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The Impact of Energy Consumption, Trade Openness and Financial Development on Economic Growth: Empirical Evidence from Turkey (1980–2014)

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Abstract

The developments in Turkish economy indicate that energy, trade openness and financial development are critical determinants of economic growth. This study aims to investigate the impact of energy consumption, trade openness and financial development on economic growth in case of Turkey over the sample period 1980-2014. The results of unit root tests reveal that the variables are integrated at *I*(1). The results of ARDL bounds test and Johansen-Juselius technique reveal that there exists a long-run relationship among energy consumption per capita, trade openness, domestic credit provided by banking sector and real GDP per capita. Energy consumption and financial development have a positive impact on economic growth while there do not a statistically significant relationship between trade openness and economic growth in the long run. The VECM Granger causality results show that there exist a uni-directional causal linkage running from energy consumption, trade openness and financial development to economic growth in the long run. The empirical findings can provide several policy implications for Turkish economy over the period.

Keywords: energy consumption, trade openness, financial development, economic growth, cointegration, causality, Turkey.

1. Introduction

The determinants of economic growth has long been argued by theoretical and empirical literature. It is well known that economic growth has been affected by energy, trade and financial development (Goldsmith, 1969; Yu, Choi, 1985; Barro, Sala-i-Martin, 1997). Energy-growth literature reveals the existence of four hypotheses on the link between energy consumption and economic growth. These theories explain the causal linkages between the variables. According to the growth hypothesis energy consumption is very important for economic growth implying that there exists a uni-directional causality running from energy consumption to economic growth (Altinay, Karagol, 2004). The conservation hypothesis suggests that there exists a uni-directional causality running from economic growth to energy consumption (Payne, 2010). The feedback hypothesis implies a bi-directional causality between energy consumption and economic growth (Soytas, Sari, 2003). The neutrality hypothesis assumes that there exist no causal linkages between energy consumption and economic growth (Zhang, Xu, 2012).

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Trade openness is an important determinant of economic growth. (Bhagwati, 1978; Romer 1986; Grossman and Helpman, 1990; Rivera-Batiz, Romer, 1991; Taylor, 1993) are the main theoretical studies investigating the link between international trade and economic growth. Generally, these literature reveal the presence of a consensus that trade openness causes economic growth. Financial development is linked with economic growth. Several theoretical studies such as (McKinnon, 1973; King, Levine, 1993; Warman, Thirlwall, 1994) discuss the link between financial development and economic growth. According to these literature, financial development will cause economic growth through productive and efficient use of financial resources.

Kraft and Kraft (1978) is the first study investigating the relationship between energy consumption and economic growth. The study reveals a uni-directional causality running from economic growth to energy consumption. Erol and Yu (1988) show that there exists a bi-directional causality between energy consumption and economic growth for Japan. The study finds a uni-directional causality running from energy consumption to economic growth for Canada. The study also finds a uni-directional causality running from economic growth to energy consumption for Germany. Masih and Masih (1996) find a uni-directional causality running from energy consumption to economic growth for India and Indonesia. In the study, a uni-directional causal linkage running from economic growth to energy consumption is found. In addition, there exists a bi-directional causality between the variables in Pakistan. Asafu-Adjaye (2000) finds no causality for Indonesia and India. Soytas and Sari (2003) indicate that there exists a uni-directional causality running from economic growth to energy consumption in Italy and Korea. The study aslo indicates that there exists a uni-directional causality running from energy consumption to economic growth in France, Germany, Japan and Turkey. Farhani and Rejeb (2012) reveal that there exists a uni-directional causality running from economic growth to energy consumption in low and high income countries. This study also reveals that there exists a bi-directional causality between the variables in upper-middle income countries.

Barro (1991), Edwards (1998) and Frankel and Romer (1999) examine the link between trade openness and economic growth through the cross-country regression analysis. Empirical results show that trade openness is positively correlated with economic growth. Musila and Yiheyis (2015) investigate the effect of trade openness on economic growth in case of Kenya. Regression analysis reveals that trade openness is positively linked with economic growth. But, the impact is found to be statistically insignificant.

