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The Relationship between Electricity Consumption and Economic Growth: Evidence from Azerbaijan

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ABSTRACT

Research examines the relations between GDP in Manat and Dollar and total electric energy consumption (1995-2017) for the last 22 years in the Republic of Azerbaijan. Besides, the relations between the electric energy consumption and the growth of GDP in these sectors were analysed. Autoregressive distributed lag model was used as a research methodology. Stationary tests of variables (ADF, PP, and KPSS) and Pairwise Granger Causality Tests were done. Stability of models was examined. Eviews_9 econometric software program was used to establish graphics and do calculations. Having analysed the research, there is a positive correlation not only in GDP and electric energy consumption but also electric energy consumption and GDP in different sectors of economy. We recommend to save electric energy.

Keywords: Electric Energy Consumption, GDP Growth, Autoregressive Distributed Lag
JEL Classifications: F15, B28, C23, Q43, O52

1. INTRODUCTION

The roles that hydrocarbon resources, including oil products as energy carriers, play in the economy and in the life of people are undeniable (Muradov et al., 2019). Policy development, ensuring the growth and development of complex, open and non-linear economic systems, as well as the measurement and evaluation of its results are widely discussed topics in modern economics. It is not by chance that these topics occupy a special place in the reports of international organizations and in the diaries of scientific journals. "How are the priority directions of economic policy chosen?," "How are the needs of economic agents studied in incentives?" "How does economic policy affect the behavior of economic agents?," "What indicators can assess the effectiveness of regulatory measures?", "How can one measure and evaluate economic development and growth?" These and many other issues still remain "apples of discord" for economists.

Angus Deaton believes that economics can be a good tool for developing successful economic policies, but for this it needs, first of all, high-quality information. Nobel laureate, noting the fundamental importance of measurement in economics, argued that, as a means of correctly evaluating the results of economic policy, measurement could also become a source for new theoretical ideas.

Currently, in countries along with microeconomic statistics, microeconomic databases are also being developed. The creation,

Table 1: Power generation in Azerbaijan, million kVt.h

Date	Years											
	1913	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2017
Generation	110,8	122	503,9	1827	2924	6590	12027	15045	23152	18699	18710	24320,9
Fuel				1802	2894	4626	10893	13825	21399	17069	15003	20445,4
Hydro				24,3	29,5	1963	1022	1098	1658	1534	3446	1746,4
Own power plant of enterprises (fuel)							111,7	122,2	95,6	83,1	259,7	1899,5
Wind											0,5	22,1
Solar												37,2
Waste												170,3
Power of electricity plants, MVt	39,8	56,4	113,4	254,4	401,6	1261	2623	2882	5051	4912	6398	7941,5

www.stat.gov.az

preservation, systematization and processing of such scientific and labor-intensive microeconomic databases requires large financial resources. And the quality of macroeconomic data is reduced under the influence of the variability of monetary units of measurement. To eliminate the above deficiency, universal natural indicators are used, one of which is the electricity consumption.

Some studies have found a statistically significant (Dhungel, 2010; Lu, 2017; Aslan, 2014) and a bi-directional causal relationship (Kasperowicz, 2014; Ogundipe and Apata, 2013; Motlokoa, 2016) between electricity consumption and economic growth.

Other studies show us that the nature of the relationship between electricity consumption and economic growth differs depending on the type of activity. There exists bidirectional causality between electricity consumption and real output in the services sector and unidirectional causality running from real output in the industrial sector to electricity consumption. However, there is no causal relationship between electricity consumption and real output in the agricultural sector (Ibrahiem, 2018).

In addition, it is believed that the living standard of the population and the economic development degree in the country also affect the relationship between electricity consumption and economic growth (Mahfoudh and Ben Amar, 2014). The results of these studies do not give us full grounds for adopting electricity consumption as an unequivocal indicator of economic growth.

Preponderance of industrial states is completely dependent on energy to fuel their economies. Besides, globalization has made the world to be so interconnected and interdependent that the energy industry is the biggest contributor of the climate change which doesn't affect a single country but have far wider implications (Vidadili et al., 2017).

Each country with its own economic structure, development level and security of natural energy resources, mechanisms for regulating energy markets, climatic, geographical and demographic conditions is a unique object of research. Conducting such studies in different countries can clarify the relationships between factors that influence the nature of the relationship between electricity consumption and economic growth. On this basis, the study of the relations between these indicators in Azerbaijan was adopted as the goal of this study.

We think that the results of our research are of scientific and practical importance in the following areas:

Table 2: Electric power consumption

Countries	kVt.h/per capita
Azerbaijan	2.202
Armenia	1.962
Georgia	2.694
Turkey	2.847
Turkmenistan	2.679
Russian Federation	6.603
Kazakhstan	5.600
Ukraine	3.419
Iran	3.022

https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC

1. Research provides some empirical information about the relationship between energy consumption and economic growth in an energy-rich country;
2. Shows the behavior of energy consumption and growth in different sectors of the Azerbaijan economy;
3. The results can be used to predict the electricity demand throughout the economy, and by its branches in countries with similar conditions.

2. GENERAL CONDITIONS OF POWER SUPPLY IN AZERBAIJAN

Electricity production in Azerbaijan dates back to the first years of the 20th century - from the time of the first oil boom. Subsequent industrialization processes and the possession of rich hydrocarbon resources led to an accelerated growth in demand for electricity. In the last 50 years alone, the production of electricity has almost doubled (Table 1).

İt can be seen that almost 90% of the total energy produced is accounted for by thermal power plants. Despite the country's huge potential for renewable and alternative energy sources, it was only in the last decade that solar and wind energy began to be used for production.

In Azerbaijan, production facilities, transmission lines and distribution of electricity are fully owned by the state and electricity tariffs are regulated by the state. The volume of production capacity is far ahead of the volume of domestic demand for electricity. Today, Azerbaijan is an exporter of electric energy to neighboring countries. Despite the fact that all parts of Azerbaijan are fully and continuously supplied with electricity, we occupy one of the last places in the region in terms of the use of electricity per capita (Table 2).

Table 3: Summary of similar empirical studies in the literature

	Data period	Rearched countries	Method(s)	Results
Marius-Corneliu et al. (2018)	Annual, 1990-2014	Ten European Union (EU) member states from Central and Eastern Europe	ARDL	The result shows that there is no relationship between renewable energy consumption and GDP in Romania and Bulgaria. However, there is resurgence in renewable energy consumption in Hungary, Lithuania and Slovenia. To sum up, cause-effect relationship between renewable energy consumption and GDP was confirmed in both states. The confirmation is true for each studied state separately
Rafał Kasperowicz (2014)	First quarter of 2000 to the fourth quarter of 2012	Poland	C.W.J. Granger, ADF, KPSS test	Achieved results reveals that there is a relationship between electricity consumption and economic growth in Poland. Direction is divided into 2 parts. Dependency of economic growth on electricity is expressed in Poland
Maria Pempetzoglou (2014)	1945-2006	Turkey	Standard linear Granger causality test and the nonparametric Diks and Panchenko causality test	Results confirm that there is a single-direction nonlinear causal relationshipship between income and electricity consumption. Besides, we can see the followings: 1. Single-direction linear approach to electricity consumption spent on residential, commercial and street lighting 2. Single-direction nonlinear causal relationshipship directed from electricity consumption to GDP in residential, commercial fields 3. Single-direction nonlinear causal relationshipship directed from income to electricity consumption in street lighting. to GDP in residential, commercial fields
Wen-Cheng Lu (2017)	1998-2014	17 industries in Taiwan	Granger causality	Results confirm the double-direction Granger causal relationshipship and long-term balance between electricity consumption and GDP. So, the growth of electricity consumption by 1% causes to increase 1.72% in GDP
Slim and Mohamed (2015)	1990-2010	19 African countries	Solow model, Granger test	There is a strong correlation between electricity consumption and rich countries. There is also a correlation relationship between the lack of using modern service of energy and the people who work for 2 dollars per day
Ömer and Bayrak (2017)	1990-2012	75 net energy-importing countries	CADF DOLS and FMOLS estimators	Based on the results of individual and group states, there is a positive and statistically significant relationship between electricity consumption and GDP in a long term. Thus, electricity consumption causes GDP growth
Uyar and Gökçe (2017)	Annual, 1985-2013	Vietnam, Indonesia, South Africa, Turkey and Argentina	Panel Quantile Regression	The influence of GDP on oil consumption is tremendously downsizing. However, hydroelectric stations impact on electricity consumption positively and surges significantly. Coal has no any influence on economic growth
Kamal (2017)	2000-2011	Five south Asian countries	Granger causality, VARM	Cointegration test proves the positive relationship and balance between electricity consumption and GDP in a long term. The electricity consumption coefficient is 1.3%. It reveals that the increase of electricity consumption by 1% causes the growth of GDP by 1.31%. Thus, electricity consumption has a significant influence on economic development in South Asia
Aslan (2014)	1980-2008	Turkey	Granger causality	There is a positive and statistically significant relationship between electricity consumption and GDP in Turkey
Ibrahiem (2018)	1971-2013	Egypt	Johansen cointegration approach, VECM	Results prove the following relationships: 1. There is a double causal relationship between electricity consumption and real product in service sector 2. There is a single-direction causal relationship from real product to electricity consumption 3. There is no causal relationship between real product and electricity consumption in agrarian sector

(*Contd...*)

Table 3: (*Continued*)

