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Energy Consumption and Financial Development: Evidence from MENA Countries with Panel Hidden Cointegration

Enerji Tüketimi ve Finansal Gelişme: Saklı Eşbütünleşme ile MENA Ülkelerinden Kanıtlar

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ÖZ

Enerji, ekonomilerin gelişmeleri hakkında ipucu veren önemli bir parametredir. Ülkelerdeki enerji tüketimi ekonomik yapıyı özetlemektedir. Günümüzde ekonomik büyümenin reel sektör belirleyicileri dışında dikkat çeken bileşeni finansal gelişme olarak kabul edilmektedir. Bu çalışmada enerji tüketimi ve finansal gelişme ilişkisi MENA ülkeleri için incelenmiştir. 1980-2017 dönemini ele alan araştırmada ekonometrik analizler Hatemi J (2011) Panel Saklı Eşbütünleşme Testi ve Panel VECM analizi ile gerçekleştirilmiştir. Test sonuçları değişkenlerin orijinal değerleri arasında eşbütünleşme olmadığını, fakat pozitif ve negatif bileşenlerinin bazıları arasında uzun dönemli bir ilişkinin olduğunu göstermiştir. Dolayısıyla seriler arasında saklı eşbütünleşme olduğu tespit edilmiştir. Bu bulgular ışığında değişkenlerinin bileşenleri arasında eşbütünleşme ve özellikle de uzun dönem nedensellik ilişkisi olması finansal gelişme göstergelerindeki değişikliğin enerji tüketimi üzerinde etkili olduğunu ortaya koymaktadır.

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ABSTRACT

Energy is an important parameter that gives clues about the developments in economies. Energy consumption (EC) in countries gives a summary of the economic structures of those countries. Today, the attention-grabbing component of economic growth, apart from the real sector determinants, is considered to be financial development. In this study, the relationship between EC and financial development in MENA countries is examined. Econometric analyzes are carried out by Hatemi J (2011) Panel Hidden Cointegration Test and Panel VECM analysis in the study covering the period between 1980 and 2017. The test results have showed that there is no cointegration between the original values of the variables, but there is a long-term relationship between some of the positive and negative components. Therefore, it has been determined that there is a hidden cointegration between the series. In light of these findings, the cointegration and especially the long-term causality relationship between the components of the variables reveal that the change in financial development indicators is effective on energy consumption.

1. Introduction

Energy is not only one of the most critical issues of the Twenty-First Century, its story dates back to the ancient antiquity. It is an adventure that begins with the discovery of fire by human beings. 900 years ago, coal was used to power steam engines after its discovery and left its mark on the industrial revolution. The oil obtained from the residues of biodegraded organic materials has been the most important source of energy since the beginning of the 20th

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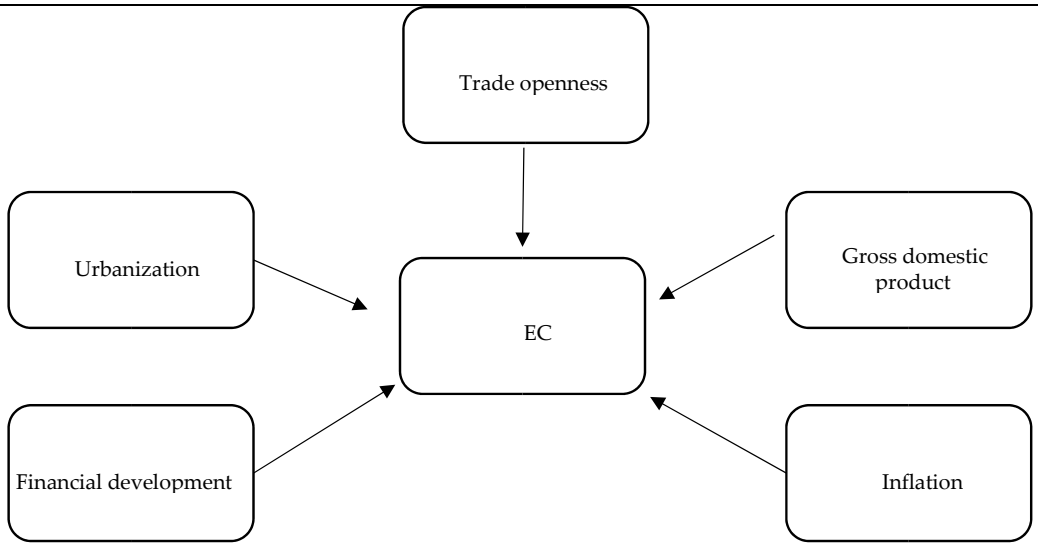
century. While coal, oil, and natural gas were considered primary energy carriers, electrical energy became the most important secondary energy source and the primary form of energy consumed with the invention of electric motors and generators in the 1870s. Considering its historical change, energy is an indispensable need in almost every aspect of our lives, from lighting to heating, from communication to transportation, from cooling to cooking and even to entertainment (Liu et al., 2010:28). Energy consumption, which is the most important necessity, defines the consumption and use of an existing energy type for the production of goods or services, transportation, lighting, air conditioning or other purposes (Uslu, 2020:28). In a globalizing world, rapid population growth and the desire to reach modern industries have significantly increased energy consumption. It is because energy is used in the production of almost all goods and services. Rapid growth in economically developing countries is accompanied by increasing energy demand (consumption). For this reason, determining the determinants of energy demand has an important place in the literature (Sadorsky, 2010:2528). The determinants of EC are shown in Figure 1. Trade openness, gross domestic product, urbanization, and inflation variables are among the important determinants of energy consumption. In addition, financial development is seen as an effective factor in EC (Gómez & Rodríguez, 2019:3).