Applying the Johansen-Juselius cointegration method and Granger causality test, Jenkins and Katircioglu (2010) explore the long run relationship among international trade, financial development and economic growth for Cyprus. Empirical results imply that there exists a long run relationship between international trade, financial development and economic growth. Empirical results also imply that there exists a uni-directional causality running from economic growth to financial development and international trade. Gokmenoglu et al. (2015) deal with the links between international trade, financial development and economic growth in Pakistan. The Granger causality analysis indicates that there exists a uni-directional causality running from financial development to economic growth.

In recent years, several studies such as Shahbaz et al. (2013), Muhammad et al. (2015) and Kumar et al. (2015) examine the relationship between energy consumption, trade, financial development and economic growth. However, these studies provide inconclusive findings and do not investigate Turkish economy. For example, Shahbaz et al. (2013) investigate the relationship between energy consumption, trade, financial development and economic growth in China by using the ARDL bounds testing approach to cointegration and VECM Granger causality method. The empirical results show that energy consumption, trade openness and financial development positively affect economic growth. The Granger causality analysis indicates that a uni-directional causality running from energy consumption to economic growth exists. The Granger causality analysis also indicates that there exists a bi-directional causality between international trade and economic growth and, financial development and economic growth.

Applying panel cointegration and PMG estimation methods, Muhammad et al. (2015) aim at exploring the impact of energy consumption, trade openness and financial development on growth in five South Asian countries. Empirical findings show that there exists a long run relationship between energy, trade, financial development and economic growth. Empirical findings also show that financial development, energy and trade are positively linked with economic growth.

In addition, a bi-directional causality between energy consumption and economic growth, and a uni-directional causality running from trade and financial development to economic growth are found in the long run.

Kumar et al. (2015) examine the effect of energy consumption, trade openness and financial development on economic growth in case of South Africa. Using the ARDL bounds and the Bayer and Hanck cointegration tests, the study shows that trade openness and energy consumption positively affect economic growth in the long run. The study also shows that financial development negatively affects economic growth in the long run. The Toda-Yamamoto causality analysis indicates that there exists a bi-directional causality between trade openness and economic growth. The Toda-Yamamoto causality analysis also indicates that there exists no causal linkage between energy consumption and economic growth. In addition, financial development does not cause economic growth.

Energy consumption, financial development and trade openess are crucial factors for economic growth of Turkish economy. Therefore, the objective of present study is to explain the impact of energy consumption, financial development and trade openess on economic growth in case of Turkey over the period of 1980-2014. The stationarity properties of the variables are investigated through different unit root tests. The study implements the ARDL bounds testing approach to cointegration to examine the long run relationship among the variables. In addition, the study applies the VECM Granger causality approach to explore the causal linkages between the variables. The findings are expected to present several implications for energy, financial and trade policies to sustain economic growth in Turkey.

The rest of the study is organized as follows. Section 2 deals with econometric specification and data description. Section 3 describes the methodology used in the study. Secton 4 reports the empirical findings. Conclusion and policy implications are offered in Section 5.

2. Econometric Specification and Data Description

In this study, the standard log-linear model is used to investigate the impact of energy consumption, trade openness and financial development on economic growth as it can present more efficient results. Following Shahbaz et al. (2013) and Kyophilavong et al. (2015) the long run relationship between the variables is specified as follows:

$$lgdp_t = \beta_0 + \beta_1 lenergy_t + \beta_2 lfinance_t + \beta_3 ltrade_t + \mu_t \quad (1)$$

where, gdp_t is per capita real GDP (constant 2010 US$), *energy* is per capita energy consumption (kg of oil equivalent), *finance* is financial development (domestic credit to private sector, % of GDP) and trade is the openness ratio (foreign trade, % of GDP). μ_t is the regression error term. The annual data covers the sample period 1980-2014. The Turkish economy has witnessed many radical changes and structural reforms since the 1980s (Terterov and Rosenblatt, 2006). Therefore, this sample period is selected to analyze the links among the variables. The data is obtained from the World Development Indicators (WDI) online database. All the series are converted to their logarithmic form.

