

Article

Financial Development, Financial Inclusion and Primary Energy Use: Evidence from the European Union Transition Economies

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Abstract: The main objective of the research is to analyze the impact of financial sector development indicators and financial institutions access on primary energy use based on a sample of European Union transition members over 20 years period (1996–2017) through panel cointegration and causality tests that allow for cross-section dependence. The causality analysis revealed that the direction of the causality among financial development indicators, financial institutions access, and primary energy use varied among the countries. On the other side, panel cointegration coefficients disclosed that the financial development index positively affected the primary energy use, but private credit did not have a significant effect on the primary energy use. Furthermore, financial institutions' access had a significant negative impact on primary energy use. However, country-level cointegration coefficients indicated that the financial development index positively affected the primary energy use in Bulgaria, Croatia, Czechia, Hungary, and Slovenia, and private credit also had a positive impact on primary energy use in Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, and Slovakia, but the effect of financial development index on primary energy use was found to be very higher than that of private credit. Moreover, financial institutions' access negatively affected the primary energy use in Croatia, Estonia, Hungary, Poland, and Romania.

Keywords: financial development; financial institutions access; primary energy use; Lagrange multiplier bootstrap cointegration test; bootstrap Granger causality test



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1. Introduction

Energy is one of the main inputs for all the production processes, considered one of the crucial components underlying economic growth and development but at the same time, we confront a lack of energy access for many people especially in African and South Asian countries [1]. Global energy use has accompanied the considerable increases in global production and consumption with the contribution of the accelerating globalization and liberalization trend in the world becoming concomitantly a key contributor to global warming and climate change.

Furthermore, global energy use is expected to increase about 50% during 2018–2050 [2] but still, the primary energy sources are fossil fuels, CO₂ emissions from their combustions being the major source of greenhouse gas emissions [3].

In this context, investigation of the main factors for energy demand can help us to understand patterns of energy production and consumption and to develop energy consumption, forecasting models. Actual context imposes substantial transformation of the global energy system: rapid transition from a system based on fossil fuels to another based

on renewable sources, adoption of innovative solutions and technologies for energy production, transmission and consumption, energy efficiency improvements in all economic sectors, etc.

The connection between economic growth and energy consumption has been intensely debated and indicated different results: some studies found unidirectional causality running from energy consumption to economic growth [4,5], others consider that a unidirectional causality exists between economic growth and energy consumption [6], and the rest found either a bidirectional relationship [7,8], either asserted that no connection exists between these variables [8]. Having in mind one of the main challenges that humanity is confronting nowadays: climate change and greenhouse gas emissions, the current studies focus more on issues like energy efficiency, solutions to decrease energy demand maintaining at the same time economic development. Therefore, it is essential to realize that the dynamics between the energy sector and economic growth are still need to be further investigated, more attention is necessary on issues like energy protection policies, patterns of energy supply and consumption, energy consumption by sector and CO₂ emissions, etc. In this context, we consider it important to analyze the impact of financial sector development on energy consumption.

Financial sector development can influence energy use through diverse direct and indirect channels. First, financial development can positively affect energy use by enhancing economic growth. Secondly, financial institutions can provide funds to the economic units at reasonable rates and maturity for purchases durable products such as refrigerators, cars, and houses etc. and, in turn, may raise the energy use [9,10]. Thirdly, a well-functioning financial system can enable the economic units to hedge in case of volatility in energy prices. On the other side, financial development can enhance the reduction of energy use by providing funds for businesses to develop energy-efficient technologies and products [11]. Therefore, the net influence of financial sector development on energy use may be changed by imposing the right policies, regulations, initiatives, by finding the proper solutions to sustain large-scale industries and companies to adopt energy efficiency measures.

Most of the scholars have discovered a positive influence of financial sector development on energy use for different countries and country groups [12–15]. Furthermore, energy use can affect the development of the financial sector, because the acquisition and use of houses, buses, cars, refrigerators, and dishwashers can influence the money needs of individuals [16]. Therefore, energy use can also affect the financial sector's development through the aforementioned indirect channels.

Financial institution access can also positively affect energy use by facilitating access to finance for both people and companies that will support investments and will increase demand for energy-intensive commodities [14]. However, financial inclusion enables the economic units to make more energy-efficient investments and to buy more energy-efficient commodities, having a direct influence on global energy consumption. Furthermore, increases in energy consumption can lead to an increased amount of funding and resources required by the economic units that in turn will affect the financial institution's access. The target of the research is to explore the impact of financial sector development indicators and financial institutions' access on primary energy use in a sample of European Union (EU) transition states. Our selected countries have undergone a remarkable institutional and economic transformation of the late 1980s with the collapse of the Soviet Block and with the contribution of EU membership negotiations and in turn, made significant improvements in both financial sector development and financial institutions access. The research was conducted through cointegration and causality tests that allowed cross-sectional dependence and heterogeneity, considering the results of pretests. However, the study duration was limited to 1996–2017, because the data for the variable of private credit by deposit money and other financial institutions were only available for 1996–2017. The findings of the study were evaluated to be useful to offer support to policymakers to develop efficient tools that can support financial development while contributing to sustainable development goals. Our main research hypotheses based on the above theoretical arguments are as following:

Hypotheses 1 (H1). *Financial sector development indicators and financial institutions' access have a significant impact on primary energy use.*

Hypotheses 2 (H2). *Primary energy use has a significant impact on financial sector development and financial institutions' access.*

This research aims to contribute to the relevant literature in three ways. Firstly, this study will be one of the pioneering studies examining the impact of financial institutions' access on primary energy use. Secondly, the study employed the financial development index of the International Monetary Fund (IMF) [17], which is calculated based on the depth, access, and efficiency of financial markets and institutions, together with private credit by deposit money bank and other financial institutions, unlike the related literature. Thirdly, the use of cointegration and causality tests that allow for heterogeneity and cross-sectional dependence lead to reach more robust findings. The forthcoming section summarized the empirical studies about the energy–finance nexus and then data and methods were briefly described; Section 4 included the empirical part of the study and the research was discussed in Section 5, followed by conclusions in Section 6.

2. Literature Review

Energy is one of the main inputs for all activities and can be classified as primary energy and secondary energy. The primary energy is extracted or captured from energy sources without its chemical and physical characteristics unchanged, but secondary energy includes the energy transformation of primary energy sources. In other words, the primary energy of fossil fuels, nuclear fuels and solar radiation may be converted to a secondary energy source such as electricity [18]. Primary energy sources are important for all sectors of the economy and since the global production and population are rapidly growing, this, in turn, will increase the energy demand, especially in emerging and developing economies [19]. The increased global energy demand is already raising the energy costs and is expected that these costs would keep their uptrend in the future. Therefore, identification of the critical factors associated with the fluctuation of energy consumption (especially it such as: population growth, industrialization, trade openness, capital stock, urbanization, financial development, and energy prices are important [20] if we want to set up strategies to foster sustainable energy consumption.

In this research, we have analyzed the effect of financial development and financial institutions' access on primary energy use. The related literature about the finance-energy nexus has reached mixed findings based on the development level of the analyzed countries, methods and the periods examined [12,14,16,21–24]. Most of the studies such as Kakar et al. [12], Bekhet et al. [13], Ma and Fu [14], Mukhtarov et al. [15], Kahouli [25] have reached the conclusion that financial sector development exerts a positive influence over energy use. Using time-series data, Kakar et al. [12] examined the influence of the financial sector development on energy use in Pakistan over the 1980–2009 period and revealed a positive influence of the sector development on energy use.

Sadorsky [16] also conducted research on the interaction between energy use and financial sector development in Bulgaria, Croatia, Estonia, Kazakhstan, Lithuania, Romania, Serbia, Slovenia and Ukraine through dynamic regression analysis and reached the same conclusion, that financial sector development raised the energy use. The findings of Xu [21] that analyzed China from 1999 to 2009 arrived at the same results, that financial development affects the demand for energy.

On the other side, Shahbaz and Lean [22] revealed a positive long-run influence of financial sector development over energy use and bidirectional causality between these variables in the case of Tunisia.

Islam et al. [26] explored the interaction among energy use, population, and production in Malaysia over the 1971–2009 period through a vector error correction model and revealed a positive influence of the development of the financial sector on energy consumption. Al-mulali and Lee [27] explored the financial development and energy consumption

nexus in the Gulf Cooperation Council (GCC) economies over the period of 1980–2019 through the Pedroni cointegration test and discovered a positive influence of financial development on energy use. Bekhet et al. [13] also conducted the same research for the GCC and reached similar findings. Using data from EU members over the 1990–2011 period, Çoban and Topcu [28] discovered a strong positive effect of financial sector development on energy consumption in EU-15 economies and an inverted U-shaped interaction between financial development proxied by bank index and energy consumption in the last twelve EU members. Investigating a sample of Organization for Economic Co-operation and Development (OECD) countries through cointegration test Başarır ve Erçakar [29] also revealed a positive influence of the development of the financial sector on energy use.

Mahalik et al. [30] researched the linkage between energy use and the development of the financial sector in Saudi Arabia over the duration of 1971–2011 through the panel ARDL approach and found that the development of the financial sector raised the energy use in the long run. Lebe and Akbaş [31] analyzed the influence of development in the financial sector on energy use for the 1960–2012 duration through the Maki cointegration test and disclosed that financial development promotes energy consumption. Kahouli [25] explored the interaction among energy use, financial development, and economic growth in Algeria, Egypt, Israel, Lebanon, Morocco, and Tunisia over the 1995–2015 period and reported a positive influence of financial development over the energy use in Morocco, Lebanon, Israel, and Algeria. Same results have also been reported by Mukhtarov et al. [32] in the case of Azerbaijan, based on a cointegration analysis conducted over the 1992–2015 period and by Mukhtarov et al. [15] that carried out an analysis through a vector error correction model based on the data from Kazakhstan that covers 1993–2014 period.

