Investigating the Link Between Foreign direct investment, Energy consumption and Economic growth in Argentina

Mavikela, Nomahlubi and Khobai, Hlalefang

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Nomahlubi Mavikela

Email: nmavikela2@gmail.com

Nelson Mandela University, South Africa

Hlalefang Khobai

Email: hlalefangk@gmail.com

Nelson Mandela University, South Africa

ABSTRACT

This paper investigates the relationship between energy consumption, foreign direct investment and economic growth in Argentina employing annual data covering the period from 1970 to 2016. To determine the long run relationship and the direction of causality among the variables, the Autoregressive Distributed Lag (ARDL) bounds testing approach and Vector Error Correction Model (VECM) technique are applied, respectively. The ARDL bounds tests suggested an existence of a long run relationship between energy consumption, foreign direct investments, economic growth and capital. More specifically, it was established that a 1% increase in foreign direct investments lead to a 0.013% increase in energy consumption, while a 1% increase in economic growth boots energy consumption by 0.35% in the long run. The VECM Granger-causality results suggested a unidirectional causality flowing from foreign direct investments and capital to energy consumption. A bidirectional causality flowing between energy consumption and economic growth was also established. This study brings a fresh perspective for the energy policy makers in Argentina.

JEL Classification: O13, Q43

Keywords: Energy consumption, Foreign direct investment; Economic growth; ARDL; VECM; Argentina

INTRODUCTION

Omri and Kahouli (2014) maintain that the link between foreign direct investment, energy consumption and economic growth has newly started to be discussed in energy economics literature. In order to investigate the relationship between these variables, literature can be divided into three sections. The first section of literature focuses on the relationship between

energy consumption and economic growth. The relationship between energy consumption and economic growth dates back to the 1970s when the pioneer work of Kraft and Kraft (1978) found evidence of a unidirectional causality from GNP growth to energy consumption in the United States for the period 1947-1974. Since then numerous studies have been conducted to test the relationship between energy consumption and economic growth which thus led to four testable hypotheses, namely: growth, conservation, feedback and neutrality. The growth hypothesis claims that energy consumption granger causes economic growth (see Apergis and Payne, 2009; Abosedra, Shahbaz and Sbia, 2015; Esen and Bayrak, 2017). The conservation hypothesis states that economic growth granger causes energy consumption (see Zhang and Cheng, 2009; Ahmad *et al*, 2012; Cheng and Lai, 1997). The feedback hypothesis posits a bidirectional causality flowing from energy consumption and economic growth (see Rezitis and Ahammad, 2015; Huang, Hwang and Yang, 2008; Shahiduzzaman and Alam, 2012; Belke, Dobnik and Dreger, 2011). The neutrality hypothesis states that there is no granger causality between energy consumption and economic growth (see Fatai, 2014; Akinlo, 2008; Sharmin and Khan, 2016; Sharaf, 2016).

The second section of literature examines the relationship between foreign direct investment and economic growth. The relationship between foreign direct investment (FDI) and economic growth is becoming more important for both developed and developing countries. Srinivasan, Kalaivani and Ibrahim (2011) informs that the most widespread belief among researchers and policy makers is that foreign direct investment boosts growth through different channels, manifesting differently depending on the area and the region of the foreign investment. A positive impact of FDI on economic growth has been confirmed by a number of studies by researchers such as Nistor (2014); Sylwester (2005); Mun, Lin and Man (2008) and Fadhil and Almsafir (2015). FDI is thought to open up export markets through enhancing competitiveness and to promote domestic investments through the technological spillovers and the induced productivity increase (Abbes et al, 2015; Almfraji, Almsafir and Yao, 2014). As it eases the transfer of technology, foreign direct investment is expected to create employment and increase and improve the existing stock of knowledge in the recipient economy through labour training and skill acquisition (Simionescu, 2016; Adams, 2009; Mawugnon and Qiang, 2011).