Figure 1. EC and Determinants



Source: Gómez and Rodríguez (2019:1)

Financial development, which is thought to be linked to energy consumption, refers to a comprehensive process. It includes the increase in the use and access of financial services, as well as the creation and expansion of instruments and institutions that drive financial investment and growth, improvements in size, efficiency, and stability in the financial system (Beck et al., 2008: 4-5). The contribution of a well-functioning, developed and effective financial structure to the formation of sound economic systems in all countries is indisputable. Countries that desire to achieve strong growth develop strategies that will support the existence of innovative financial markets in their growth policies. Financial systems are not just a transfer mechanism between those with fund surplus and those with fund deficit. In order to protect the future value of any asset, evaluating assets in different baskets and converting the same asset into a payment instrument are among the services offered by financial markets. For developing countries whose one of the main economic problems is lack of investment due to inadequate savings, the most important task of a developed financial structure is to provide a fund supply for investors by increasing household savings. In this way, economic growth will gain momentum by ensuring the optimum use of capital and productivity increase.

Various indicators are used to make financial development comparable across countries. The indicators considered can be divided into two groups. The first group of indicators consists of quantity measurements, structural measurements, financial prices, product range, and transaction costs (Lynch, 1996:7). The second group of financial development indicators includes the size of financial institutions and markets (financial depth), the degree to which individuals can benefit from financial institutions and markets (accessibility), the efficiency of financial institutions and markets in providing financial services (efficiency), and the stability of financial institutions and markets (reliability) (Čihák et al., 2013: 3). In these groupings, variables such as M1, M2, M2Y, M3, total loan volume and loans to the private sector, real interest levels, bank loans, number of people with bank accounts, total financial asset stock, and the ratio of some of these to income are used (Levine, 2004: 6). In addition to the mentioned indicators, the Financial Development Index (FDI), developed by the International Monetary Fund (IMF), is also included in measuring financial development.

FDI consists of the combination of the financial institution index and the financial markets index, the details of which are given in Table 1 below, created with multiple indicators such as financial depth, access, and efficiency. With these features, FD is an indicator that handles financial development in a very comprehensive way.

Table1. Indicators Used in Financial Development Index

Financial Institutions Index	
Depth	Bank credit to private sector/GDP
	Pension fund assets/GDP
	Mutual fund assets/GDP
	Insurance premiums (life and non-life)/GDP
Access	Bank branches per 100.000 adults
	ATMs per 100.000 adults
Efficiency	Banking sector net interest margin
	Non-interest income/total income
	Lending-deposits spread
	Return on assets
	Overhead costs/total assets
	Return on equity
Financial Market Index	
Depth	Stock market capitalization/GDP
	Stocks traded/GDP
	International debt securities of government/GDP
	Total debt securities of financial and nonfinancial corporations/GDP
Access	Percent of market capitalization outside of top largest companies
	Total number of issuers of debt per 100.000 adults
Efficiency	Stock market turnover ratio

Source: IMF (2020)

Financial development affects investments through providing preliminary information on possible investments, monitoring investments, implementing corporate governance, diversification of trade, risk management, mobility of savings, and trading goods and services, and thus economic growth. It is known that financial development affects EC through economic growth. This effect can be positive or negative depending on whether economic growth is efficient. For example, growth in the financial sector increases the availability of funds for investment projects resulting in industrial growth leading to an expansion in production activities. This increases economic growth and the demand for new infrastructure and more energy. Thus, it positively affects energy consumption. However, the ability to adopt technological innovations in the development of industrial sector differs among countries (Komal & Abbas, 2015:212). Although the relationship between EC and financial development is explained through economic growth in the literature, Sadorsky (2011) mentions the existence of three mechanisms. According to Sadorsky (2011) first of all, financial development offers people the opportunity to find loans easier and cheaper. If people direct these loans to durable consumer goods, such as refrigerators, automobiles, air conditioners, and washing machines, there will be an impact for the country in general, and the total energy demand will increase. This first case can be considered as a direct effect of financial development on energy consumption. Second, with financial development, companies will be able to access financial capital in a less costly and easy way. Thus, companies have the opportunity to make new investments, to purchase new machinery and equipment, and to benefit from a new workforce. This situation leads to new production and new energy demand. The third situation is related to developments in the stock market. The fund source created through stocks will offer companies the opportunity to borrow financing and improve their current situation. The expansion in the stock market can increase the distribution of risk with a wealth effect for both firms and consumers. With the effect of wealth, trust in the consumer and the firm is affected. Increasing economic confidence will increase EC by causing economic growth when stock markets are considered as an indicator of prosperity (Sadorsky, 2011:1000). Just as financial development affects energy consumption, EC also affects financial development. If the countries are developed or developing countries, it can be said that financial development is positively affected in the economy strengthened by energy production and consumption. In undeveloped countries, the negative impact of increasing EC costs on the weak financial system may further damage the unsustainable financial structure (Gümüş and Koç, 2015:152). On the other side, Shahbaz et al., (2017), think that the relationship between EC and financial development can be very complex due to the many channels of influence between them. With the influence mechanisms listed by Sadorsky (2010), Shahbaz et al., (2017) argue that financial development leads to economic growth and thus to an increase in energy consumption. But there is also a negative interaction mechanism between financial development and energy consumption, according to the authors because financial development can also lead to increased investment in technologies that reduce energy consumption. Therefore, according to Shahbaz et al., (2017), it is very important to examine how the positive and negative changes in financial development can affect energy consumption. Since there are positive and negative interactions between financial development and energy consumption, they recommend considering asymmetry while performing cointegration and causality analyzes among these variables.