The parameters, β_i, i=1, 2, 3, indicate the long-run elasticities of per capita real GDP with respect to per capita energy use, domestic credit to private sector (% of GDP) and trade openness, respectively. Under the energy, finance and trade-led eonomic growth hypotheses, the signs of β_1, β_2 and β_3 are expected to be positive (Shaw, 1973; Levine, 1997; Payne, 2010; Yenokyan et al., 2014).

The descriptive statistics and correlation matrix of the series are presented in Table 1. It shows that there exists a positive and significant relation between energy consumption and economic growth. Financial development is positively correlated with economic growth. In addition, it is found that there exists a positive correlation between trade openness and economic growth. Figure 1 shows the plots of the variables employed in the study.

Table 1. Descriptive Statistics and Correlation Matrix (Time Series Data: 1980-2014, Observations=35)

Statistics/Variables	*lgdp*	*lenergy*	*lfinance*	*ltrade*
Mean	8.909	6.984	3.119	3.692
Median	8.910	7.026	2.897	3.765
Std. dev.	0.257	0.239	0.468	0.295
Min.	8.473	6.559	2.609	2.838
Max.	9.327	7.353	4.312	4.094
Skewness	0.008	-0.145	1.324	-0.874
Kurtosis	1.931	1.994	3.548	3.446
Observations	35	35	35	35
lgdp	1.000			
lenergy	0.994	1.000		
lfinance	0.753	0.730	1.000	
ltrade	0.879	0.889	0.605	1.000