The third section of literature has examined the relationship between foreign direct investment and energy consumption. Using the dynamic simultaneous equations model, Omri and Kahouli (2014) found a unidirectional causality flowing from FDI to energy consumption for the panel group of 65 countries. On the contrary, Abdouli and Hammami (2017) found a unidirectional

causality flowing from energy consumption to FDI. Using a panel data set on 22 emerging countries covering the period 1990 to 2006, Sardosky (2010) empirically found a positive and statistically significant relationship between financial development and energy consumption when financial development is measured using stock market variables. These results are supported by Salman and Atya (2014), Kakar (2016) and Islam et al (2013) who found a positive and significant relationship between financial development and energy consumption in Algeria, Tunisia, Pakistan and Malaysia. Moreover, they found that energy consumption is influenced by economic growth and financial development, both in the short and the long run. Financial development refers to a country's decision to allow and promote activities such as increased foreign direct investment (FDI), increases in banking activity and increases in stock market activity. Furthermore, financial development is important because it can increase the economic efficiency of a country's financial system. Sardosky (2010) explains that financial development in emerging economies is likely to affect economic growth since it is often cited as a very important driver of energy demand.

The main objective of the study is to investigate the relationship between foreign direct investment, energy consumption and economic growth in Argentina for the period 1970 to 2016. The study employs the autoregressive distributed lag (ARDL) model to depict the long-run relationship between foreign direct investment, energy consumption and economic growth. Furthermore, the vector error correction model (VECM) is applied to unravel the causal relationships among the variables. The remainder of the paper is organised as follows. Section 2 provides a review of empirical literature on the relationship between foreign direct investment, energy consumption and economic growth in Argentina. Section 3 presents the model specification and the estimation technique that will be utilised in the study. Section 4 discusses the empirical results. Finally, section 5 summarises the main findings of the study and provides some policy recommendations.

OVERVIEW OF RELATED LITERATURE

Many studies have been conducted to investigate the relationship between foreign direct investment, energy consumption and economic growth but have found mixed and conflicting results across methodologies and countries.

COUNTRY SPECIFIC STUDIES

Kuo et al (2012) investigated the relationship between foreign direct investment, energy consumption and economic growth for the period 1978 to 2010 for China. The empirical results revealed that there is a unidirectional granger causality running from GDP to energy consumption. Furthermore, a bi directional granger causality was found between energy consumption and FDI. Khatun and Ahamad (2015) examined the causal relationship between foreign direct investment in the energy and power sector and economic growth in Bangladesh. The study found evidence of a positive and unidirectional causality running from energy consumption to economic growth and that an increased inflow of FDI is found to have a positive impact on energy consumption. Alam (2013) investigated the causal relationship between electric power consumption, foreign direct investment and economic growth in India and Pakistan. The study found that in the long run, electric power consumption granger causes both economic growth and FDI for India and that a bi-directional relationship was estimated for FDI and economic growth. In the case of Pakistan, FDI and economic growth were observed to granger cause electric power consumption in the long run. Ibrahiem (2015) examined the relationship between renewable electricity consumption, foreign direct investment and economic growth in Egypt for the period 1980 to 2011. Using the ARDL bound testing approach the study empirical found that the variables in the study are all cointegrated. Furthermore, renewable electricity consumption and foreign direct investment were found to have a long-run positive effect on economic growth. The granger causality test showed that there is a unidirectional causality running from foreign direct investment to economic growth and that there is bidirectional causality between economic growth and renewable electricity consumption.

MULTI-COUNTRY STUDIES

Amri (2016) investigated the relationship between foreign direct investment, energy consumption and economic growth for the period 1990 to 2010 for 75 countries. The study found a bidirectional linkage between FDI and GDP per capita; renewable energy consumption and GDP per capita; and non-renewable energy and GDP per capita in the panel group. Abdouli and Hammami (2017) investigated the relationship between foreign direct investment, energy consumption and economic growth for 17 Middle Eastern countries for the period 1990 to 2012. Making use of the simultaneous equation models, the study empirically found a bidirectional causal relationship between FDI inflows and economic growth and between