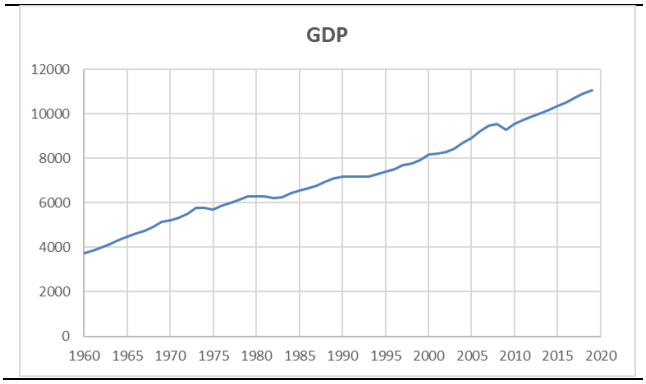
In this study, the relationship between financial development and EC in MENA countries has been investigated by hidden cointegration and causality test for the period of 1980-2017. The most important source of motivation of the research is to contribute to the development of strategies around energy policy and even environmental policies by revealing the effect of financial development on energy demand. In addition, it is expected to contribute to the relevant literature in order to investigate the relationship between financial development and EC asymmetrically and in more depth with current econometric techniques.

2. EC and Financial Development Outlook in MENA Countries

Globalization, accompanying rapid technological progress, has a role in increasing economic activities worldwide. The size of economies across countries is compared to the volume of goods and services produced. The course of GDP around the world in the period of 1961-2019 can be seen with the help of Figure 2. It is seen that GDP is in an increasing trend all over the world as of the period exceeding half a century.

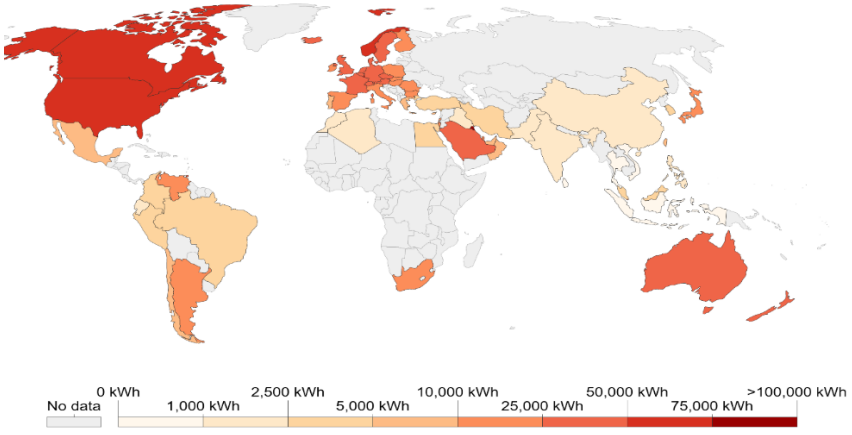
The increase in GDP, that is, the production of goods and services all over the world, has increased the demand for production factors. Considering that energy plays an important input role in the growth of countries, energy use increases. Energy use per capita in 1965 and 2019 worldwide can be compared with the maps in Figure 3 and Figure 4. EC per capita increased significantly from 1965 to 2019. Especially the increase in developing countries is more noticeable.