	Data period	Rearched countries	Method(s)	Results
Junsheng et al. (2018)	1953-2013	China	Granger causes, Toda-Yamamoto test	The result confirms the positive relationship between electricity consumption and economic growth
Basiru (2014)	1980-2011	18 Sub-Saharan Africa countries	Panel Unit Root Test	There is no any causal relationship between electricity consumption and economic growth in the studied states. It is appropriate to neutrality hypothesis. In other words, GDP and electricity consumption are neutral to each other
Adeyemi and Ayomide (2013)	1980-2008	Nigeria	VECM, Pairwise Granger Causality test	The research result confirms the cointegartion relationship between electricity consumption and economic growth and sets the double-direction causal relationship between electricity consumption and economic growth
Ranjan et al. (2017)	1990-2012	BRICS countries	The Pedroni (1999-2004) Panel cointegration test, PECM	There is no any strong relationship between GDP and electricity consumption. The growth of GDP is a key factor that causes the increase of electricity consumption in the studied states
Muhammad and Nur-Syazwani (2018)	1971-2014	Malaysia	ARDL	There is a cointegration relations between real GDP and electricity consumption. Electricity consumption influences positively on economic growth in a short term
Lira and Mamofokeng (2016)	1982-2013	Uganda	Granger causality test	The result confirms the double-direction causal relationship between electricity consumption and economic growth in a long term
Ozturk et al. (2019)	1970-2012	Denmark	ARDL Granger causality test	The result confirms the neutrality of the relationship between electricity consumption and economic growth in Denmark
Bekareva et al. (2017)	2000-2014	United States	Arellano-Bond method	The result confirms the positive relationship between renewable energy consumption and economic growth.
Molem and Ndifor (2016)	1980-2014	Cameroon	Generalised Method of Moments	The result confirms that there is a relationship among electricity consumption, economic growth, population and electricity price
Mukhtarov et al., 2017	1990-2015	Azerbaijan	Toda-Yamamoto causality test, VAR	The results of this test show that there is bidirectional causality between energy consumption and economic growth. Findings of the study
Mukhtarov et al., 2018	1992-2015	Azerbaijan	Gregory–Hansen test, VECM	The results confirm the existence of a long-run relationship among the variables (between energy consumption, financial development, and economic growth). Find that there is a positive and statistically significant impact of financial development and economic growth on energy consumption in the long-run

The availability and relatively low tariffs of natural gas in all regions of Azerbaijan are the main argument for explaining this paradoxical situation.

3. LITERATURE REVIEW

The research of the relationships between energy consumption and economic growth has been a focal issue among scientists (Table 3). During research, a number of methods were employed. We can classify them as the following: for example, the relationships between energy consumption and economic growth has been analysed through autoregressive distributed lag (ARDL) method (Lefteris and Theologos, 2011; Ozturk and Ali, 2011; Ramazan et al., 2008; Nicholas, 2009; Fuinhas et al., 2012). However, other scientists researched the relationships between energy consumption and economic growth by Granger test (Narayan et al., 2010; Yemane, 2014; Śmiech and Monika, 2014; Appiah, 2018; Mutascu, 2016; Turgut and Resatoglu, 2016; Masako and Zijian, 2016; Muhammad et al., 2011; Richard and Jonathan, 2015; Muhammad and Hooi, 2012).

4. MATERIALS AND METHODS

4.1. ARDL Model

ARDL model was used for the research. Through this model, cointegration between electric energy and GDP was estimated. To be exact, research assessed the influence of total electric energy production to GDP and the impact of electric energy consumption in different fields to GDP in Azerbaijan Republic (A.Figure 1). The relations in long and short term were researched.

4.2. Unit Root Tests

It is essential to check the stationary of variables through Unit Root before the assessment of regression equations. Because, keeping stability between variables is important while assessing the dependency between two or more variables by using regression analysis. However, probability distribution for every time series in order to be stationary must be identical. Nevertheless, stationary of variables is not always desirable. For a long term or cointegration relation and assessment, the variables must be non-stationary in most methods. It is also required that the first difference should be stationary or I(1). It must be noted that if any time series variable is stationary with real values, then it can be considered I(0). If a variable is not I(0), then its first difference is calculated and its stationary is checked. In this case, if the variable is stationary, then it is considered I(1). A variable sometimes changes because of probability distribution. In that case, the variable becomes trend-stationary. One can refer to modern econometric books regarding the stationary of changes and its effect in time series analysis (Hill et al., 2001; Heij et al., 2005; Asteriou and Hall, 2007). We can analyze them by applying three different unit root tests in order to get more reliable stationary test results: Augmented Dickey Fuller, Phillips−Perron (PP) and Kwiatkowski−Phillips−Schmidt−Shin (KPSS). The evaluation of these tests is done through E-Views 9. It must be noted that "unit root problem" or "variable is non-stationary" null hypothesis in unit root tests is checked. In KPSS test, "variable is stationary" hypothesis is taken and considered as stationary null hypothesis. If the variable is non-stationary without trend, and becomes stationary if trend is included, then the checked variable is considered "trend-stationary".

4.3. Test Cointegration

Cointegration test proves long-term relations and F−statistics is indicated to express it. Menatime, cointegration was identified by ECM model. In these models, GDP is dependent variable while electric energy consumption is an independent variable.

$$\Delta lN_t = \alpha + \delta lN_{t-1} + \theta lM_{t-1} + \sum_{i=1}^{n-1} \varphi_i \Delta lN_{t-i} + \sum_{i=0}^{m-1} \rho_i \Delta lM_{t-i} + \varepsilon_i \quad (1)$$

INt − GDP
lMt − Electric energy consumption
α − Constant factor
*φ*i, *ρ*i, − Parameters
Null hypothesis: H0: $\delta_i = q_i = 0$, No cointegration.
Alternative hypothesis: H0: $\delta_i \neq qi \neq 0$, Cointegration exists.

Table 4: VAR lag order selection criteria

	Lag	LogL	LR	FPE	AIC	SC	HQ
Lgdpm	0	−18.98	NA	0.02	1.90	2.007	1.93
leci	1	38.52	99.32*	0.0002*	−2.96*	−2.65*	−2.88*
lgdpd	0	−19.53	NA	0.02	1.96	2.06	1.98
leci	1	29.13	84.05*	0.0004*	−2.10*	−1.81*	−2.03*
lepegdp	0	−31.82	NA	0.07	3.07	3.17	3.09
lepetec	1	3.97	61.83*	0.004*	0.18*	0.48*	0.25*
ligdp	0	−49.32	NA	0.36	4.67	4.77	4.69
lecii	1	−6.49	73.99*	0.01*	1.13*	1.43*	1.22*
lmigdp	0	−28.63	NA	0.06	2.77	2.88	2.81
lecmii	1	12.61	71.23*	0.002*	−0.60*	−0.31*	−0.53*
lcgdp	0	−53.06	NA	0.5	5.01	5.11	5.03
liecc	1	−6.957	79.65*	0.01*	1.18*	1.47*	1.25*
lahfgdp	0	−31.80	NA	0.07	3.07	3.17	3.09
lecahfi	1	34.76	114.96*	0.0002*	−2.61*	−2.32*	−2.55*
ltwtgdp	0	−13.16	NA	0.01	1.38	1.48	1.40
lectwti	1	30.63	75.62*	0.0003*	−2.23*	−1.94*	−2.16*
lcpsgdp	0	−43.31	NA	0.22	4.11	4.22	4.10
leccpsi	1	4.43	82.467*	0.003*	0.15*	0.44*	0.21*
lpi	0	−32.67	NA	0.08	3.15	3.25	3.18
lecpi	1	41.22	127.62*	0.0001*	−3.20*	−2.90*	−3.13*

*Indicates lag order selected by the criterion. LR: Sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-quinn information criterion

Table 5: Results from bound tests

Dependant variable	AIC lags	F–statistic	Decision	Significance								
				I (0) Bound				I (1) Bound				
				10%	5%	2.5%	1%	10%	5%	2.5%	1%	
lgdpm		5.30	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
lgdpd		9.65	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
lepegdp		29.39	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
ligdp		3.02	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	No cointegration
lmigdp		1.37	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	No cointegration
lcgdp		8.37	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
lahfgdp		6.15	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
ltwtgdp		1.57	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	No cointegration
lcpsgdp		37.17	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration
lpi		7.77	1	4.04	4.94	5.77	6.84	4.78	5.73	6.68	7.84	Cointegration

F−statistics Narayan (2005) is compared with proposed limited indicators. If $F_{statistic} > F_{critical}$, then null hypothesis is rejected. It means cointegration exists.

The Long Run Model

$$lN_t = \alpha + \sum_{i=1}^{n-1}\varphi_i \Delta lN_{t-i} + \sum_{i=0}^{m-1}\rho_i \Delta lM_{t-i} + \mu_i \qquad (2)$$

Error Correction (short run) Model

$$\Delta lN_t = \alpha + \sum_{i=1}^{n-1}\varphi_i \Delta lN_{t-i} + \sum_{i=0}^{m-1}\rho_i \Delta lM_{t-i} + \sigma ECT_{t-1} + \omega_i \qquad (3)$$

Table 6: Long run coefficients

	Variable	Coefficient	Std. error	t–statistic	Prob.
lgdpm	*leci*	11.88*	3.54	3.36	0.0202
	c	−107.09*	34.85	−3.07	0.0277
lgdpd	*leci*	11.92**	2.45	4.88	0.0018
	c	−105.89**	23.86	−4.43	0.0030
lepegdp	*lepeitec*	4.47**	0.57	7.77	0.0045
	c	−29.77**	4.39	−6.77	0.0065
lecigdp	*lecii*	−5.29	20.89	−0.25	0.8123
	c	50.18	158.97	0.31	0.7680
lmigdp	*lecmii*	11.57	18.38	0.63	0.5565
	c	−40.32	80.57	−0.51	0.6383
lcgdp	*liecc*	1.31***	0.08	16.81	0.0005
	c	0.85	0.45	1.85	0.1604
lahfgdp	*lecahfi*	82.92	1147.92	0.071	0.9444
	c	−586.69	8233.25	−0.07	0.9452
ltwtgdp	*lectwti*	−28.63	36.11	−0.77	0.4638
	c	190.89	231.71	0.82	0.4475
lcpsgdp	*leccpsi*	9.45	6.41	1.47	0.2364
	c	−84.12	64.53	−1.31	0.2834
lpi	*lecpi*	−20.50	13.47	−1.52	0.2027
	c	195.45	121.45	1.61	0.1828

4.4. Diagnostic Test

This article will use *Breusch Godfrey LM test* (null hypothesis: "no serial correlation") in order to check subsequent correlation problem and use both *Breusch−Pagan−Godfrey* (null hypothesis: *"no heteroskedasticity problem*") and *Autoregressive Conditional Hederoscedasticity test* (ARCH) for obtaining more reliable outcomes for heteroskedasticity problem. During ARCH test, null hypothesis "no heteroskedasticity problem" theory is checked. Nonetheless, *Ramsey RESET* Test and *Normality Test (Jarque–Bera)* JB was checked. Null hypothesis rejection is acceptable for every five cases.

