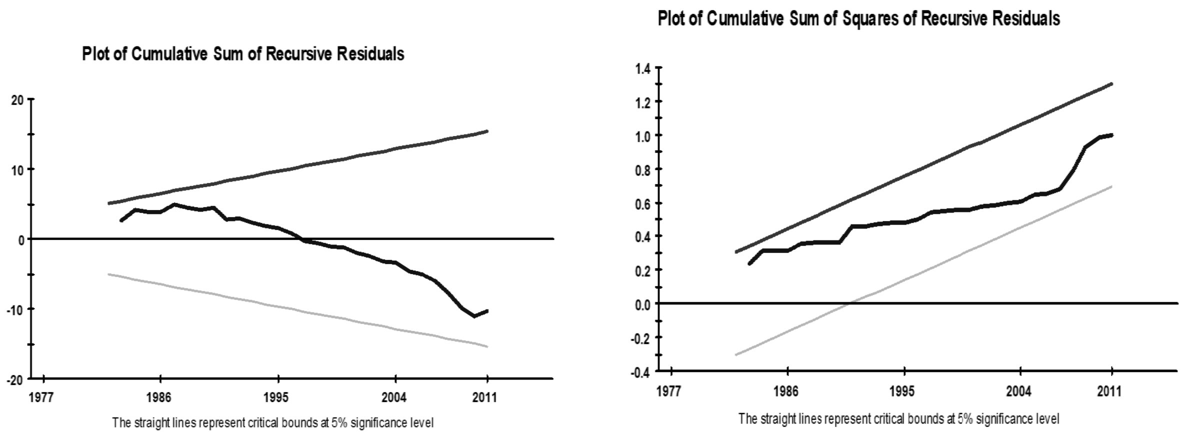

Figure 3: Plots of CUSUM and CUSUMQ Underwriting *EPC*.
Source: Output of Microfit Package, version 4.1

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العلاقة التوازنية بين الاستثمار الأجنبي المباشر، استهلاك الطاقة الكهربائية، والناتج المحلي الإجمالي في الأردن: تحليل السلاسل الزمنية

علي مطر [1]

ملخص

تهدف هذه الدراسة للتحقيق في العلاقة التجريبية ما بين الاستثمار الأجنبي المباشر، ونصيب الفرد الواحد من استهلاك الكهرباء، والنمو الاقتصادي (متمثلا بنصيب الفرد الواحد من الناتج المحلي الإجمالي بالأسعار الثابتة)، ومؤشر أسعار المستهلك في الأردن خلال الفترة (1976–2011). تم توظيف تحليل السلاسل الزمنية باستخدام نموذج الانحدار المتباطئ الموزع لاختبار العلاقة مابين المتغيرات. اقترحت النتائج وجود علاقة توازنية طويلة الأجل بين نصيب الفرد الواحد من استهلاك الكهرباء والنمو الاقتصادي. أكدت النتائج أيضا على وجود دليل قوي لعلاقة أحادية الاتجاه تتجه من النمو الاقتصادي إلى استهلاك الكهرباء والتي تشير إلى أن زيادة نصيب الفرد الواحد من النمو الاقتصادي من شأنه أن يسبب ارتفاع دائم في استهلاك الكهرباء في الأردن.

الكلمات الدالة: التكامل المشترك، واستهلاك الطاقة الكهربائية، ونموذج الانحدار المتباطئ، والنمو الاقتصادي، والسببية، والأردن.

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