Figure 2. GDP around the World



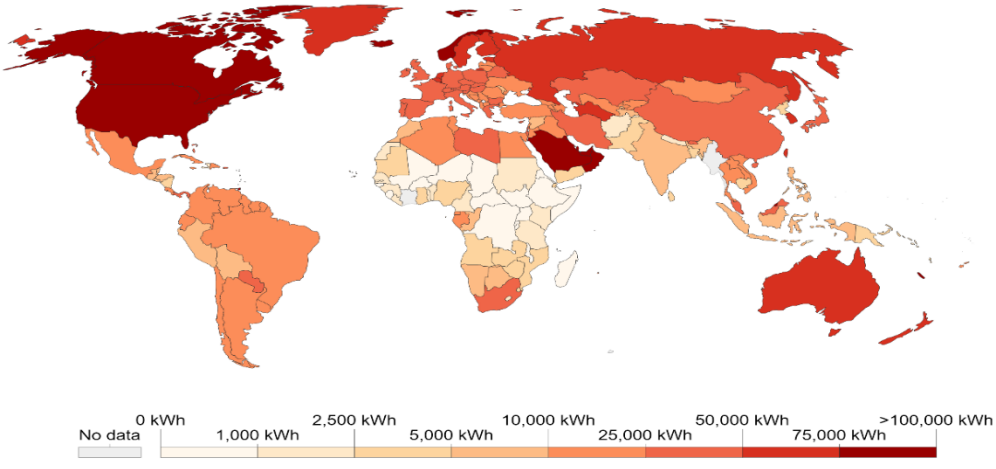
Source: World Bank (2020)

Figure 3. EC Per Capita,1965



Source: Ritchie (2020)

Figure 4. EC Per Capita, 2019

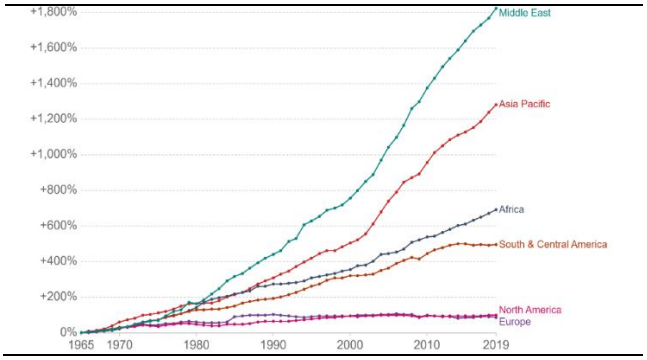


Source: Ritchie (2020)

While examining the economic growth and energy consumption, authors, such as Akinlo (2008), Chontanawat et al., (2008), Hamilton (1983), Hondroyiannis et al., (2002) Kraft and Kraft (1978) found a single, sometimes bidirectional causal relationship between two variables. Some studies claim that there is no clear link between growth and energy. Despite these complex results, the relationship between GDP and EC is that EC causes an increase in welfare.

The most important region that meets the increasing energy need is the countries in Asia Pacific and Africa, especially the Middle East, as seen in Figure 5. MENA countries, which have a say in energy production, have an important place. However, it is vital to find an answer to whether energy affects GDP growth in MENA countries.

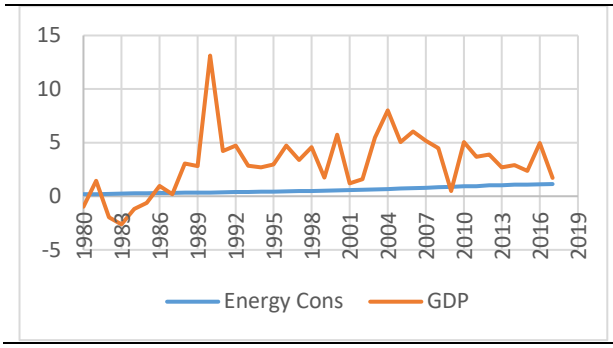
Figure 5. Regional Energy Production



Source: Ritchie (2020)

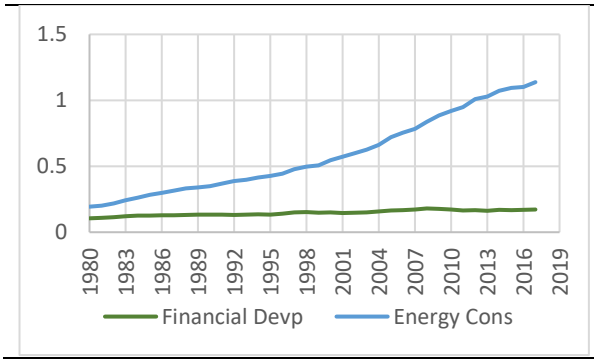
According to Figure 6, it can be said that while EC increases over time in MENA countries, GDP increase also occurs. The main concern in the research is the effect of financial development on EC in MENA countries. Parallel with it, Figure 7 reveals evidence that EC and financial development parameters act together.

Figure 6. EC and GDP in MENA Countries



Source: World Bank (2020)

Figure 7. EC and Financial Development in MENA Countries



Source: IMF (2020)

3. Literature Review

In the literature, the relationship between financial development and EC is examined in models that examine the relationship between economic growth and energy consumption, as well as direct models. The literature summary on the relationship between the EC of financial development is given in Table 2 below.