Statistical data encompasses 1995-2017. Data have been taken from Statistics Committee of the Republic of Azerbaijan.

5. RESULTS AND DISCUSSIONS

5.1. Unit Root Test

Let's have a look at stationary of variables before identifying methods for evaluation. All stationary test results of variables for evaluation of both problems were given in the table. Each variable has been checked through three different unit root tests. The table shows that the majority of variables are I(1).

Thus, according to ADF test, in *With Intercept only* case, ECI, ECMII, ECAHFI are stationary. (I(0)). Out of the variables GDPD and PI are stationary (I(2). The rest of the variables are stationary I(1). In *With Intercept & Trend* case ECI and ECII I(0) GDPM, GDPD, EPEGDP and PI I(2) are stationary. The rest of the variables are stationary I(1). In *No Intercept & No Trend case,* PI I(2) is stationary again. The rest of the variables are stationary I(1) (A.Table 1).

In PP Unit Root Test, in *With Intercept only case,* ECII, ECAHF I(0) GDPD and PI I(2) are stationary. The rest of the variables are stationary I(1). In *With Intercept & Trend* case, ECMII and IECC I(0) GDPM, GDPD, ECCPSI and PI I(2) are stationary.

Table 7: Error correction (short run) model coefficients

	Coefficient					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	*Δlgdpm*	*Δlgdpd*	*Δlepetecgdp*	*Δlecigdp*	*Δlecmigdp*	*Δleccgdp*
$\Delta lgdpm_{(t-1)}$	0.39					
$\Delta leci_{(t-1)}$	0.25					
$ect_{(t-1)}$	−0.04					
$\Delta lgdpd_{(t-1)}$		0.59**				
$\Delta leci_{(t-1)}$		0.29				
$ect_{(t-1)}$		−0.06				
$\Delta lepegdp_{(t-1)}$			0.44*			
$\Delta lepeitec_{(t-1)}$			0.06			
$ect_{(t-1)}$			−0.03			
$\Delta ligdp_{(t-1)}$				0.33		
$\Delta lecii_{(t-1)}$				0.005		
$ect_{(t-1)}$				−0.03		
$\Delta lmigdp_{(t-1)}$					0.23	
$\Delta lecmii_{(t-1)}$					0.005	
$ect_{(t-1)}$					−0.08	
$\Delta lcgdp_{(t-1)}$						0.23
$\Delta liecc_{(t-1)}$						0.23
$ect_{(t-1)}$						−0.16
Constant	0.09	0.05	0.08	0.12	0.17	0.12*

Table 7a: Error correction (short run) model coefficients

Variable	Coefficient			
	Model 7	Model 8	Model 9	Model 10
	$\Delta lecahfgdp_{(t-1)}$	$\Delta lectwtgdp_{(t-1)}$	$\Delta leccpsgdp_{(t-1)}$	$\Delta logpi_{(t-1)}$
$\Delta lahfgdp_{(t-1)}$	0.003			
$\Delta lecahfi_{(t-1)}$	0.15			
$ect_{(t-1)}$	−0.03			
$\Delta ltwtgdp_{(t-1)}$		0.1		
$\Delta lectwti_{(t-1)}$		−0.18		
$ect_{(t-1)}$		−0.01		
$\Delta lcpsgdp_{(t-1)}$			0.22	
$\Delta leccpsi_{(t-1)}$			0.09	
$ect_{(t-1)}$			−0.04	
$\Delta lpi_{(t-1)}$				0.45
$\Delta lecpi_{(t-1)}$				−0.15
$ect_{(t-1)}$				−0.06
Constant	0.09*	0.13	0.12*	0.08*

The rest of the variables are stationary I(1). In *No Intercept & No Trend* case only PI I(2) is stationary. The rest of the variables are stationary I(I) (A.Table 2).

According to Kwiatkowski−Phillips−Schmidt−Shin test statistics most of the variables are I(0).

All these results are available for next assessment and methods. Reliant on the enumerated test results, variable are accepted as I(1) (A.Table 3). It means that all above-mentioned methods are applicable. As mentioned above, during application process of ARDL cointegration method, one of the important issues while establishing a model is to identify optimum lag length. At this time, the most important factor is to eliminate the subsequent correlation problem in selected optimum model and keep the minimum of SBC information criteria value.

5.2. VAR Lag Order Selection Criteria

In order to determine optimal lag for ARDL model, VAR Lag Order Selection Criteria was employed and we got the below-mentioned results (Table 4).

Table 5 illustrates whether cointegration relations between variables exist or not. Thus, there are cointegration relations among electric energy consumption per year (ECI) and GDP in manat (GDPM) and in dollar (GDPD), electric energy consumption of electric energy production entities (EPEITEC) and their GDP (EPEGDP), electric energy consumption in construction (IECC) and its GDP (CGDP), electric energy consumption in agriculture, hunting and forestry (ECAHFI) and their GDP (AHFGDP), electric energy consumption in other, commercial and public service entities (ECCPSI) and their GDP (CPSGDP) and electric energy consumption of people (ECPI) and People's income (PI). In other words, there are long-term relations. F–statistics factors are above the minimum indicators of 5% according to Narayan (2005) table. However, there are no cointegration relations among electric energy consumption in industry (ECII) and its GDP (IGDP), electric energy consumption in mining (ECMII) and its GDP (MIGDP) and electric energy consumption in telecommunication, transport and warehouse (ECTWTI) and their GDP (TWTGDP).

$$Cointeq = lN - a \times lM + c$$

According to the table, electric energy consumption causes the increase of GDP (Table 6). Having a closer look at the table:

Energy consumption	GDP
Energy consumption increases (ECI) 1% per year	GDP in manat increases 11.88%
Energy consumption increases (ECI) 1% per year	GDP in dollar increases 11.91%
Energy producing entities increases their energy consumption 1%. (EPEITEC)	GDP increases 4.47% in electric energy production
Energy consumption in mining industry increases 1% (ECMII)	GDP increases 11.57% in mining industry
Increase of energy consumption in construction (IECC)	GDP increases 1.31% in construction
Energy consumption in agriculture, hunting and forestry increases 1% (ECAHFI)	GDP increases 82.90% in agriculture, hunting and forestry
Energy consumption in other, commercial and public service increases 1% (ECCPSI)	GDP increases 9.45% in commercial and public service
Energy consumption in industry increases 1% (ECII)	GDP decreases 5.3% in industry
Energy consumption in transport, warehouse and telecommunication increases 1% (ECTWTI)	GDP decreases 28.63% in transport, warehouse and telecommunication
Energy consumption of people increases 1% (ECPI)	People's income decreases 20.50%

In general, there are valuable from economic standpoint. Except the equations refer to relations among the energy consumption in industry (ECII) and GDP and the energy consumption in transport, warehouse and telecommunication (ECTWTI) and their GDP. The main reason for this is other factors that play key roles in the augmentation of GDP.

Referring to A.Tables 4 and 5, we can mention that coefficients are 5% 1% and 0.1% significant.

5.3. Error Correction (Short Run) Model

This table reveals the results of short-term and ECM model. The results are in the following: There is a positive relation between GDP and electric energy consumption in all models. GDPD coefficient is significant at the level of 1% in correlation model between GDPD and total electric energy consumption (ECI). (model 1). Besides,

Table 8: Diagnostic test results (LM version)

	Ramsey RESET Test (t–statistic)	Normality Test (Jarque–Bera) JB	Heteroskedasticity Test: ARCH χ^2	Heteroskedasticity Test: Breusch−Pagan−Godfrey	Breusch–Godfrey Serial Correlation LM Test: χ^2	R^2	D_W
lgdpm	0.31	0.53	0.007	10.95	7.71	0.99	2.65
	0.61	0.77	0.93	0.45	0.02		
lgdpd	1.33	0.51	0.81	15.77	12.88	0.99	2.29
	0.29	0.77	0.37	0.11	0.002		
lepegdp	0.52	0.63	0.001	14.06	11.97	0.99	3.01
	0.55	0.72	0.97	0.37	0.003		
ligdp	7.60	14.13	0.32	5.23	6.83	0.98	2.05
	0.07	0.0008	0.57	0.95	0.03		
lmigdp	1.77	0.61	0.29	10.47	11.10	0.97	2.97
	0.25	0.77	0.59	0.49	0.003		
lcgdp	0.18	0.12	2.49	14.35	16.09	0.99	3.15
	0.71	0.95	0.11	0.35	0.0003		
lahfgdp	0.03	0.12	2.61	13.70	5.51	0.99	2.63
	0.85	0.95	0.11	0.13	0.06		
ltwtgdp	2.95	0.53	0.0008	6.89	9.29	0.99	2.17
	0.16	0.77	0.97	0.81	0.01		
lcpsgdp	8.31	3.59	0.44	8.69	7.81	0.99	1.27
	0.10	0.17	0.51	0.80	0.02		
lpi	1.33	0.77	1.45	11.99	2.71	0.99	1.88
	0.20	0.69	0.23	0.45	0.25		

Table 8a: Diagnostic test results (F version)