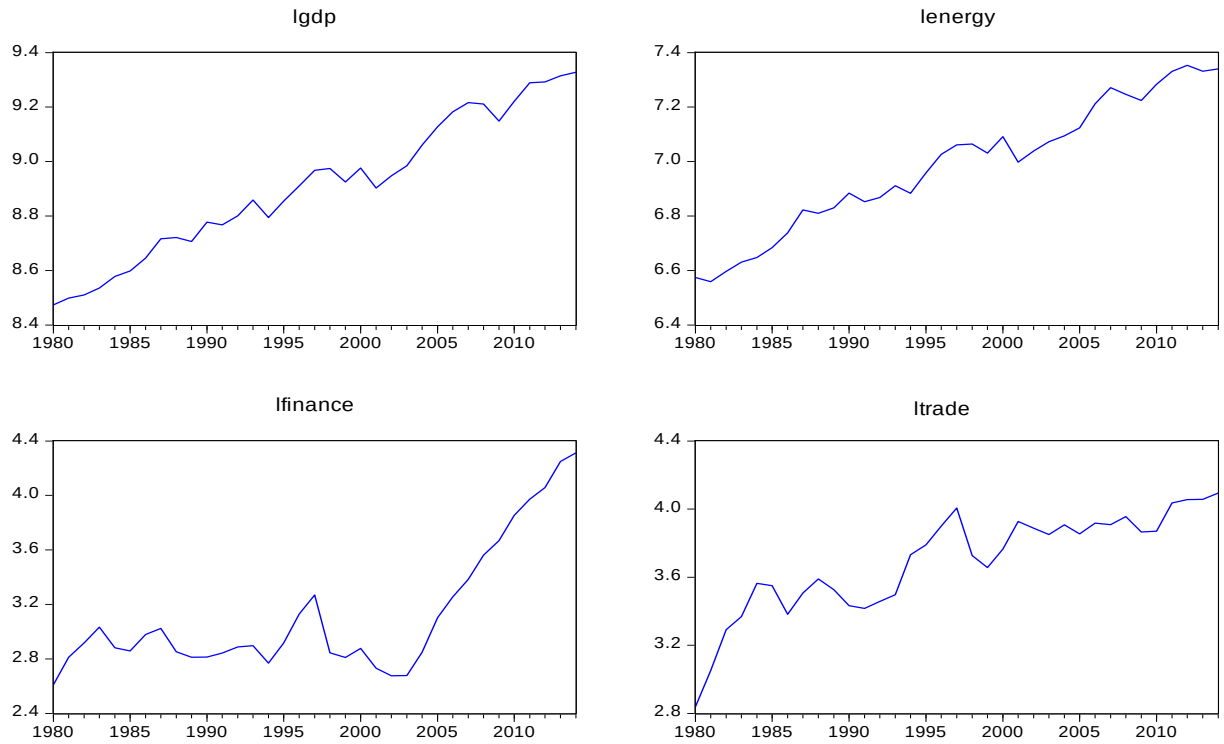

Fig. 1. Trends of the Series in Turkey

3. Methodology

The present study aims at examining the relationship between energy consumption, financial development, trade openness and economic growth over the period 1980-2014. The unit root properties of the variables are determined by different unit root tests. The ARDL bounds testing approach to cointegration is applied to investigate the presence of long run relationship among the variables. In addition, the VECM Granger causality framework is applied to determine the causal links between the variables.

3.1 Cointegration Analysis

This study applies the ARDL bounds testing approach to cointegration in order to test the long run relationship between the variables. This approach has a flexible procedure. In this procedure, the variables can be integrated at $I(0)$ or $I(1)$. This procedure presents consistent results

for small sample. In addition, a dynamic unrestricted error correction model (UECM) includes the short run and the long run dynamics (Pesaran and Shin, 1999; Pesaran et al., 2001). The equation of UECM model is expressed as follows:

$$\Delta lgdp_t = \alpha_0 + \sum_{i=1}^{m} \beta_{1i} \Delta lgdp_{t-i} + \sum_{i=0}^{m} \beta_{2i} \Delta lenergy_{t-i} + \sum_{i=0}^{m} \beta_{3i} lfinance_{t-i} + \sum_{i=0}^{m} \beta_{4i} ltrade_{t-i} + \lambda_1 lgdp_{t-1} + \lambda_2 lenergy_{t-1} + \lambda_3 lfinance_{t-1} + \lambda_4 ltrade_{t-1} + \lambda_5 trend + \varepsilon_t \quad (2)$$

where, α_o, Δ and ε_t are the constant, the first difference operator and the random error term, respectively. The appropriate lag order is selected by the Akaike Information Criterion (AIC). The ARDL bounds test uses *F*-statistic to determine the existence of cointegration between the variables. This test compares the computed *F*-statistic with the upper critical bound (UCB) and lower critical bound (LCB). These critical bounds are presented by Pesaran et al. (2001) and Narayan (2005). Here, the null and the alternative hypotheses are $H_0: \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$ and $H_a: \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0$, respectively. There exists a cointegration between the variables when the computed *F*-statistic exceeds the UCB. There exists no cointegration between the variables when the computed *F*-statistic below the LCB. The finding is uncertain when the computed *F*-statistic falls between the UCB and LCB.

Several diagnostic tests can be used to examine the robustness of the ARDL model. These are serial correlation, functional form, normality of error term and heteroskedasticity tests. Additionally, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMsq) tests developed by Brown et al. (1975) can be applied to investigate the stability of the ARDL parameters.

3.2 Granger Causality Analysis

The cointegration methods do not provide any information about the direction of causality. This study uses the VECM Granger causality test as this method examines the long run and the short run causality between the variables. The VECM specification is expressed as follows:

$$(1-L)\begin{bmatrix} \lg dp_t \\ lenergy_t \\ lfinance_t \\ ltrade_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} + \sum_{i=1}^{p} (1-L) \begin{bmatrix} b_{11i} b_{12i} b_{13i} b_{14i} \\ b_{21i} b_{22i} b_{23i} b_{24i} \\ b_{31i} b_{32i} b_{33i} b_{34i} \\ b_{41i} b_{42i} b_{43i} b_{44i} \end{bmatrix} x \begin{bmatrix} \lg dp_{t-1} \\ lenergy_{t-1} \\ lfinance_{t-1} \\ ltrade_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha \\ \beta \\ \lambda \\ \delta \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} (3)$$

where (1- *L*) is the lag operator and ECT_{t-1} is the lagged error correction term. This term is obtained from the long run specification. ε_{1t}, ε_{2t}, ε_{3t} and ε_{4t} are error terms assumed to be N (0,σ). A significant *F*-statistic on the first differences of the variables implies the presence of a short run causality between the variables. In addition, a significant *t*-statistic on the coefficient of ECT_{t-1} implies the existence of a long run cusality between the variables.