Table 2. Summary of Empirical Findings on the Financial Development-EC Nexus

Author	Period	Method	Explanation	Country/region	Results
Sadorsky (2010)	1990-2010	System GMM	FD = Stock market variables DV = Energy demand	Emerging Countries	Financial development positively affects energy consumption.
Sadorsky (2011)	1996-2016	System GMM	FD = Banking variables FD = Stock market turnover DV = Energy demand	Easter European Frontier Economies	Financial development positively affects energy consumption.
Al-mulali and Lee (2013)	1980-2009	Pedroni Cointegration Granger Causality	FD = The domestic credits to private sector DV = EC	Gulf Cooperation Council (GCC)	Financial development positively affects energy consumption. The long-run FD↔EC The short-run FD→ EC
Çoban and Topçu (2013)	1990-2011	System GMM	FD_1 = Banking Index FD_2 = Stock Market Index DV = Energy demand	EU-27	No effect
Islam et al., (2013)	1971-2009	ARDL (cointegration) Granger Causality	FD = The domestic credits to private sector (% of GDP) DV = EC	Malaysia	Positive effect The long-run FD↔EC The short-run FD→ EC
Shahbaz et al., (2013)	1975-2011	ARDL (cointegration) Granger Causality	FD = Real domestic credit to private sector DV = CO_2 emissions	Indonesia	The long-run FD →EC

Shahbaz et al., (2013)	1971-2011	ARDL (cointegration) Granger Causality	FD = Real domestic credit to private sector DV = Real domestic output	China	The long-run EC→FD
Shahbaz et al., (2013)	1971-2008	ARDL (cointegration) Granger Causality	FD = Domestic credits to private sector per capita DV = CO_2 emissions	Malaysia	The long-run FD ↔ EC
Zeren and Koç (2014)	1971-2010	Hatemi-J Asymmetric Causality	FD_1 = Privates credits to GDP FD_2 = Deposit Money Assets to GDP FD_3 = Financial system deposits to GDP	New Industrialized Countries	$EC^+ \rightarrow FD_1^+$ India, Malaysia Mexico, Turkey) $EC^- \rightarrow$ (Malaysia, Mexico, Thailand) $FD_1^+ \rightarrow EC^+$(Thailand) $FD_1^- <\neq> EC^-$(All countries) $EC^+ \rightarrow FD_2^+$ (India) $EC^- \rightarrow FD_2^-$ (Mexico, Thailand) $FD_2^+ \rightarrow EC^+$(Thailand, Turkey) $FD_2^- \rightarrow EC^-$(Turkey) $EC^+ \rightarrow FD_3^+$ (Malaysia) $EC^- \rightarrow FD_3^-$ (Phillipines, Thailand) $FD_3^+ \rightarrow EC^+$(India, Thailand, Turkey) $FD_3^- \rightarrow EC^-$(Turkey)
Ziaei (2015)	1980-2011	PVAR	FD = Stocks market development	Europe, East Asia and Ocean	Financial development has a long-term impact.
Furuoka (2015)	1980-2015	Pedroni cointegration, Dumitrescu-Hurlin Panel Symmetric and Asymmetric Causality	FD = Domestic credits to private sector (% of GDP) DV = EC	Asian Countries	There is cointegration between variables. EC →FD
Paramati et al., (2016)	1991-2012	Westerlund Cointegration, Dumitrescu-Hurlin Panel Causality	EC=Clean energy consumption FD=Stock market development DV=Clean energy consumption	Emerging Market Economies	There is cointegration between variables. FD→EC
Bekhet et al., (2017)	1980-2011	ARDL (cointegration) Granger Causality	FD = Domestic credit to private sector (% of GDP) DV = Carbon emission	GCC	The long-run FD→EC (UAE, Bahrain), EC→FD (Oman) The short-run EC→FD(UAE) EC↔FD (KSA, Oman, Bahrain, Qatar), EC<≠>FD (Kuwaite)
Shahzad et al., (2017)	1971-2011	ARDL (cointegration) Granger Causality	FD = Financial development DV = Carbon emission	Pakistan	FD↔EC
Rafindadi and Öztürk (2017)	1970-2011	ARDL, Bayer Hanck Test (cointegration)	FD = Real domestic credit to private sector DV = EC	South Africa	Positive effect The long-run FD↔EC The short-run EC<≠>FD
Liu et al., (2018)	1980-2014	ARDL (cointegration) Granger Causality	FD = Total loan to GDP DV = EC	China	Financial development positively affects energy consumption. The long-run FD↔EC The short-run FD→EC
Ouyang and Li (2018)	1996-2015	GMM Panel VAR Granger Causality	FD=Financial development	China	Positive effect EC<≠>FD (West Region) EC↔FD (East Region, Central region)
Pradhan et al., (2018)	1961, 1980, 1990-2015	Granger Causality	FD = Private credits EC = Gas consumption	Financial Action Task Force (FATF)	The long-run FD→EC
Baloch et al., (2019)	1980-2016	Westerlund Cointegration Pairwise Dumitrescu-Hurlin Panel Causality	FDPS=Financial development private sector FDBS=Financial development banking sector FDFS=Financial development financial sector DV = EC	OECD	There is a nonlinear relationship. Financial development (private sector-FDPS) positively affects energy consumption. EC→FD (FDPS, FDBS) FD→EC (FDPS, FDBS)
Gaies et al., (2019)	1996-2014	System GMM	FD_1 = Banking intermediary services	MENA	There is a nonlinear relationship. Positive effect