energy consumption and economic growth. Though, altogether there was a unidirectional causality flowing from energy consumption to FDI inflows for the global panel. Omri and Kahouli (2014) examined the relationship between energy consumption, foreign direct investment and economic growth using the dynamic panel data models in simultaneous-equations for a panel of 65 countries. The study found that for the high income countries, a bi-directional causal relationship between energy consumption, FDI inflows and economic growth was found. For the middle income countries on the other hand, the study found a bi-directional causal relationship between economic growth and energy consumption, and between economic growth and FDI inflows. Whereas there was a uni-directional causal relationship from FDI to energy consumption. Lastly, for the low income countries, the study also found that there is bi-directional causal relationship between economic growth and FDI inflows; a uni-directional causal relationship from economic growth to energy consumption and from energy consumption to FDI inflows. Tang and Tan (2014) examined the linkages among energy consumption, economic growth, relative price, foreign direct investment and financial development in Malaysia for the period 1972 to 2009. Making use of both the Johansen-Juselius co-integration test and bounds testing approach to co-integration, the study found that the variables are co-integrated. Furthermore the study found that there is a bidirectional causality between energy consumption and economic growth in the short and long run. In addition, the FDI-led growth and finance-led growth hypotheses are supported by the findings from the study. Lastly, a unidirectional causality is found from energy consumption to financial development.

From the literature above it can be realised that a growing number of studies have investigated the long run and causal relationship between foreign direct investment, energy consumption and economic growth, but few studies have been conducted that are country specific and that focus solely on Latin American countries, particularly Argentina. Therefore this study serves to fill this gap.

3. METHODOLOGY

This paper serves to investigate the long run relationship and the direction of causality between energy consumption, economic growth and foreign direct investments. Thus, this section is devoted to providing the methodological framework within which the effect of foreign direct investment and economic growth on energy consumption can be determined.

3.1 Model specification

Following from the literature review on energy consumption - foreign direct investments – economic growth nexus, this study treats energy consumption as the dependent variable which is consistent with studies conducted by Omri and Kahouli (2014) and Matar (2015). Economic growth and capital are incorporate into the model to form a multivariate framework. To determine the impact of these variables on energy consumption, the following relationship is tested

$$EC_t = f(FDI_t, GDP_t, K_t) \tag{3.1}$$

All the series are expressed in log-linear form and equation 3.1 now becomes;

$$LEC_t = \alpha \ + \beta_1 LFDI_t + \beta_2 LGDP_t + \beta_3 LK_t + \mu_t \tag{3.2}$$

Where

LEC denotes the natural logarithm of energy consumption

LFDI represents the natural logarithm of foreign direct investment

LGDP is the natural logarithm of economic growth and is measured by real GDP per capita

LK is the natural logarithm of capital formation

3.2 Unit root

Spurious regression results when regression of two or more variables are non-stationary. Therefore, to avoid the problem of spurious regression, the characteristics of the time series data utilised for the estimation of the model will be determined. This study uses three unit root tests, namely; Augmented Dickey Fuller (ADF) unit root test by Said and Dickey (1984), Phillips-Perron (PP) unit root test by Phillips and Perron (1988) and the Dickey Fuller Generalised Least Squares (DF-GLS) test proposed by Elliot, Rothenberg and Stock (1996). The ADF and the Phillips-Perron test have been criticised for their low power when variables are stationary but with a root close to non-stationary boundary (Brooks, 2014). Elliot et al (1996) states that the DF-GLS test has more power in the presence of an unknown mean or trend compared to the ADF and the Phillips-Perron tests. The null of a unit root is estimated against the alternative of stationarity in all tests.

3.4 Co-integration test

In the empirical estimation of the long run relationship between energy consumption and foreign direct investment, this study employs the autoregressive distributed lag model (ARDL) approach to co-integration developed by Pesaran et.al (2001). This model is chosen because it is applicable irrespective of the order of integration of the underlying variables. However, to avoid spurious results or a crush of the ARDL procedure, it is necessary to ensure that none of the variables are *I*(2). This study acknowledges the possibility of a bidirectional relationship between energy consumption and foreign direct investment, which usually can create endogeneity or simultaneity problem in empirical estimations. The ARDL model is able to correct simultaneity issues allowing for an unrestricted number of lags for the regressand and regressor. ARDL model is also efficient in studies using finite or small samples. Therefore, it is for this reasons that this study chose the ARDL bounds testing procedure. To determine the long run relationship between energy consumption and other variables, the following ARDL models are estimated;

$$\Delta LEC_t = \alpha_1 + \alpha_T T + \alpha_{EC} LEC_{t-1} + \alpha_{FDI} LFDI_{t-1} + \alpha_{GDP} LGDP_{t-1} + \alpha_K LK_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LEC_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta LFDI_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta LGDP_{t-k} + \sum_{m=0}^{s} \alpha_m \Delta LK_{t-m} + \varepsilon_{1t} \quad (3.3)$$