4. Empirical Findings

The study applies several unit root tests such as DF-GLS, PP and Ng-Perron methods to explore the unit root properties of the series. Ng-Perron tests provide more reliable results compared to classical unit root tests. Additionally, it can be more suitable for small sample size (Alimi, 2014).

The results of DF-GLS, PP and Ng-Perron tests are reported in Table 2. The results indicate that the variables are not stationary at a level. However, after taking the first difference of the variables, the series are found to be stationary. The results imply that all the variables are

integrated at *I*(1). The results also imply that the ARDL bounds testing approach to cointegration can be applied to test the presence of cointegration between the variables.

Table 2. The Unit Root Tests Results

Regressor	DF-GLS	PP	Ng-Perron			
	(*t*)	(Adj. *t*)	MZ_a	MZ_t	*MSB*	*MPT*
lgdp	0.742	-0.479	1.473	1.434	0.973	72.223
lenergy	0.474	-0.886	1.180	1.136	0.963	67.146
lfinance	1.038	0.570	2.636	1.332	0.505	28.477
ltrade	-0.720	-2.925	-0.074	-0.041	0.560	21.852
Δlgdp	-6.572***	-7.857***	-16.128***	-2.836***	0.175**	1.530***
Δlenergy	-5.700***	-6.628***	-16.336***	-2.857***	0.174**	1.499***
Δlfinance	-3.925***	-4.395***	-14.176***	-2.659***	0.187**	1.740***
Δltrade	-3.983***	-5.801***	-14.089***	-2.644***	0.187**	1.775***

Notes: The model with constant and trend is used for unit root analysis. The optimal lag length is selected automatically using SBC for ADF test and the bandwidth is selected using the Newey-West method for PP test. *** and ** denote the significant at 1 % and 5 % level of significance, respectively.

Table 3 reports the results of bounds *F*-test for cointegration. As noted in Table 4, we use critical bounds obtained by Pesaran et al. (2001) and Narayan (2005)**.** According to Pesaran et al. (2001) critical values, the results show that calculated *F*-statistic is greater than UCB at 1 per cent. According to Narayan (2005) critical values, the results show that calculated *F*-statistic is greater than UCB at 5 per cent. All the findings indicate that the series are cointegrated implying that there exists a long run relationship between per capita energy consumption, domestic credit to private sector, trade openness and per capita real GDP for Turkish economy over the period of 1980–2014. The results for diagnostic tests of ARDL model are also reported in the lower part of Table 3. The findings show that the ARDL model passes all the tests successfully.

Table 3. Cointegration Test Results

Bounds testing approach to cointegration		
Model	ARDL lag order	Calculated *F*-statistics
F(lgdp/lenergy, lfinance, ltrade)	[2,1,0,0]	7.411
Peseran et al. (2001) critical value bounds of the *F*-statistic: unrestricted intercept and unrestricted trend		
Significance level	Lower bounds, *I*(0)	Upper bounds, *I*(1)
1%	5.17	6.36
5%	4.01	5.07
10%	3.47	4.45
Narayan (2005) critical value bounds of the *F*-statistic: unrestricted intercept and unrestricted trend (T = 35)		
Significance level	Lower bounds, *I*(0)	Upper bounds, *I*(1)
1%	6.38	7.73
5%	4.56	5.79
10%	3.80	4.88
Diagnostic tests		
R^2		0.988
Adjusted-R^2		0.930
F-statistic		17.259***
Breusch-Godfrey LM test		3.320(0.142)
ARCH LM test		0.162 (0.689)

J-B normality test	1.428 (0.489)
Ramsey RESET test	0.636 (0.469)

Notes: The model with constant and trend is used for cointegration analysis. Optimal lag order is selected based on SBC. The values in parentheses indicate the probabilities. *** denotes the significant at 1 % level of significance.