			FD_2 = Banking system DV = Energy demand		
Yue et al., (2019)	2006-2015	Fixed effect liner regression, PSTR Model	FD_1 =Stock markets development FD_2 = Financial openness development DV = EC	Transitional Economies	FD_1 negatively affects EC in Poland and China. FD_2 reduces EC in all countries except Georgia and Kyrgyzstan.
Hao et. al. (2020)	1995-2014	Pedroni Cointegration, Granger Causality	FD_1 = Financial efficiency FD_2 = Financial depth FD_3 = Company deposit share DV = EC	China	$FD_1 \rightarrow$ EC $EC \rightarrow FD_3$
Mukhtarov et al., (2020)	1993-2014	Johansen Cointegration Toda Yamamoto Causality	FD = Domestic credit (% of GDP) DV = EC	Kazakhstan	FD→EC Positive effect
Öcal and Han (2021)	1980-2018	Panel Quantile Regression	FD_1 =Banking sector development index FD_2 = Bond market development index DV = EC	G7 Countries	Positive effect

Notes: FD = Financial Development, DV = Dependent Variable, EC = Energy Consumption

4. Data and Econometric Method

In this study, annual data for the period of 1980-2017 are used to examine the relationship between EC and financial development. In this context, for the EC (EC), the Total Primary EC (quadrillion Btu) data obtained from the U.S. Energy Information Administration (EIA, 2021) database representing were used. To represent financial development, The Financial Development Index (FD) data obtained from the IMF Financial Development Index database were taken into account. We consider 16 selected MENA countries according to the availability of data. These countries are Djibouti, Bahrain, Egypt, Algeria, Iran, Jordan, Israel, Libya, Kuwait, Lebanon, Oman, Tunisia, Saudi Arabia, Qatar, Yemen and United Arab Emirates.

In the empirical analysis, first of all, the stationarity of variables is investigated with the panel unit root test by Im et al., (2003). Then, the Panel Hidden Cointegration test developed by Hatemi J (2011) was applied to investigate long-term relationships. Finally, the short- and long-term causality relationship between variables is investigated using the panel VECM method.

4.1. Panel Unit Root Test (Im et al., (2003))

A test has been developed by Im et al., (2003) that can be applied separately for time series belonging to all units depending on the average of unit root statistics for dynamic heterogeneous panels. In addition, it is assumed that each unit has an autocorrelation coefficient, and y_it was created by using the first-order autoregressive process:

$$y_{it} = (1 - \emptyset)\mu_i + \emptyset_i y_{i,t-1} + \varepsilon_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T \quad (1)$$

The null hypothesis for all i is H_0:∅_i=1. Equation (1),

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \varepsilon_{it} \quad (2)$$

In equation (2), $\alpha_i = (1 - \emptyset_i)\mu_i$, $\beta_i = -(1 - \emptyset_i)$ ve $\Delta y_{it} = y_{it} - y_{i,t-1}$ Accordingly, for all i's

Null hypothesis is $H_0: \beta_i = 0$,

Alternative hypothesis $H_1: \beta_i < 0, \quad \beta_i = 0, \quad i = N_1 + 1, N_1 + 2, \dots, N$.

This formulation of the alternative hypothesis is more comprehensive than alternative hypotheses of homogeneous tests, as it allows for the variation of β_i between units. ($\beta_i = \beta < 0$). The alternative standardized t-statistic computed under these conditions is as follows:

$$W_{tbar}(p,p) = \frac{\sqrt{N}\left[tbar_{NT} - \frac{1}{N}\sum_{i=1}^{N} E(t_{iT}(p_i,0)|\beta_i = 0)\right]_{T,N}}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} Var(t_{iT}(p_i,0)|\beta_i = 0)}} \rightarrow N(0,1) \quad (3)$$

In equation (3), it is calculated as follows (Im et al., 2003: 55-64; Tatoğlu, 2017: 44):

$$t - bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT_i} \quad (4)$$

4.2. Panel Hidden Cointegration Test

The hidden cointegration test developed by Granger and Yoon (2002) for time series has been expanded for panel data analysis by Hatemi-J (2011). With the panel hidden cointegration test, variables can be divided into negative and positive components, and the existence of hidden cointegration relationship can be investigated. If there is no cointegration relationship between the original variables, with this test, the variables can be divided into positive or negative components and the hidden cointegration relationship between the components can be determined. In this respect, Panel Hidden Cointegration test has a

significant advantage over other cointegration tests.

In the test, variables that are I(1) and specified by the recursive approach are included in the model:

$$y_{i,t} = y_{i,t-1} + e_{i1,t} = y_{i,0} + \sum_{j=1}^{t} e_{i1,j} \quad (5)$$

$$x_{i,t} = x_{i,t-1} + e_{i2,t} = y_{i,0} + \sum_{j=1}^{t} e_{i2,j} \quad (6)$$

i=1,2,…,*m*, and *m* represents the cross-section size while *e* represents the error term. Positive and negative components (shocks) for each variable can be represented as:

$$e_{i1,t}^{+} \coloneqq Max(e_{i1,t}, 0), \qquad e_{i2,t}^{+} \coloneqq Max(e_{i2,t}, 0) \quad (7)$$

$$e_{i1,t}^{-} \coloneqq Min(e_{i1,t}, 0), \qquad e_{i2,t}^{-} \coloneqq Min(e_{i2,t}, 0) \quad (8)$$