$$\Delta LFDI_t = \alpha_1 + \alpha_T T + \alpha_{EC} LEC_{t-1} + \alpha_{FDI} LFDI_{t-1} + \alpha_{GDP} LGDP_{t-1} + \alpha_K LK_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LEC_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta LFDI_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta LGDP_{t-k} + \sum_{m=0}^{s} \alpha_m \Delta LK_{t-m} + \varepsilon_{2t} \quad (3.4)$$

$$\Delta LGDP_t = \alpha_1 + \alpha_T T + \alpha_{EC} LEC_{t-1} + \alpha_{FDI} LFDI_{t-1} + \alpha_{GDP} LGDP_{t-1} + \alpha_K LK_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LEC_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta LFDI_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta LGDP_{t-k} + \sum_{m=0}^{s} \alpha_m \Delta LK_{t-m} + \varepsilon_{3t} \quad (3.5)$$

$$\Delta LK_t = \alpha_1 + \alpha_T T + \alpha_{EC} LEC_{t-1} + \alpha_{FDI} LFDI_{t-1} + \alpha_{GDP} LGDP_{t-1} + \alpha_K LK_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta LEC_{t-i}$$

$$+ \sum_{j=0}^{q} \alpha_j \Delta LFDI_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta LGDP_{t-k} + \sum_{m=0}^{s} \alpha_m \Delta LK_{t-m} + \varepsilon_{4t} \quad (3.6)$$

Where

LEC_t is the natural logarithm of energy consumption

$LFDI_t$ is the natural logarithm of foreign direct investment

$LGDP_t$ is the natural logarithm of economic growth

LK_t is the natural logarithm of capital formation

T denotes the time period

Δ represents the first difference operator

It is assumed that the residuals ($\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, \varepsilon_{5t,}$) are normally distributed and white noise.

Equation (3.3) can be viewed as an ARDL of order (p, q, r, s). Equation (3.3) implies that energy consumption tends to be influenced and explained by its past values and other variables. After estimation of equation (3.3) the joint F-statistics (or Wald test) is computed to determine existence of co-integration among the variables. The null hypothesis of the non-existence of co-integration for equations 3.3 are as follows;

H_0: $\alpha_{EC} = \alpha_{FDI} = \alpha_{GDP} = \alpha_K = 0$

tested against the alternative hypothesis

H_1: $\alpha_{EC} \neq \alpha_{FDI} \neq \alpha_{GDP} \neq \alpha_K \neq 0$

The computed F-statistics value is compared to the critical values reported by Pesaran and Pesaran (1997) and Pesaran et.al (2001). The one assumes that all the variables incorporated in the ARDL model are *I*(0) and the other one assumes that the variables are *I*(1). If the calculated F-statistics exceeds the upper critical bound value, then the H_0 is rejected and the results conclude in favour of co-integration. If the F-statistics falls below the lower critical bound

value, H_0 cannot be rejected. If the F-statistics falls within the two bounds, then the co-integration test becomes inconclusive

3.5 Granger-causality

The existence of a long run relationship between the variables does not show which variable causes the other. As a result, the granger-causality test is applied to find the direction of causality among the variables. Granger-causality works in a way that, a time series EC causes another time series FDI, if FDI can be predicted better utilising the past values of EC than by not doing so. This means that if the past values of EC significantly contribute to forecasting FDI, then it implies that EC granger-causes FDI and that causality from FDI to EC can be explained in the same way. The VECM is used to determine the long and short run relationship between the variables and can detect sources of causation. The VECM is moulded by equation (3.7) - equation (3.11). In each equation, the dependent variable is explained by itself, the independent variables and the error correction term

$$\Delta LEC_t = \alpha_{10} + \sum_{i=1}^{q} \alpha_{11} \Delta LEC_{t-i} + \sum_{i=1}^{r} \alpha_{12} \Delta LFDI_{t-i} + \sum_{i=1}^{s} \alpha_{13} \Delta LGDP_{t-i} + \sum_{i-1}^{t} \alpha_{14} \Delta LK_{t-i} + \psi_1 ECT_{t-1} + \varepsilon_{1t} \quad (3.7)$$