Table 4 reports long run results. The effect of energy consumption on economic growth is positive and statistically significant at 1 % level. A 1 % growth in energy consumption is expected to increase economic growth by 0.630 %, indicating that energy consumption plays dominant role to stimulate economic growth in Turkey. Financial development has a positive impact on economic growth. It is statistically significant at 10 % level. A 1 % increase in financial development raises economic growth by 0.023 %. In addition, trade openness has a negative effect on economic growth. But, it is statistically insignificant. These findings indicate the dependence of Turkish economic growth on energy consumption and financial development.

Table 4 also reports short run results. The impact of energy consumption is positive and statistically significant at 1 % level. A 1 % increase in energy consumption raises economic growth by 0.844 %. In addition, the impact of financial development and trade openness on economic growth is statistically insignificant. The negative and statistically significant estimate for ECM_{t-1} confirms the presence of long run relationship among the series in case of Turkey. The coefficient is statistically significant at 1 % level. The short run deviations from the long run equilibrium are corrected by 77.0 % towards long run equilibrium path each year.

The diagnostic tests for the long run model are presented in the lower part of Table 4. The diagnostic tests reveal that error terms are normally distributed. The diagnostic tests also reveal free of serial correlation, heteroskedasticity, and ARCH problems in the model. In addition, functional form for the long run model is well specified. The cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) tests inform us about the stability of long run parameters (Fig. 2). The graphs of CUSUM and CUSUMsq tests lie within the 5 % critical bounds. The results reveal that the ARDL estimates are reliable and stable. Therefore, the results will be used to provide policy implications.

Table 4. Estimated Coefficients from ARDL Model

Panel A: Long-run results		
Regressors	Coefficient	*t*-statistic
Constant	4.438	5.379***
lenergy	0.630	5.046***
lfinance	0.023	1.722*
ltrade	-0.055	-1.258
Panel B: Short-run results		
Dependent variable: *Δlnco*		
Regressors	Coefficient	*t*-statistic
Constant	0.008	1.791*
Δlenergy	0.844	9.079***
Δlfinance	0.034	1.270
Δltrade	-0.048	-1.486
ECT(-1)	-0.777	-4.497***
Panel C: Long-run diagnostic test statistics		
R^2		0.994
Adjusted-R^2		0.993
F-statistic		674.409***
Breusch-Godfrey LM test		1.852 (0.186)
ARCH LM test		0.211 (0.649)
J-B normality test		1.015 (0.601)
Ramsey RESET test		0.770 (0.388)

Notes: The long-run and short-run coefficients are obtained on the basis of ARDL (2,1,0,0) model, decided by the SBC. The values in parentheses indicate the probabilities. *** and * denote the significant at 1 % and 10 % level of significance, respectively.