	Ramsey RESET Test (F–Statistic)	Normality Test (Jarque–Bera) JB	Heteroskedasticity Test: ARCH	Heteroskedasticity Test: Breusch−Pagan−Godfrey	Breusch–Godfrey Serial Correlation LM Test
lgdpm	F (1,4) 0.31	N/A	F (1,14) 0.006	F (11,5) 0.82	F (2,3) 1.25
	0.61	N/A	0.95	0.63	0.40
lgdpd	F (1, 6) 1.33	N/A	F (1,15) 0.77	F (10,7) 4.87	F (2,5) 6.29
	0.29	N/A	0.40	0.02	0.04
lepegdp	F (1, 2) 0.52	N/A	F (1,14) 0.001	F (13,3) 1.10	F (2,1) 1.18
	0.55	N/A	0.97	0.53	0.55
ligdp	F (1, 3) 7.60	N/A	F (1,14) 0.29	F (12,4) 0.14	F (2,2) 0.67
	0.07	N/A	0.60	0.99	0.59
lmigdp	F (1, 4) 1.77	N/A	F (1,14) 0.26	F (11,5) 0.71	F (2,3) 2.82
	0.25	N/A	0.61	0.69	0.20
lcgdp	F (1, 2) 0.18	N/A	F (1,14) 2.57	F (13,3) 1.25	F (2,1) 8.92
	0.71	N/A	0.13	0.48	0.2303
lahfgdp	F (1, 6) 0.03	N/A	F (1,14) 2.71	F (9,7) 3.23	F (2,5) 1.18
	0.85	N/A	0.12	0.06	0.38
ltwtgdp	F (1, 4) 2.97	N/A	F (1,14) 0.0006	F (11,5) 0.31	F (2,3) 1.81
	0.16	N/A	0.9770	0.95	0.31
lcpsgdp	F (1, 2) 8.31	N/A	F (1,14) 0.40	F (13,3) 0.24	F (2,1) 0.42
	0.10	N/A	0.53	0.97	0.71
lpi	F (1, 15) 1.77	N/A	F (1,18) 1.41	F (12,4) 0.77	F (2,14) 1.05
	0.20	N/A	0.25	0.69	0.38

Legend: N/A–Not Applicable

(EPEGDP) coefficient is significant at the level of 5% in the model between energy consumption in electric energy producing entities (EPEITEC) and their GDP (model 3). On the other hand, *ect* coefficient is negative (−) for all. According to the models, velocity to balance in a long term is 4% (model 1), 6% (model 2), 3% (model 3), 3% (model4), 8% (model 5), 16% (model 6), 3% (model 7), 2% (model 8), 4% (model 9), 9% (model 10) (Tables 7 and 7a). Although *ect* coefficients are insignificance in these models, their negativity substantiates the existence of cointegration relations proposed by Paseran and others (2001). Having positive relation in these models shows the role of electric energy and its consumption in the increase of GDP for new economic growth.

Some models for ARDL models (model 1-3 and 6) are 5% 1% and 0.1% significant. Regression equations are adequate. It also passes all the diagnostic tests against serial correlation (Durbin Watson test and Breusch-Godfrey test), heteroscedasticity (White Heteroskedasticity Test), and normality of errors (Jarque-Bera test). The Ramsey RESET test also suggests that the model is well specified. All the results of these tests are shown in Table 8 and 8a. The stability of the long-run coefficient is tested by the short-run dynamics. Once the ECM model given by equations (Table 7 and 7a) has been estimated, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are applied to assess the parameter stability (Pesaran and Pesaran (1997). A.Figure 2 plot the results for CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability However, non-stability in model 2 and model 3 was observed (A.Figure 2).

6. CONCLUSION

Energy and especially electricity is one of the main factors of the development of society. From this perspective, energy and electricity consumption is essential in Azerbaijan too. We have achieved some results from the research that electricity consumption plays an important role in economic growth. Electricity is also important as an economic resource. Although the relationship between electricity consumption and GDP growth is not strong, we can mention the followings: there is a positive dependency between total electricity consumption and GDP in manat and dollar, as well as electricity consumption in electricity producing entities such as mining, construction, agriculture, hunting and forestry, commercial and public service and others and GDP in those sectors. Conversely, there is a negative dependency between electricity consumption in industry, transportation, warehouse and telecommunication and GDP. On the contrary, the opposite dependency was observed between electricity consumption of population and people's income. The positive income was also observed between electricity consumption and GDP according to ECM model results in a short term. Having a positive relationship in models shows that electricity consumption plays an important role in GDP growth.

So, the analysis has revealed that there is a weak relationships betwen either the electricity consumption and GDP in the Republic or in different sectors of economy. From this perspective, we recommend not to waste electricity consumption.

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APPENDIX

A.Table 1: ADF unit root test

Model	Variable	ADF−Stat	Levels of critical values			Lag	P-value	Stationarity	İntegrir I (0,1,2)
			1%	5%	10%				
With intercept only			**At level form**						
	leci	−3.01*	−3.80	−3.02	−2.65	2	0.0507	S	I (0)
	lepeitec	−1.35	−3.77	−3.00	−2.64	0	0.5881	N/S	I (1)
	lecii	−2.83*	−3.77	−3.00	−2.64	0	0.0694	S	I (0)
	lecmii	−1.71	−3.77	−3.00	−2.64	0	0.4112	N/S	I (1)
	liecc	−0.92	−3.77	−3.00	−2.64	0	0.7596	N/S	I (1)
	lecahfi	−2.76*	−3.77	−3.00	−2.64	0	0.0797	S	I (0)
	lectwti	−1.12	−3.77	−3.00	−2.64	0	0.6849	N/S	I (1)
	leccpsi	−2.30	−3.77	−3.00	−2.64	0	0.1798	N/S	I (1)
	lecpi								
	lgdpm	−0.88	−3.77	−3.01	−2.65	1	0.7739	N/S	I (1)
	lgdpd	−1.26	−3.77	−3.01	−2.65	1	0.6243	N/S	I (2)
	lepegdp	−0.37	−3.77	−3.00	−2.64	0	0.8983	N/S	I (1)
	ligdp	−1.62	−3.77	−3.00	−2.64	0	0.4557	N/S	I (1)
	lmigdp	−1.99	−3.77	−3.00	−2.64	0	0.2876	N/S	I (1)
	lcgdp	−2.39	−3.77	−3.00	−2.64	0	0.1547	N/S	I (1)
	lahfgdp	−0.13	−3.77	−3.00	−2.64	0	0.9334	N/S	I (1)
	ltwtgdp	−0.01	−3.77	−3.00	−2.64	0	0.9502	N/S	I (1)
	lcpsgdp	−0.81	−3.77	−3.00	−2.64	0	0.7961	N/S	I (1)
	lpi	−0.83	−3.77	−3.01	−2.65	1	0.7874	N/S	I (1)
With intercept only			**At first differencing**						
	dleci	−3.88***	−3.77	−3.01	−2.65	0	0.0081	S	I (0)
	dlepeitec	−4.12***	−3.77	−3.01	−2.65	0	0.0048	S	I (0)
	dlecii	−3.83**	−3.85	−3.04	−2.66	3	0.0105	S	I (0)
	dlecmii	−4.85***	−3.77	−3.01	−2.65	0	0.0010	S	I (0)
	dliecc	−5.06***	−3.77	−3.01	−2.65	0	0.0006	S	I (0)
	dlecahfi	−3.65**	−3.77	−3.01	−2.65	0	0.0135	S	I (0)
	dlectwti	−6.60***	−3.77	−3.01	−2.65	0	0.0000	S	I (0)
	dleccpsi	−5.03***	−3.77	−3.01	−2.65	0	0.0007	S	I (0)
	dlpi	−3.29***	−3.77	−3.01	−2.65	0	0.0291	S	I (0)
	dlgdpm	−2.77*	−3.77	−3.01	−2.65	0	0.0771	S	I (0)
	dlgdpd	−2.25	−3.77	−3.01	−2.65	0	0.1974	N/S	I (1)
	ddlgdpd	−4.17***	−3.80	−3.02	−2.65	0	0.0046	S	I (0)
	dlepegdp	−3.25**	−3.77	−3.01	−2.65	0	0.0312	S	I (0)
	dligdp	−3.06**	−3.77	−3.01	−2.65	0	0.0451	S	I (0)
	dlmigdp	−3.39**	−3.77	−3.01	−2.65	0	0.0231	S	I (0)
	dlcgdp	−5.02***	−3.77	−3.01	−2.65	0	0.0007	S	I (0)
	dlahfgdp	−4.02***	−3.77	−3.01	−2.65	0	0.0059	S	I (0)
	dltwtgdp	−4.82***	−3.77	−3.01	−2.65	0	0.0010	S	I (0)
	dlcpsgdp	−3.38**	−3.77	−3.01	−2.65	0	0.0236	S	I (0)
	dlpi	−2.36	−3.77	−3.01	−2.65	0	0.1642	N/S	I (1)
	ddlpi	−4.17***	−3.80	−3.02	−2.65	0	0.0021	S	I (0)
With intercept and trend			**At level form**						
	leci	−3.69*	−4.44	−3.63	−3.25	2	0.0466	S	I (0)
	lepeitec	−2.29	−4.44	−3.63	−3.25	0	0.4217	N/S	I (1)
	lecii	−5.26***	−4.44	−3.63	−3.25	3	0.0024	S	I (0)
	lecmii	−2.63	−4.44	−3.63	−3.25	0	0.2695	N/S	I (1)
	liecc	−2.10	−4.44	−3.63	−3.25	0	0.5152	N/S	I (1)
	lecahfi	−1.67	−4.44	−3.63	−3.25	0	0.7299	N/S	I (1)
	lectwti	−2.86	−4.44	−3.63	−3.25	0	0.1920	N/S	I (1)
	leccpsi	−2.81	−4.44	−3.63	−3.25	0	0.2063	N/S	I (1)
	lecpi	−2.45	−4.44	−3.63	−3.25	0	0.3424	N/S	I (1)
	lgdpm	−1.55	−4.47	−3.65	−3.26	1	0.7782	N/S	I (2)
	lgdpd	−1.81	−4.47	−3.65	−3.26	1	0.6591	N/S	I (2)
	lepegdp	−2.12	−4.47	−3.65	−3.26	1	0.5029	N/S	I (2)
	ligdp	−0.60	−4.44	−3.63	−3.25	0	0.9685	N/S	I (2)
	lmigdp	−0.80	−4.44	−3.63	−3.25	0	0.9501	N/S	I (1)
	lcgdp	−2.71	−4.47	−3.65	−3.26	1	0.2349	N/S	I (1)
	lahfgdp	−3.00	−4.47	−3.65	−3.26	1	0.1545	N/S	I (1)
	ltwtgdp	−2.17	−4.44	−3.63	−3.25	0	0.4776	N/S	I (1)
	lcpsgdp	−2.32	−4.47	−3.65	−3.26	1	0.4044	N/S	I (1)
	lpi	−1.92	−4.47	−3.65	−3.26	1	0.6094	N/S	I (2)