$$\Delta LFDI_t = \alpha_{20} + \sum_{i=1}^{q} \alpha_{21} \Delta LFDI_{t-i} + \sum_{i=1}^{r} \alpha_{22} \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_{23} \Delta LGDP_{t-i} + \sum_{i-1}^{t} \alpha_{24} \Delta LK_{t-i} + \psi_2 ECT_{t-1} + \varepsilon_{2t} \quad (3.8)$$

$$\Delta LGDP_t = \alpha_{30} + \sum_{i=1}^{q} \alpha_{31} \Delta LGDP_{t-i} + \sum_{i=1}^{r} \alpha_{32} \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_{33} \Delta LFDI_{t-i} + \sum_{i-1}^{t} \alpha_{34} \Delta LK_{t-i} + \psi_3 ECT_{t-1} + \varepsilon_{3t} \quad (3.9)$$

$$\Delta LK_t = \alpha_{40} + \sum_{i=1}^{q} \alpha_{41} \Delta LK_{t-i} + \sum_{i=1}^{r} \alpha_{42} \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_{43} \Delta LFDI_{t-i} + \sum_{i-1}^{t} \alpha_{44} \Delta LGDP_{t-i} + \psi_4 ECT_{t-1} + \varepsilon_{4t} \quad (3.10)$$

Where

Δ denotes the difference operator

α_{it} is the constant term

ECT represents the error correction term derived from the long run cointegrating relationships

The t-statistics is employed to test the significance of the speed of adjustment in ECT terms. The statistical significance of ECT_{t-1} with a negative sign validates the existence of a long run causality flowing among the variables. To investigate the short run causality, the Wald test is applied on differenced and lagged differenced terms of the independent variables.

3.6 Data sources

Time series data is used for South Africa over the period 1970 – 2016. Data was collected from different sources. Energy consumption was sourced from International Energy Agency (IEA). The data for foreign direct investments and capital were extracted from the World Development Indicators. Finally, data for economic growth measured as gross domestic product (using constant prices of 2010) was collected from the South African Reserve Bank.

4. FINDINGS OF THE STUDY

The main aim of the study is to investigate the long run relationship between energy consumption, foreign direct investment, economic growth and capital as well as determining the granger causality between energy consumption and foreign direct investment. The ARDL model will be employed through several steps. Firstly, the stationarity test will be applied. Secondly, the order of lags of the ARDL model will be selected. Thirdly, the F-statistics test will be conducted to determine the long-run relationship. Fourthly, the long run coefficients will be estimated and the error correction model will be established followed by the diagnostic tests and stability tests. Finally, the granger-causality tests will be examined.

4.1 Unit root tests

The unit root test is conducted using the Augmented Dickey Fuller (ADF), Phillips and Perron (PP) and Dickey Fuller Generalised Least Squares (DF-GLS). These tests are conducted to ensure that none of the variables are I(2). The results are illustrated in Table 1. Table 1 shows all the variables are none stationary at levels and become stationary at first difference except for foreign direct investment. Foreign direct investment is stationary at levels which means it

is integrated of order zero, I(0). This implies that the unit root results validated a combination of I(0) and I(1). As a result, the ARDL model is appropriate to determine the long run relationship among the variables. But prior to examining the long run relationship, it is important to determine the maximum lag order.

Table 1: Unit root tests

	Levels			**First difference**		
Variable	**ADF**	**PP**	**DF-GLS**	**ADF**	**PP**	**DF-GLS**
LEC	-1.9941	-1.8324	-1.9800	-6.6097*	-9.0242*	-6.7653*
LFDI	-4.064**	4.0489**	-4.1284*	-8.8528*	-22.024*	-8.8208*
LGDP	-2.4300	-2.1576	-2.4309	-5.4121*	-5.3011*	-5.5230*
LK	-2.6108	-2.3286	-2.1513	-5.5847*	-5.6224*	-5.7048*

Source: Own calculation

This study selects the suitable ARDL model using the Akaike Info Criterion (AIC) and Schwarz Bayesian Criterion (SBC). To choose the suitable model, several lag models were fitted. Among the models the preferred models to explain the long run relationship were AIC and SB. Following from Table 2, these two models selected the lag 2 as the best model.