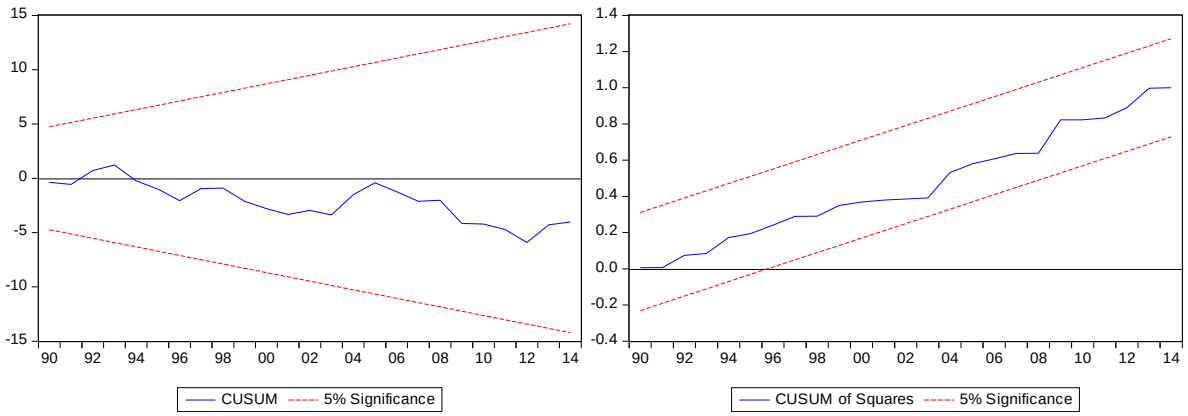

Fig. 2. Plots of CUSUM and CUSUMsq Tests for the Parameter Stability

The Granger causality results are presented in Table 5. The results reveal that there exists a uni-directional causal linkage running from energy consumption, financial development and trade openness to economic growth implying that energy consumption, financial development and trade openness Granger cause economic growth in the long run. The results confirm that the energy-led growth, the finance-led growth and trade-led growth hypotheses are valid for Turkish economy in the long run.

Table 5. VECM Granger Causality Test Results

		Short-run (*F*-statistic)				Long-run (*t*-statistic)
Dependent variable		*Δlgdp*	*Δlenergy*	*Δlfinance*	*Δltrade*	
Δlgdp		-	0.806(0.459)	2.691 (0.090)	0.323 (0.727)	-1.747 (0.094)
Δlenergy		1.719 (0.202)	-	2.003 (0.158)	0.338 (0.716)	0.341 (0.736)
Δlfinance		1.104 (0.349)	0.429 (0.656)	-	0.412 (0.666)	-0.259 (0.797)
Δltrade		0.149 (0.862)	0.459 (0.637)	0.185 (0.832)	-	-0.475 (0.638)

Notes: The values in parentheses indicate the probabilities.

5. Conclusion and Policy Recommendations

This study investigates the effect of energy consumption, financial development and trade openness on economic growth in Turkey for the period of 1980-2014. It applies DF-GLS, PP and Ng-Perron unit root tests to examine the stationarity properties of the variables. The presence of cointegration among the variables is analyzed by using the ARDL bounds test. In addition, the Granger causality within VECM is applied to test the direction of causality between the variables.

The results indicate that the series are integrated at *I*(1). The results also indicate that there exists cointegration among the variables. A negative and statistically significant estimate for ECM_{t-1} provides an evidence for cointegration between the variables. This implies that there exists a long run relationship between energy consumption, financial development, trade openness and economic growth. Energy consumption and financial development are positively linked with economic growth implying that energy consumption and financial development increases economic

growth in the long run. A significant relationship between trade openness and economic growth is not found in the long run. In the short run, there exists a positive link between energy consumption and economic growth. Energy consumption, financial development and trade openness Granger cause economic growth in the long run. So, the energy-led growth, the finance-led growth and trade-led growth hypotheses are valid for Turkey over the period.

This study openness up new implications for policy makers in Turkish economy. Empirical findings indicate that energy consumption is the vital factor for economic growth. This implies that a reduction in energy supply will slow down economic growth. Turkish government should diversify the energy sources and improve the energy efficiency. In addition, policy makers should stimulate domestic investors to apply new technologies. Empirical findings also indicate that financial development is a significant factor for Turkey. Turkish government should mobilize financial resources to most productive investments and support the financial development to have stable economic growth. Therefore, the innovative use of technology is implemented in most of the financial services. In this study, it is found that trade openness Granger causes economic growth. Therefore, Turkish government should improve trade activities and strengthen international economic relations. Policymakers should make more effective export promotions to the small and medium sized enterprieses to improve export performance.

A comparative empirical analysis can be applied for future research on the relationship between energy consumption, financial development, trade openness and economic growth in some developing countries. The unit root and cointegration tests with single or two unknown structural breaks stemming in the series can also be applied to investigate the unit root and cointegration properties of the variables.

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