(*Contd...*)

A.Table 1: (*Continued*)

Model	Variable	ADF−Stat	Levels of critical values			Lag	p-value	Stationarity	İntegrir I (0,1,2)
			1%	5%	10%				
With intercept and trend			At first differencing						
	dleci	−3.76**	−4.47	−3.65	−3.26	0	0.0397	S	I (0)
	dlepeitec	−4.01**	−4.47	−3.65	−3.26	0	0.0251	S	I (0)
	dlecii	−3.71**	−4.57	−3.69	−3.29	3	0.0477	S	I (0)
	dlecmii	−4.77***	−4.47	−3.65	−3.26	0	0.0054	S	I (0)
	dliecc	−5.35***	−4.47	−3.65	−3.26	0	0.0017	S	I (0)
	dlecahfi	−4.72***	−4.47	−3.65	−3.26	0	0.0060	S	I (0)
	dlectwti	−6.45***	−4.47	−3.65	−3.26	0	0.0002	S	I (0)
	dleccpsi	−4.87***	−4.47	−3.65	−3.26	0	0.0044	S	I (0)
	dlpi	−3.42*	−4.47	−3.65	−3.26	0	0.0753	S	I (0)
	dlgdpm	−2.77	−4.47	−3.65	−3.26	0	0.2166	N/S	I (1)
	dlgdpmd	−5.30***	−4.49	−3.65	−3.26	0	0.0020	S	I (0)
	dlgdpd	−2.36	−4.47	−3.65	−3.26	2	0.3853	N/S	I (1)
	ddlgdpd	−3.85**	−4.53	−3.67	−3.29	1	0.0359	S	I (0)
	dlepegdp	−3.09	−4.47	−3.65	−3.26	0	0.1331	N/S	I (1)
	ddlepegdp	−5.48***	−4.53	−3.67	−3.29	1	0.0016	S	I (0)
	dlecigdp	−3.16	−4.47	−3.65	−3.26	0	0.1185	N/S	I (1)
	ddligdp	−5.22***	−4.49	−3.65	−3.26	0	0.0024	S	I (0)
	dlmigdp	−3.60**	−4.47	−3.65	−3.26	0	0.0543	S	I (0)
	dlcgdp	−4.61***	−4.47	−3.65	−3.26	0	0.0075	S	I (0)
	dlahfgdp	−3.99**	−4.47	−3.65	−3.26	0	0.0258	S	I (0)
	dltwtgdp	−4.65***	−4.47	−3.65	−3.26	0	0.0068	S	I (0)
	dlcpsgdp	−3.32*	−4.47	−3.65	−3.26	0	0.0905	S	I (0)
	dlpi	−2.23	−4.47	−3.65	−3.26	0	0.4457	N/S	I (1)
	ddlpi	−4.61***	−4.53	−3.67	−3.29	1	0.0085	S	I (0)
No Intercept & No Trend			At level form						
	leci	0.77	−2.67	−1.96	−1.61	0	0.8758	N/S	I (1)
	lepeitec	0.71	−2.67	−1.96	−1.61	0	0.8665	N/S	I (1)
	lecii	−0.06	−2.67	−1.96	−1.61	0	0.6517	N/S	I (1)
	lecmii	0.77	−2.67	−1.96	−1.61	0	0.8697	N/S	I (1)
	liecc	0.36	−2.67	−1.96	−1.61	0	0.7814	N/S	I (1)
	lecahfi	−1.22	−2.67	−1.96	−1.61	0	0.1954	N/S	I (1)
	lectwti	−1.61	−2.67	−1.96	−1.61	1	0.1004	N/S	I (1)
	leccpsi	0.12	−2.67	−1.96	−1.61	0	0.7115	N/S	I (1)
	lecpi	0.65	−2.67	−1.96	−1.61	0	0.8499	N/S	I (1)
	lgdpm	1.77	−2.67	−1.96	−1.61	1	0.9775	N/S	I (1)
	lgdpd	0.77	−2.67	−1.96	−1.61	1	0.8765	N/S	I (1)
	lepegdp	1.19	−2.67	−1.96	−1.61	0	0.9350	N/S	I (1)
	ligdp	1.47	−2.67	−1.96	−1.61	1	0.9597	N/S	I (1)
	lmigdp	1.45	−2.67	−1.96	−1.61	1	0.9578	N/S	I (1)
	lcgdp	2.62	−2.67	−1.96	−1.61	0	0.9965	N/S	I (1)
	lahfgdp	4.41	−2.67	−1.96	−1.61	0	1.0000	N/S	I (1)
	ltwtgdp	3.69	−2.67	−1.96	−1.61	0	0.9997	N/S	I (1)
	lcpsgdp	4.69	−2.67	−1.96	−1.61	0	1.0000	N/S	I (1)
	lpi	1.80	−2.67	−1.96	−1.61	1	0.9789	N/S	I (2)
No Intercept & No Trend			At First differencing						
	dleci	−3.85***	−2.67	−1.96	−1.61	0	0.0006	S	I (0)
	dlepeitec	−4.11***	−2.67	−1.96	−1.61	0	0.0003	S	I (0)
	dlecii	−3.85***	−2.69	−1.96	−1.61	3	0.0006	S	I (0)
	dlecmii	−4.85***	−2.67	−1.96	−1.61	0	0.0000	S	I (0)
	dliecc	−5.21***	−2.67	−1.96	−1.61	0	0.0000	S	I (0)
	dlecahfi	−3.69***	−2.67	−1.96	−1.61	0	0.0008	S	I (0)
	dlectwti	−6.19***	−2.67	−1.96	−1.61	0	0.0000	S	I (0)
	dleccpsi	−5.09***	−2.67	−1.96	−1.61	0	0.0000	S	I (0)
	dlecpi	−3.41***	−2.67	−1.96	−1.61	0	0.0017	S	I (0)
	dlgdpm	−1.83*	−2.67	−1.96	−1.61	0	0.0640	S	I (0)
	dlgdpd	−2.05**	−2.67	−1.96	−1.61	0	0.0419	S	I (0)
	dlepegdp	−3.02***	−2.67	−1.96	−1.61	0	0.0044	S	I (0)
	dligdp	−2.39***	−2.67	−1.96	−1.61	0	0.0197	S	I (0)
	dlmigdp	−2.71***	−2.67	−1.96	−1.61	0	0.0090	S	I (0)
	dlcgdp	−4.52***	−2.67	−1.96	−1.61	0	0.0001	S	I (0)
	dlahfgdp	−2.71***	−2.67	−1.96	−1.61	0	0.0093	S	I (0)

(*Contd...*)

A.Table 1: (*Continued*)

Model	Variable	ADF−Stat	Levels of critical values			Lag	p-value	Stationarity	İntegrir I (0,1,2)
			1%	5%	10%				
No Intercept & No Trend			At First differencing						
	dltwtgdp	−2.69***	−2.67	−1.96	−1.61	0	0.0099	S	I (0)
	dlcpsgdp	−2.15**	−2.67	−1.96	−1.61	0	0.0330	S	I (0)
	dlpi	−1.15	−2.67	−1.96	−1.61	0	0.2192	N/S	I (1)
	ddlpi	−4.67***	−2.69	−1.95	−1.60	0	0.0001	S	I (0)

ADF denotes the Augmented Dickey–Fuller single root system respectively. The maximum lag order is 3. The optimum lag order is selected based on the Shwarz criterion automatically; ***, ** and *indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (Mackinnon, 1996). Assessment period: 1995-2017. S: Stationarity; N/S: No stationarity

A.Table 2: PP unit root test

Model	Variable	PP−test statistic	Levels of critical values			Bandwidth	P-value	Stationarity	Integrir I (0,1,2)
			1%	5%	10%				
With Intercept only			At level form						
	leci	−1.60	−3.77	−3.01	−2.64	2	0.4646	N/S	I (1)
	lepeitec	−1.31	−3.77	−3.01	−2.64	0	0.5881	N/S	I (1)
	lecii	−2.84*	−3.77	−3.01	−2.64	1	0.0689	S	I (0)
	lecmii	−1.71	−3.77	−3.01	−2.64	0	0.4112	N/S	I (1)
	liecc	−0.92	−3.77	−3.01	−2.64	1	0.7622	N/S	I (1)
	lecahfi	−2.69*	−3.77	−3.01	−2.64	1	0.0900	S	I (0)
	lectwti	−0.83	−3.77	−3.01	−2.64	1	0.7896	N/S	I (1)
	leccpsi	−1.41	−3.77	−3.01	−2.64	2	0.5596	N/S	I (1)
	lecpi	−2.33	−3.77	−3.01	−2.64	2	0.1705	N/S	I (1)
	lgdpm	−1.18	−3.77	−3.01	−2.64	2	0.6598	N/S	I (1)
	lgdpd	−1.56	−3.77	−3.01	−2.64	2	0.4836	N/S	I (1)
	lepegdp	−0.37	−3.77	−3.01	−2.64	0	0.8983	N/S	I (1)
	ligdp	−1.62	−3.77	−3.01	−2.64	0	0.4557	N/S	I (1)
	lmigdp	−1.89	−3.77	−3.01	−2.64	1	0.3265	N/S	I (1)
	lcgdp	−2.21	−3.77	−3.01	−2.64	1	0.2095	N/S	I (1)
	lahfgdp	−0.17	−3.77	−3.01	−2.64	1	0.9290	N/S	I (1)
	ltwtgdp	−0.02	−3.77	−3.01	−2.64	1	0.9465	N/S	I (1)
	lcpsgdp	−0.81	−3.77	−3.01	−2.64	0	0.7961	N/S	I (1)
	lpi	−0.11	−3.77	−3.01	−2.64	2	0.9356	N/S	I (2)
With Intercept only			At First differencing						
	dleci	−3.92***	−3.78	−3.01	−2.65	2	0.0073	S	I (0)
	dlepeitec	−4.12***	−3.78	−3.01	−2.65	1	0.0048	S	I (0)
	dlecii	−6.71***	−3.78	−3.01	−2.65	1	0.0000	S	I (0)
	dlecmii	−4.99***	−3.78	−3.01	−2.65	3	0.0007	S	I (0)
	dliecc	−5.01***	−3.78	−3.01	−2.65	2	0.0007	S	I (0)
	dlecahfi	−3.65**	−3.78	−3.01	−2.65	1	0.0136	S	I (0)
	dlectwti	−6.61***	−3.78	−3.01	−2.65	0	0.0000	S	I (0)
	dleccpsi	−5.78***	−3.78	−3.01	−2.65	7	0.0001	S	I (0)
	dlecpi	−3.29***	−3.78	−3.01	−2.65	2	0.0293	S	I (0)
	dlgdpm	−2.78*	−3.78	−3.01	−2.65	2	0.0771	S	I (0)
	dlgdpd	−2.30	−3.78	−3.01	−2.65	1	0.1798	N/S	I (1)
	ddlgdpd	−4.17***	−3.80	−3.02	−2.65	8	0.0047	S	I (0)
	dlepegdp	−3.18**	−3.78	−3.01	−2.65	2	0.0358	S	I (0)
	dligdp	−3.09**	−3.78	−3.01	−2.65	1	0.0422	S	I (0)
	dlmigdp	−3.41**	−3.78	−3.01	−2.65	1	0.0223	S	I (0)
	dlcgdp	−5.02***	−3.78	−3.01	−2.65	0	0.0007	S	I (0)
	dlahfgdp	−4.02***	−3.78	−3.01	−2.65	0	0.0059	S	I (0)
	dltwtgdp	−4.77***	−3.78	−3.01	−2.65	1	0.0011	S	I (0)
	dlcpsgdp	−3.31**	−3.78	−3.01	−2.65	3	0.0273	S	I (0)
	dlpi	−2.36	−3.78	−3.01	−2.65	2	0.1623	N/S	I (1)
	ddlpi	−5.42***	−3.80	−3.02	−2.65	11	0.0003	S	I (0)
With Intercept & Trend			At Level Form						
	leci	−2.15	−4.44	−3.63	−3.25	2	0.4927	N/S	I (1)
	lepeitec	−2.29	−4.44	−3.63	−3.25	0	0.4217	N/S	I (1)