Accordingly, the following results are obtained:

$$y_{i,t}^{+} = y_{i,0}^{+} + e_{i1,t}^{+} = y_{i,0} + \sum_{j=1}^{t} e_{i1,j}^{+} \quad (9)$$

$$x_{i,t}^{+} = x_{i,0}^{+} + e_{i2,t}^{+} = x_{i,0} + \sum_{j=1}^{t} e_{i2,j}^{+} \quad (10)$$

$$y_{i,t}^{-} = y_{i,0}^{-} + e_{i1,t}^{-} = y_{i,0} + \sum_{j=1}^{t} e_{i1,j}^{-} \quad (11)$$

$$x_{i,t}^{-} = x_{i,0}^{-} + e_{i2,t}^{-} = x_{i,0} + \sum_{j=1}^{t} e_{i2,j}^{-} \quad (12)$$

Potential two cointegration equations between positive and negative components are as follows:

$$y_{i,t}^{+} = \propto_i^{+} + \beta_i^{+} x_{i,t}^{+} + e_{i,t}^{+} \quad (13)$$

$$y_{i,t}^{-} = \propto_i^{-} + \beta_i^{-} x_{i,t}^{-} + e_{i,t}^{-} \quad (14)$$

If $e_{i,t}^{+}$ ve $e_{i,t}^{-}$ are stationary, there is a cointegration relationship between positive and negative shocks in the panel, respectively. In terms of determining the stationarity, Augmented Dickey Fuller (ADF) is the simplest test that can be used. To test the cointegration relationship in Equation (13), the panel ADF test equation can be written as follows:

$$e_{i,t}^{+} = \rho^{+} e_{i,t-1}^{+} + \sum_{l=1}^{k} \gamma_i^{+} \Delta e_{1i,t-1}^{+} + w_{i,t}^{+} \quad (15)$$

The optimal lag length (*l*) is determined by minimizing the information criterion. The null hypothesis showing that there is no cointegration between positive components is $H_{0:}\, \rho^{+} = 1$. To test this hypothesis, the following test statistics are used in light of the results obtained by Kao (1999):

$$ADF = \frac{t_{\rho}^{+} + \sqrt{6m}x\,\frac{\sigma_v}{2\sigma_{0v}}}{\sqrt{\frac{\sigma_{0v}^2}{2\sigma_v^2} + \frac{3\sigma_v^2}{10\sigma_{0v}^2}}} \quad (16)$$

In equation (16), t_{ρ}^{+} is the t statistic for the ρ^{+} parameter in equation (15). Variance is $\sigma_v^2 = \sigma_{e_1^+}^2 - \frac{\sigma_{e_1^+,e_2^+}^2}{\sigma_{e_2^+}^2}$. Long-term variance is estimated as $\sigma_{0v}^2 = \sigma_{0e_1^+}^2 - \frac{\sigma_{0e_1^+,e_2^+}^2}{\sigma_{0e_2^+}^2}$ (Hatemi-J, 2011: 1-4).

4.3. Panel Causality Test

When the cointegration relationship between the series is determined, the two-stage vector error correction model (VECM) developed by Engle and Granger (1987) is used to investigate long-run and short-run dynamic relationships. The first stage is to estimate the long-run parameters in the models created in accordance with equations (13) and (14) in this study in order to obtain residuals associated with deviation from equilibrium. The second stage estimates the parameters associated with short-run adjustments. Accordingly, the obtained equations are handled together with the panel Granger causality test. Depending on the results, short-run causality is determined according to the statistical significance of partial F-statistics. Long run causality is explained according to the statistical significance of vector error terms using the t-test (Apergis and Payne, 2010: 1424; Hechmy, 2019: 119).

5. Empirical Findings

First, IPS unit root test was applied to determine the stationarity of variables. The results are presented in Table 3 below.

Table 3. The Results of Panel Unit Root Test

	IPS	
	Level	1.Difference
FD	-1.144	-11.295***
	(0.126)	(0.000)
EC	2.992	-11.417***
	(0.998)	(0.000)
FD^{+}	0.343	-10.779***
	(0.634)	(0.000)
EC^{+}	1.716	-10.641***
	(0.957)	(0.000)
FD^{-}	1.511	-8.354***
	(0.935)	(0.000)
EC^{-}	1.990	-10.171***
	(0.977)	(0.000)

Notes: The values in the parenthesis indicate the P-values. *, **, *** means significant at the 10%, 5%, 1% significance level, respectively.

The results in Table 3 show that both variables are stationary at the 1st degree in their original values and their positive and negative components. Therefore, since all variables have the property of I(1), the prerequisite for the cointegration test is provided. The results of the panel hidden cointegration test are given in Table 4 below.

Table 4. The Results of Panel Kao Cointegration Test

Variables (Model)	H_0: I(1), H_1: (0)
(EC, FD)	1.129 (0.129)
(EC^+, FD^+)	2.089** (0.018)
(EC^-, FD^-)	1.440 (0.075)
(EC^-, FD^+)	1.315 (0.094)
(EC^+, FD^-)	1.715** (0.043)

Notes: If the estimated test value is lower than the critical value -1.64, the null hypothesis stating that there is no cointegration is rejected at the 5% significance level. **, indicates significant at the 5% significance level.