Table 2 Selection order criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	182.2201	NA	1.97e-09	-8.693664	-8.526486	-8.632787
1	306.7515	218.6893*	9.94e-12*	-13.98788*	-13.15199*	-13.68349*
2	317.4726	16.73541	1.32e-11	-13.73037	-12.22577	-13.18248
3	334.2926	22.97358	1.35e-11	-13.77037	-11.59706	-12.97897

Source: own calculation

4.2 Co-integration

After conducting the unit root test and establishing that none of the variables are I(1), the next step is to examine the long run relationship among the variables. Commencing with energy consumption as the dependent variable, the calculated F-statistics is 5.51. The critical values ranges are I(0) = 3.372 and I(1)= 4.797 at 1% level of significance. Therefore, comparing the F-statistics with the critical values, it can be realised that F-statistics is greater than the upper critical value at 1% level of significance. This implies that the null hypothesis of no co-integration will be rejected indicating the existence of long-run relationship between the variables. Similar result are established when economic growth and capital are used as the dependent variables. When foreign direct investment is used as the dependent variable, the calculated F-statistics is less than the lower bound critical value at 5% level of significance, which indicates that there is no long run relationship when foreign direct investment is used as the dependent variable. Nevertheless, since three of co-integration equations validate the existence of a long run relationship between the variables, we conclude that there is a long run relationship between energy consumption, foreign direct investment, economic growth and capital in Argentina. The results are consistent to studies conducted by Tang and Tan (2014), Kim (2015) and Gökmenoğlu and Taspinar (2015).

Table 3 ARDL Co-Integration Test

Critical value bound of the F-statistic						
K	90% level		95% level		99% level	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
3	2.022	3.112	2.459	3.625	3.372	4.797
4	1.919	3.016	2.282	3.340	3.061	4.486

Calculated F-statistics

F_{EC}(EC/FID, GDP, K) = 5.51

F_{FDI}(FDI/EC, GDP, K) = 2.41

F_{GDP}(GDP/EC, FDI, K) = 7.78

F_{K}(K/EC, FDI, GDP) = 6.54

……

Note: The critical bound values were taken from Narayam and Smyth (2005: 470)

The next step involves estimating the long run coefficients and the results are illustrated in Table 4. Table 4 shows that foreign direct investments and economic growth are statistically significant and positively correlated with energy consumption in the long run. Specifically, the coefficient of foreign direct investment is 0.013, which implies that a 1% increase in foreign direct investment leads to 0.013% increase in energy consumption. The results are consistent to studies conducted by Abdouli and Hammami (2017) and Khatun and Ahamad (2015). The coefficient of GDP is 0.35, which means that a 1% increase in economic growth results in an increase of about 0.35% in energy consumption. The results are consistent to studies conducted by Ozturk, Aslan and Kalyoncu (2010), Salman and Atya (2014) and Altunbas and Kapusuzoglu (2011). Capital has a positive effect on energy consumption but it is not statistically significant.

Table 4 Long run results

Dependent Variable = LEC			
Long Term Results			
Variable	Coefficients	Standard Error	T-statistics
Constant	-1.82*	0.4178	-4.3618
LFID	0.013*	0.0046	2.8776
LGDP	0.35**	0.1808	1.9173
LK	0.012	0.0626	0.1910
R-squared 0.98 Durbin Watson Stat 2.02			

Source: Own calculations

Table 5 presents the short run results and the error correction term. It is established that the coefficient of the error correction term (-0.76) is negative and statistically significant at the 1% level of significance. This indicates that approximately 76% of the disequilibrium of energy consumption shock of the previous year will result in the adjustment back to the long run rate equilibrium of energy consumption and should be corrected in the current year. The specified variables are found to have a positive and a statistically significant effect on energy consumption except for capital in the short run. Capital has a positive effect on energy consumption but it is not statistically significant.

Table 5 Short run analysis

Variable	Coefficient	Standard error	T-statistics
LFDI	0.005**	0.0034	1.5574
LGDP	0.35*	0.1155	3.0011
LK	0.012	0.0413	0.2892
ECM_{t-1}	-0.76*	0.1341	-5.6548
R^2	0.81		
D.W test	2.02		
*,**represent 1% and 5% significance levels, respectively			

Source: Own calculation

The ARDL model passes all the diagnostic tests as depicted in (Table 6). The results suggest that the error terms of the short run models have no serial correlation; are free of heteroskedasticity; and are normally distributed. Furthermore the results established that the short run models are not spurious because the Durban-Watson statistics was found to be greater than the R^2. The Ramsey RESET test validated that the functional form of the model is well specified.