(*Contd...*)

A.Table 2: (*Continued*)

Model	Variable	PP−test statistic	Levels of critical values			Bandwidth	p-value	Stationarity	Integrir I (0,1,2)
			1%	5%	10%				
With Intercept & Trend			**At level form**						
	lecii	−3.57*	−4.44	−3.63	−3.25	6	0.0565	S	I (0)
	lecmii	−2.63	−4.44	−3.63	−3.25	0	0.2695	N/S	I (1)
	liecc	−2.06	−4.44	−3.63	−3.25	1	0.5402	N/S	I (1)
	lecahfi	−1.77	−4.44	−3.63	−3.25	6	0.6807	N/S	I (1)
	lectwti	−2.99	−4.44	−3.63	−3.25	2	0.1579	N/S	I (1)
	leccpsi	−2.81	−4.44	−3.63	−3.25	2	0.2077	N/S	I (1)
	lecpi	−2.40	−4.44	−3.63	−3.25	2	0.3680	N/S	I (1)
	lgdpm	−0.99	−4.44	−3.63	−3.25	2	0.9253	N/S	I (1)
	lgdpd	−0.41	−4.44	−3.63	−3.25	2	0.9803	N/S	I (1)
	lepegdp	−2.12	−4.44	−3.63	−3.25	1	0.5081	N/S	I (1)
	ligdp	−0.83	−4.44	−3.63	−3.25	1	0.9458	N/S	I (1)
	lmigdp	−0.95	−4.44	−3.63	−3.25	1	0.9309	N/S	I (1)
	lcgdp	−3.31*	−4.44	−3.63	−3.25	2	0.0913	S	I (0)
	lahfgdp	−1.71	−4.44	−3.63	−3.25	0	0.7014	N/S	I (1)
	ltwtgdp	−2.40	−4.44	−3.63	−3.25	2	0.3680	N/S	I (1)
	lcpsgdp	−1.77	−4.44	−3.63	−3.25	1	0.6712	N/S	I (1)
	lpi	−1.75	−4.44	−3.63	−3.25	2	0.6914	N/S	I (2)
With Intercept & Trend			**At First differencing**						
	dleci	−3.82**	−4.47	−3.65	−3.26	2	0.0362	S	I (0)
	dlepeitec	−3.99**	−4.47	−3.65	−3.26	2	0.0260	S	I (0)
	dlecii	−8.77***	−4.47	−3.65	−3.26	11	0.0000	S	I (0)
	dlecmii	−4.95***	−4.47	−3.65	−3.26	3	0.0039	S	I (0)
	dliecc	−5.20***	−4.47	−3.65	−3.26	2	0.0023	S	I (0)
	dlecahfi	−4.77***	−4.47	−3.65	−3.26	3	0.0053	S	I (0)
	dlectwti	−6.45***	−4.47	−3.65	−3.26	0	0.0002	S	I (0)
	dleccpsi	−5.81***	−4.47	−3.65	−3.26	8	0.0007	S	I (0)
	dlpi	−3.45***	−4.47	−3.65	−3.26	2	0.0705	S	I (0)
	dlgdpm	−2.82	−4.47	−3.65	−3.26	1	0.2072	N/S	I (1)
	ddlgdpm	−6.29***	−4.49	−3.65	−3.26	7	0.0003	S	I (0)
	dlgdpd	−2.37	−4.47	−3.65	−3.26	2	0.3823	N/S	I (1)
	ddlgdpd	−3.84**	−4.49	−3.65	−3.26	9	0.0356	S	I (0)
	dlepegdp	−3.01	−4.47	−3.65	−3.26	2	0.1543	N/S	I (1)
	ddlepegdp	−8.98***	−4.49	−3.65	−3.26	19	0.0000	S	I (0)
	dligdp	−3.08	−4.47	−3.65	−3.26	3	0.1370	N/S	I (1)
	ddligdp	−7.92***	−4.47	−3.65	−3.26	10	0.0000	S	I (0)
	dlmigdp	−3.45*	−4.47	−3.65	−3.26	3	0.0706	S	I (0)
	dlcgdp	−4.61**	−4.47	−3.65	−3.26	0	0.0075	S	I (0)
	dlahfgdp	−3.99**	−4.47	−3.65	−3.26	0	0.0258	S	I (0)
	dltwtgdp	−4.63***	−4.47	−3.65	−3.26	1	0.0071	S	I (0)
	dlcpsgdp	−3.25	−4.47	−3.65	−3.26	2	0.1017	N/S	I (1)
	ddlcpsgdp	−4.60***	−4.49	−3.65	−3.26	17	0.0000	S	I (0)
	dlpi	−2.22	−4.47	−3.65	−3.26	2	0.4540	N/S	I (1)
	ddlpi	−7.34	−4.49	−3.65	−3.26	16	0.0000	S	I (0)
No Intercept & No Trend			**At Level Form**						
	leci	0.69	−2.67	−1.96	−1.61	2	0.8575	N/S	I (1)
	lepeitec	0.71	−2.67	−1.96	−1.61	1	0.8624	N/S	I (1)
	lecii	0.11	−2.67	−1.96	−1.61	13	0.7087	N/S	I (1)
	lecmii	1.22	−2.67	−1.96	−1.61	4	0.9381	N/S	I (1)
	liecc	0.39	−2.67	−1.96	−1.61	1	0.7903	N/S	I (1)
	lecahfi	−1.06	−2.67	−1.96	−1.61	2	0.2505	N/S	I (1)
	lectwti	−1.18	−2.67	−1.96	−1.61	1	0.2069	N/S	I (1)
	leccpsi	0.25	−2.67	−1.96	−1.61	7	0.7484	N/S	I (1)
	lecpi	0.49	−2.67	−1.96	−1.61	2	0.8138	N/S	I (1)
	lgdpm	3.63	−2.67	−1.96	−1.61	2	0.9997	N/S	I (1)
	lgdpd	1.77	−2.67	−1.96	−1.61	2	0.9774	N/S	I (1)
	lepegdp	1.18	−2.67	−1.96	−1.61	0	0.9355	N/S	I (1)
	ligdp	2.38	−2.67	−1.96	−1.61	2	0.9938	N/S	I (1)
	lmigdp	2.31	−2.67	−1.96	−1.61	1	0.9928	N/S	I (1)
	lcgdp	2.29	−2.67	−1.96	−1.61	1	0.9926	N/S	I (1)
	lahfgdp	4.17	−2.67	−1.96	−1.61	1	0.9999	N/S	I (1)

(*Contd...*)

A.Table 2: (*Continued*)

Model	Variable	PP−test statistic	Levels of critical values			Bandwidth	p-value	Stationarity	Integrir I (0,1,2)
			1%	5%	10%				
No Intercept & No Trend			At level form						
	ltwtgdp	3.48	−2.67	−1.96	−1.61	1	0.9995	N/S	I (1)
	lcpsgdp	4.66	−2.67	−1.96	−1.61	0	1.0000	N/S	I (1)
	lpi	4.55	−2.67	−1.96	−1.61	2	1.0000	N/S	I (2)
No Intercept & No Trend			At First differencing						
	dleci	−3.89***	−2.67	−1.96	−1.61	2	0.0005	S	I (0)
	dlepeitec	−4.11***	−2.67	−1.96	−1.61	1	0.0003	S	I (0)
	dlecii	−6.88***	−2.67	−1.96	−1.61	2	0.0000	S	I (0)
	dlecmii	−4.86***	−2.67	−1.96	−1.61	2	0.0000	S	I (0)
	dliecc	−5.12***	−2.67	−1.96	−1.61	2	0.0000	S	I (0)
	dlecahfi	−3.68***	−2.67	−1.96	−1.61	1	0.0008	S	I (0)
	dlectwti	−6.18***	−2.67	−1.96	−1.61	1	0.0000	S	I (0)
	dleccpsi	−5.42***	−2.67	−1.96	−1.61	6	0.0000	S	I (0)
	dlecpi	−3.40***	−2.67	−1.96	−1.61	2	0.0017	S	I (0)
	dlgdpm	−1.77*	−2.67	−1.96	−1.61	2	0.0793	S	I (0)
	dlgdpd	−2.00**	−2.67	−1.96	−1.61	2	0.0456	S	I (0)
	dlepegdp	−2.99***	−2.67	−1.96	−1.61	3	0.0048	S	I (0)
	dligdp	−2.33**	−2.67	−1.96	−1.61	2	0.0223	S	I (0)
	dlmigdp	−2.71***	−2.67	−1.96	−1.61	1	0.0093	S	I (0)
	dlcgdp	−4.38***	−2.67	−1.96	−1.61	1	0.0001	S	I (0)
	dlahfgdp	−2.71***	−2.67	−1.96	−1.61	1	0.0093	S	I (0)
	dltwtgdp	−2.77***	−2.67	−1.96	−1.61	2	0.0083	S	I (0)
	dlcpsgdp	−2.05**	−2.67	−1.96	−1.61	3	0.0408	S	I (0)
	dlpi	−1.08	−2.67	−1.96	−1.61	6	0.2451	N/S	I (1)
	ddlpi	−5.65***	−2.69	−1.96	−1.61	11	0.0000	S	I (0)