According to the results of the cointegration test, it is proved that there is no cointegration between the original values of the variables, but there is a long-run relationship between the positive component of EC (EC+) and the positive component of financial development (FD+) and the positive component of EC (EC+) and the negative component of financial development (FD-). According to these findings, it is determined that there is a hidden cointegration between financial development and energy consumption. Depending on the determination of the cointegration relationship, the results of the short-run and long-run causality relationship tested by the Panel VECM method are shown in Table 5.

Table 5. Panel VECM Granger Causality Test Results

Panel A			
Source of Causation (Independent Variable)			
	The short-run		The Long-run
Dependent Variable	ΔEC^+	ΔFD^+	ECT(-1)
ΔEC^+	-	2.696 (0.259)	-0.219*** [-9.265]
ΔFD^+	3.599 (0.165)	-	0.026*** [5.424]
Panel B			
	ΔEC^+	ΔFD^-	ECT(-1)
ΔEC^+	-	2.153 (0.341)	-0.029*** [-2.533]
ΔFD^-	1.476 (0.478)	-	-0.010*** [-5.061]

Note: () contents denote probability values. Values in [] denote t statistic. ***, means significant at the 1% significance level.

According to the short-run causality results, it is determined that there is no causality relationship between positive shocks in EC and positive and negative shocks in financial development. According to the long-run results, it is determined that the error correction mechanism of the causality relationship from the positive component of the EC to the positive component of financial development (EC+→ FD+) does not work. However, a unidirectional causality relationship has been found from positive shocks in the financial development to positive shocks in EC (FD+→ EC+). Accordingly, it is observed that the error correction mechanism works, and the systematic deviations in the EC+ variable in the short-run disappear after about 5 periods. In addition, a bidirectional causality relationship is observed between positive shocks in EC and negative shocks in financial development (FD+↔EC-). Accordingly, the deviations in the FD+ variable in the short-run will disappear after approximately 34 periods and the deviations in the EC- variable in a very long period, that is, approximately 100 periods, and equilibrium will be restored with the error correction mechanism.

6. Conclusion and Discussion

Energy is a fundamental pillar and an urgent challenge for economic development, human well-being, and poverty reduction. The oil crisis in the 1970s has revealed how great the world's energy needs are. The reason for this is that production can only be made by consuming energy, and economies grow through production. Just like in energy, as it becomes easier to reach loans in the finance world, consumption increases or firms make new investments and thus economic growth accelerates. From this perspective, the concepts of energy and financial development, which seem to be unrelated to each other, come together due to economic growth. For today's economies, both energy and finance are considered among the determinants of sustainable growth. In this study, the cointegration and asymmetric causality relationship between EC and financial development in MENA countries in the period of 1980-2017 was investigated. Basically, the Panel Hidden Cointegration model proposed by Hatemi-J (2011) based on panel data analysis was used, and the existence of hidden cointegration relationship between EC and financial development was determined. In addition, as a result of the causality test, no relationship was found between the components of the variables in the short-run. However, in the long-run, a one-way causality relationship from the positive component of financial development to the positive component of EC and a two-way causality relationship between the positive component of EC and the negative component of financial development were observed. The emergence of the relationship between financial development and EC in the long-run is consistent with the studies in the literature. The fact that MENA countries are the center of energy in the world offers these countries an important advantage. However, the energy-based economic order causes other economic activities to progress slowly. Although the quantitative improvement of the financial structure is fast, especially in developing countries such as MENA countries, it is possible to gain qualitative strength in the long-run. The causal relationship from the positive component of financial development to the positive component of EC shows that policies aiming at changing financial development will also affect energy consumption. For example, improvement in financial development will lead to EC. On the other hand, it can be thought that a negative shock to be experienced in financial development will prevent EC because a financial shock may cause an increase in interest rates, a decrease in

credit volume, a decrease in expenditures and demands, an increase in emissions, and a decrease in savings, employment, investment, and production. In a sense, this means restricting economic activities, that is, reducing energy consumption.

The findings guide policymakers for energy and financial development, which tend to act together. The increase in the number and diversity of financial instruments and institutions as a result of financial development increases financial services per capita. Thus, the supply and demand of funds are stimulated. When the three mechanisms predicted by Sadorsky (2011) operate, production and consumption accelerate. In other words, financial development should be handled with energy because it is indispensable in energy production, especially in industry. Although the back-and-forth links of the energy sector are strong, it has a complementary role. However, the substitution of energy in production processes is very poor. For this reason, the energy need should be accurately estimated in accordance with the expanding production. Necessary infrastructure studies should be completed, and energy efficiency should be considered. It should be borne in mind that not every country has an equal chance in terms of energy resources. The biggest problem of growing economies is finding alternative energy sources instead of imported energy. Moreover, considering that the energy issue creates environmental problems, it should be emphasized that EC has hidden determinants such as financial development.

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