Table 6 Short-run diagnostics

Short run diagnostics		
Test	F-statistics	P-value
Normality	1.3924	0.4985
Heteroskedasticity	1.6736	0.1267
Serial correlation	0.0883	0.9158

Source: Own calculation

The stability of the long run parameters were estimated using the cumulative sum of recursive residuals (CUSUM). The results are presented in figures 1 and 2. The results fall within the critical bounds, which means that the estimated coefficients of the model are stable and the straight lines in figures 1 and 2 represent the critical bounds at 5% level of significance.

Figure 1 CUSUM

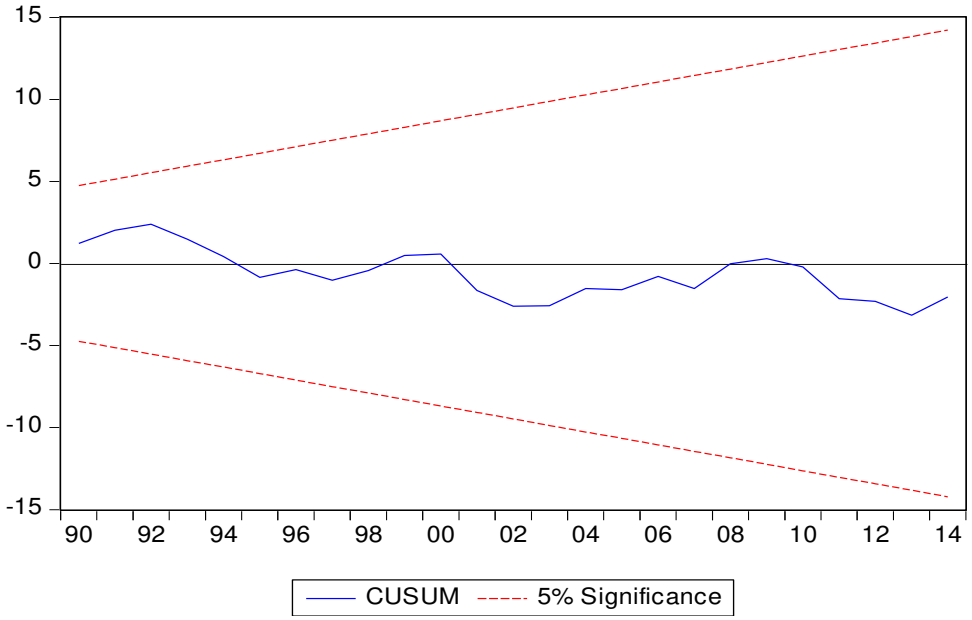
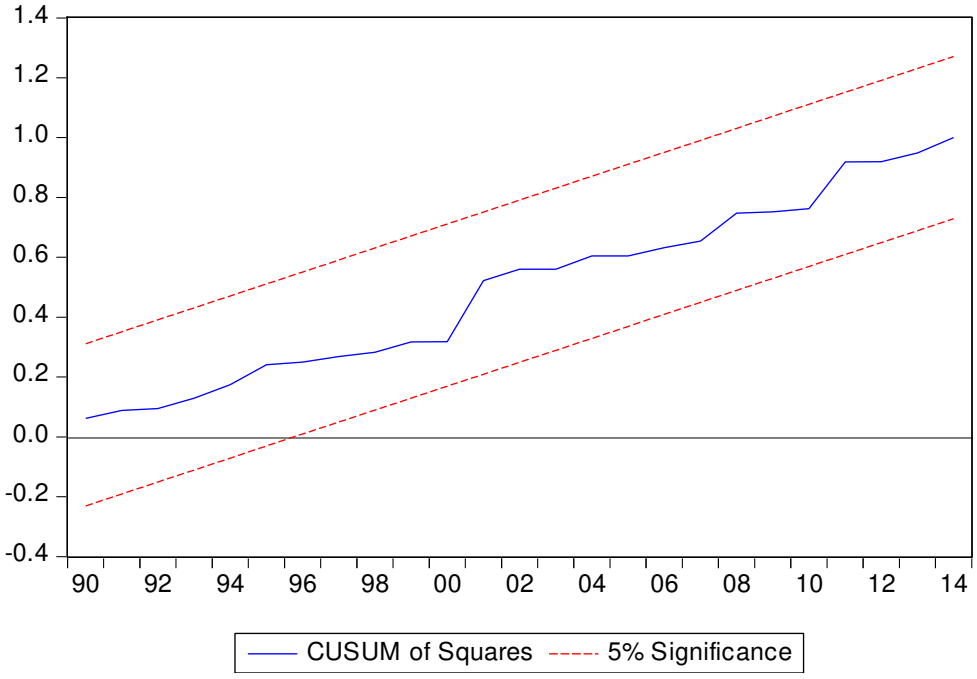