PP Phillips–Perron is single root system. The optimum lag order in PP test is selected based on the Newey–West criterion automatically; ***, ** and *indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from MacKinnon (Mackinnon, 1996). Assessment period: 1995-2017. S: Stationarity, N/S: No Stationarity

A.Table 3: KPSS unit root test

Model	Variable	Kwiatkowski−Phillips−Schmidt−Shin test statistic	Levels of Critical Values			Bandwidth	Stationarity	Integrir I (0,1,2)
			1%	5%	10%			
With Intercept only			At level form					
	leci	0.38*	0.71	0.47	0.35	3	S	I (0)
	lepeitec	0.49**	0.71	0.47	0.35	3	S	I (0)
	lecii	0.32	0.71	0.47	0.35	2	N/S	
	lecmii	0.53**	0.71	0.47	0.35	2	S	I (0)
	liecc	0.47**	0.71	0.47	0.35	3	S	I (0)
	lecahfi	0.26	0.71	0.47	0.35	3	N/S	
	lectwti	0.57**	0.71	0.47	0.35	3	S	I (0)
	leccpsi	0.45*	0.71	0.47	0.35	3	S	I (0)
	lecpi	0.12	0.71	0.47	0.35	3	N/S	
	lgdpm	0.65**	0.71	0.47	0.35	3	S	I (0)
	lgdpd	0.61**	0.71	0.47	0.35	3	S	I (0)
	lepegdp	0.57**	0.71	0.47	0.35	3	S	I (0)
	ligdp	0.63**	0.71	0.47	0.35	3	S	I (0)
	lmigdp	0.63**	0.71	0.47	0.35	3	S	I (0)
	lcgdp	0.69**	0.71	0.47	0.35	3	S	I (0)
	lahfgdp	0.66**	0.71	0.47	0.35	3	S	I (0)
	ltwtgdp	0.66**	0.71	0.47	0.35	3	S	I (0)
	lcpsgdp	0.67**	0.71	0.47	0.35	3	S	I (0)
	lpi	0.66**	0.71	0.47	0.35	3	S	I (0)
With Intercept only			At First differencing					
	dleci	0.06	0.71	0.47	0.35	2	N/S	
	dlepeitec	0.05	0.71	0.47	0.35	1	N/S	
	dlecii	0.36*	0.71	0.47	0.35	13	S	I (0)
	dlecmii	0.15	0.71	0.47	0.35	3	N/S	
	dliecc	0.15	0.71	0.47	0.35	1	N/S	

(*Contd...*)

A.Table 3: (*Continued*)

Model	Variable	Kwiatkowski−Phillips−Schmidt−Shin test statistic	Levels of Critical Values			Bandwidth	Stationarity	Integrir I (0,1,2)
			1%	5%	10%			
With Intercept only			**At First differencing**					
	dlecahfi	0.57	0.71	0.47	0.35	2	N/S	
	dlectwti	0.11	0.71	0.47	0.35	1	N/S	
	dleccpsi	0.23	0.71	0.47	0.35	7	N/S	
	dlecpi	0.31	0.71	0.47	0.35	2	N/S	
	dlgdpm	0.20	0.71	0.47	0.35	2	N/S	
	dlgdpd	0.29	0.71	0.47	0.35	2	N/S	
	dlepegdp	0.19	0.71	0.47	0.35	0	N/S	
	dligdp	0.26	0.71	0.47	0.35	1	N/S	
	dlmigdp	0.41	0.71	0.47	0.35	0	N/S	
	dlcgdp	0.22	0.71	0.47	0.35	1	N/S	
	dlahfgdp	0.10	0.71	0.47	0.35	1	N/S	
	dltwtgdp	0.13	0.71	0.47	0.35	1	N/S	
	dlcpsgdp	0.12	0.71	0.47	0.35	0	N/S	
	dlpi	0.17	0.71	0.47	0.35	2	N/S	
With Intercept & Trend			**At Level Form**					
	leci	0.08	0.21	0.15	0.12	2	N/S	
	lepeitec	0.07	0.21	0.15	0.12	2	N/S	
	lecii	0.13	0.21	0.15	0.12	0	N/S	
	lecmii	0.09	0.21	0.15	0.12	1	N/S	
	liecc	0.47	0.21	0.15	0.12	3	N/S	
	lecahfi	0.18	0.21	0.15	0.12	3	N/S	
	lectwti	0.08	0.21	0.15	0.12	2	N/S	
	leccpsi	0.15	0.21	0.15	0.12	2	N/S	
	lecpi	0.13	0.21	0.15	0.12	3	N/S	
	lgdpm	0.12	0.21	0.15	0.12	3	N/S	
	lgdpd	0.12	0.21	0.15	0.12	3	N/S	
	lepegdp	0.12	0.21	0.15	0.12	3	N/S	
	ligdp	0.15	0.21	0.15	0.12	3	N/S	
	lmigdp	0.16	0.21	0.15	0.12	3	N/S	
	lcgdp	0.09	0.21	0.15	0.12	2	N/S	
	lahfgdp	0.09	0.21	0.15	0.12	3	N/S	
	ltwtgdp	0.09	0.21	0.15	0.12	3	N/S	
	lcpsgdp	0.09	0.21	0.15	0.12	2	N/S	
	lpi	0.09	0.21	0.15	0.12	3	N/S	
With Intercept & Trend			**At First differencing**					
	dleci	0.06	0.21	0.15	0.12	2	N/S	
	dlepeitec	0.05	0.21	0.15	0.12	1	N/S	
	dlecii	0.50	0.21	0.15	0.12	21	N/S	
	dlecmii	0.12	0.21	0.15	0.12	3	N/S	
	dliecc	0.12	0.21	0.15	0.12	1	N/S	
	dlecahfi	0.13	0.21	0.15	0.12	3	N/S	
	dlectwti	0.05	0.21	0.15	0.12	0	N/S	
	dleccpsi	0.18	0.21	0.15	0.12	10	N/S	
	dlecpi	0.13	0.21	0.15	0.12	2	N/S	
	dlgdpm	0.12	0.21	0.15	0.12	2	N/S	
	dlgdpd	0.15	0.21	0.15	0.12	2	N/S	
	dlepegdp	0.15	0.21	0.15	0.12	0	N/S	
	dligdp	0.12	0.21	0.15	0.12	0	N/S	
	dlmigdp	0.09	0.21	0.15	0.12	3	N/S	
	dlcgdp	0.08	0.21	0.15	0.12	0	N/S	
	dlahfgdp	0.09	0.21	0.15	0.12	2	N/S	
	dltwtgdp	0.13	0.21	0.15	0.12	1	N/S	
	dlcpsgdp	0.10	0.21	0.15	0.12	0	N/S	
	dlpi	0.16	0.21	0.15	0.12	2	N/S	

KPSS denotes Kwiatkowski–Phillips–Schmidt–Shin (Kwiatkowski et al.,1992) single root system. The optimum lag order in KPSS test is selected based on the Newey–West criterion automatically; ***, ** and *indicate rejection ofthe null hypotheses at the 1%, 5% and 10% significance levels respectively. The critical values are taken from Kwiatkowski–Phillips–Schmidt–Shin. Assessment period: 1995-2017. S: Stationarity, N/S: No Stationarity