Figure 2 CUSUMSQ



4.4 Granger Causality

If a set of variables are found to have one or more co-integrating vectors, this shows that there is an existence of causality among the variables. As a result a suitable estimation technique to determine the direction of causality is the vector error correction model (VECM). The results of the VECM are presented in Table 7. The results reveal that there is a long causality flowing from foreign direct investments, economic growth and capital to energy consumption. This is because the coefficient of the error correction term in equation 3.7 has a negative sign and is statistically significant at the 5% level of significance. The results are consistent to studies conducted by Kuo et al (2012); He, Gao and Wang (2012) and Kuo et al (2014).

It was also revealed that the coefficient of the error correction term in Equation 10 has a negative sign and is significant at the 5% level of significance. This is interpreted as a unidirectional causality flowing from energy consumption, foreign direct investment and capital to economic growth in the long run. The results are consistent to studies conducted by Alam (2013) and Bekhet and Othman (2011). The coefficients of the error correction terms in equation 3.8 and 3.10 are negative but not significant at 5% level of significance. In addition it was established that there is a short run causality flowing from energy consumption to economic growth.

Table 7 Vector Error Correction Model (VECM)

Dependent variable	Types of Causality				
	Short run				Long run
	∑ΔLec	∑ Δlfdi	∑ Δlgdp	∑ Δlk	ECT_{t-1}
ΔLec	……..	1.16	0.47	0.11	-0.85**
Δlfdi	2.72	…….	1.50	2.30	-4.18
Δlgdp	0.09*	0.19	…….	0.34	-0.06**
Δlk	0.68	0.86	0.43	…….	-2.22

Source: Own calculation

5. Conclusion

This paper contributes to the growing literature on energy consumption, foreign direct investments and economic growth nexus. We investigated for the case of Argentina the interrelationship between foreign direct investment, economic growth and energy consumption employing annual data covering the period from 1970 to 2016. Our study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach to examine the long run relationship between the variables. The Vector Error Correction Model (VECM) technique is adopted to determine the direction of causality among the variables.

The ARDL bounds tests confirmed an existence of a long run relationship between energy consumption, foreign direct investments, economic growth and capital. More specifically, it was established that a 1% increase in foreign direct investments leads to a 0.013% increase in energy consumption, while a 1% increase in economic growth boosts energy consumption by 0.35% in the long run. The VECM Granger-causality results suggested a unidirectional causality flowing from foreign direct investments and capital to energy consumption. A bidirectional causality flowing between energy consumption and economic growth was also established.

The following policy implications can be derived from the results found in this study. First, a bidirectional causality between energy consumption and economic growth implies that our results do not support the neoclassical assumption that energy is neutral for growth. Our results imply that economic growth promotes energy consumption and energy consumption boosts economic growth in Argentina. Therefore, policies on energy conservation should not be applied in Argentina as they might have a negative effect on economic growth. Second, our results established that foreign direct investments Granger-cause energy consumption. This implies that foreign direct investments are important drivers of energy consumption. Therefore, the policy makers should enhance investment in energy consumption and encourage the usage of green technology. This can be made possible if the country can focus on attracting foreign direct investments, which will in turn encourage the usage of renewable energy. Finally, our findings established a unidirectional causality flowing from foreign direct investments to economic growth, which implies that attracting the stock of foreign direct investments inflow boosts economic growth. Therefore, the government and policy makers should come up with policies which will combat barriers to local firms from access to inputs such as technology

which will improve domestic production, as this will attract foreign direct investments inflows and enhance economic growth in Argentina.

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