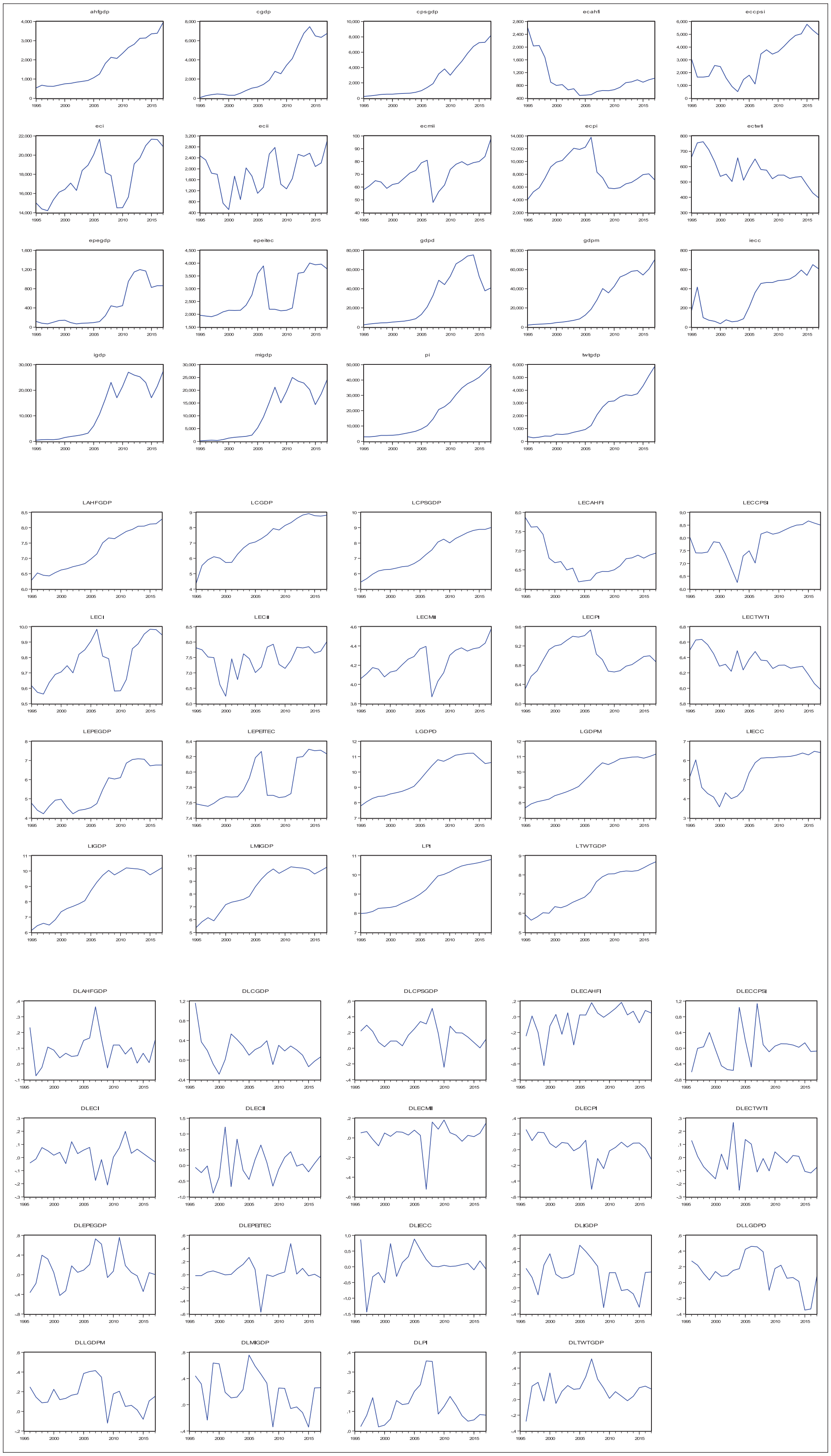
A.Table 4: Coefficients ARDL model

	Coefficient					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	*Δlgdpm*	*Δlgdpd*	*Δlepegdp*	*Δligdp*	*Δlmigdp*	*Δlcgdp*
$\Delta lgdpm_{(t-1)}$	0.44					
$lgdpm_{(t-1)}$	−0.03					
$\Delta leci_{(t-1)}$	0.06					
$leci_{(t-1)}$	−0.03					
$\Delta lgdpd_{(t-1)}$		0.61*				
$lgdpd_{(t-1)}$		−0.03				
$\Delta leci_{(t-1)}$		0.18				
$leci_{(t-1)}$		0.09				
$\Delta lepegdp_{(t-1)}$			0.32			
$lepegdp_{(t-1)}$			−0.25			
$\Delta lepeitec_{(t-1)}$			−0.38			
$lepeitec_{(t-1)}$			−0.25			
$\Delta ligdp_{(t-1)}$				0.25		
$ligdp_{(t-1)}$				0.03		
$\Delta lecci_{(t-1)}$				−0.38*		
$lecci_{(t-1)}$				0.03		
$\Delta lmigdp_{(t-1)}$					0.22	
$lmigdp_{(t-1)}$					−0.03	
$\Delta lecmii_{(t-1)}$					−0.22	
$lecmii_{(t-1)}$					0.09	
$\Delta lcgdp_{(t-1)}$						0.33*
$lcgdp_{(t-1)}$						0.02
$\Delta liecc_{(t-1)}$						0.08
$liecc_{(t-1)}$						−0.03
Constant	−2.22	−0.57	1.85	2.61*	0.083	0.05

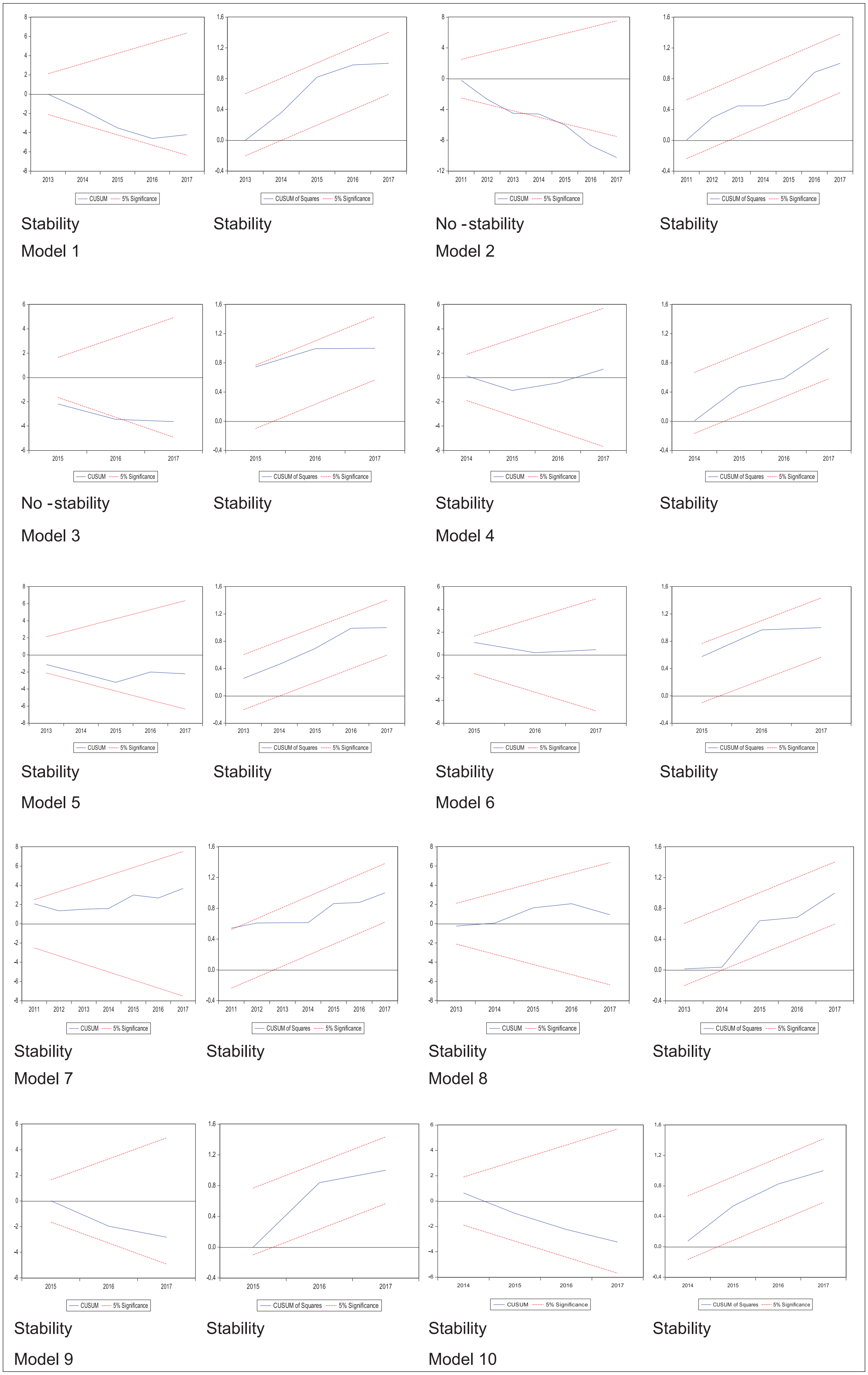
A.Table 5: Coefficients ARDL model

	Coefficient			
	Model 7	Model 8	Model 9	Model 10
Variable	*Δlahfgdp*	*Δltw tgdp*	*Δlcpsgdp*	*Δlpi*
$\Delta lahfgdp_{(t-1)}$	−0.001			
$lahfgdp_{(t-1)}$	0.01			
$\Delta lecahfi_{(t-1)}$	0.07			
$lecahfi_{(t-1)}$	−0.13			
$\Delta ltwtgdp_{(t-1)}$		0.11		
$ltwtgdp_{(t-1)}$		0.03		
$\Delta lectwti_{(t-1)}$		−0.39		
$lectwti_{(t-1)}$		0.44		
$\Delta lcpsgdp_{(t-1)}$			0.23	
$lcpsgdp_{(t-1)}$			0.02	
$\Delta leccpsi_{(t-1)}$			0.08	
$leccpsi_{(t-1)}$			−0.06	
$\Delta lpi_{(t-1)}$				0.43*
$lpi_{(t-1)}$				−0.01
$\Delta lecpi_{(t-1)}$				−0.20
$lecpi_{(t-1)}$				0.07
Constant	0.90	−2.92	0.39	−0.49

A.Figure 1: Dynamic



A.Figure 2: Plot of cumulative sum of recursive residuals



A. Abbreviations		
ECI	Electric energy consumption, total	million kVt.h
EPEITEC	Internal consumption of electric energy producing entities	million kVt.h
ECII	Elcertic energy consumption in industry	million kVt.h
ECMII	Electric energy consumption in mining	million kVt.h
IECC	Electric energy consumption in construction	million kVt.h
ECAHFI	Electric energy consumption in agriculture, hunting and forestry	million kVt.h
ECTWTI	Electric energy consumption in transport, warehouse and telecommunication	million kVt.h
ECCPSI	Electric energy consumption in other, commercial and public service	million kVt.h
ECPI	Electric energy consumption by people and in household	million kVt.h
GDPM	GDP in manat	mln. manat
GDPD	GDP in dollar	mln. dollar
EPETECGDP	GDP in electric energy producing entities	mln. manat
ECIGDP	GDP in industry	mln. manat
ECMIGDP	GDP in mining industry	mln. manat
ECCGDP	GDP in construction	mln. manat
ECAHFGDP	GDP in agriculture, hunting and forestry	mln. manat
ECTWTGDP	GDP in transport, warehouse and telecommunication	mln. manat
ECCPSGDP	GDP in other, commercial and public service	mln. manat
PI	People's income	mln. manat