Using data for 1991–2014 collected from 120 nations, Ma and Fu [14] pointed out that financial sector development promotes energy consumption in the developing countries, but could not find a significant influence for the developed countries. Based on cointegration and causality analyses, Janpolat et al. [33] investigated 32 Belt and Road countries over the 2000–2015 period and reported the same findings, that the development of the financial sector exerts a positive influence on energy consumption.

In the relevant literature, relatively few studies have reached the conclusion that financial development contributes to the reduction of energy consumption. In this sense, Chtioui [23] employed a panel cointegration analysis to explore the influence of financial development on energy use in Tunisia over the 1972–2010 period and disclosed a negative influence of financial sector development on overall energy consumption by improving energy efficiency. On the other side, Chang [24] conducted similar research for a panel of 53 countries through threshold regression analysis and reached similar findings with Chtioui [23].

Furthermore, Altay and Topçu [34] explored the finance-energy nexus in Turkey over the 1980–2011 period and revealed no significant interaction between the two variables. The same result has been reached by Topcu and Payne [35] that examined the same relationship using 32 high-income economies during the period 1990–2014 and by Denisova [36] for the case of Germany. Moreover, in Nigeria, Ozdeser et al. [37] found a negative influence of the development of the financial sector on fossil fuel use based using the ARDL method.

Aslan et al. [38] explored the interaction among financial development, economic growth, and energy use in G7 economies and emerging economies over the 1990–2015 duration through the VAR approach and reached the conclusion that stock market development positively affected the energy use in both group countries, but banking sector development positively affected the energy use in emerging economies and decreased the energy use in G7 economies. Godil et al. [39] analyzed the factors behind energy use in India over the 1995–2018 duration through Quantile Autoregressive Distributed Lag and disclosed a positive influence of financial development over energy use.

Some scholars have explored the causal interaction between energy use and the development of the financial sector but reached different causality directions. In this context, Furuoka [40] explored the causal interaction between the development of the financial

sector and energy use in Asia countries during 1980–2012 and discovered a unilateral causality from energy use to the development of the financial sector, but Çağlar and Kubar [41] disclosed a unilateral causality from financial sector development to fossil fuel use for Turkey. Çetin [42] explored the relationship between financial sector development and energy use in Turkey for the duration of 190–2015 through the ARDL approach and disclosed that financial sector development raised the energy use and revealed a unilateral causality from financial development to energy use. Ayaydin et al. [43] and Kurt [44] also reached a unilateral causal interaction from the development of the financial sector to energy use for Turkey. Fernandes and Reddy [45] explored the determinants of energy consumption in China, India, Indonesia, Malaysia, Philippines and Thailand and disclosed a unilateral causality from financial development to energy consumption in China. Shahbaz et al. [46] discovered a bilateral causality between energy use and financial development in Pakistan. Gungor and Uzoamaka Simon [47] also disclosed a bilateral causality between financial development and energy consumption for South Africa.

3. Data and Econometric Methodology

The research investigated the impact of financial development indicators and financial institutions' access on primary energy use. In this context, the dependent variable of primary energy use was proxied by primary energy use as million tonnes of oil equivalent and was collected from BP [48]. The independent variable of financial sector development was proxied by the financial development index of IMF [17] and private credit by deposit money banks and other financial institutions as a percent of gross domestic product (GDP) by World Bank [49]. The financial development index is calculated based on the access, depth, and efficiency of financial markets and institutions. On the other side, financial institutions access was represented by the financial institutions access the index of IMF [17] and the index is calculated based on bank branches and ATMs per 100,000 adults, bank accounts per 1000 adults, the percent of firms with a line of credit, and usage of mobile phones to send and receive money considering the lack of similar data for insurance companies, mutual funds and pension funds (see Svirydzenka [50] for detailed information about the methodology of financial development index and financial institutions index.). All the variables in Table 1 were annual, and the study period was specified as 1996–2017, because the private credit by deposit money banks and other financial institutions existed between the 1996–2017 period.

Table 1. Data description.

| Variables | Description | Source |
|-----------|---|-----------------|
| ENERGY | Primary energy consumption (million tonnes oil equivalent) | BP [48] |
| FDI | Financial development index | IMF [17] |
| PCREDIT | Private credit by deposit money banks and other financial institutions to GDP (%) | World Bank [49] |
| FIA | Index of financial institutions access | IMF [17] |

The eleven EU transition states constituted the sample of the research. The software programs of Gauss 10.0 (APTECH Systems, Higley, AZ, USA), EViews 11.0 (HIS Global, Irvine, CA, USA), and Stata 15.0 (StataCorp LLC, TX, USA) have been used in the econometric analyses. The main characteristics of the series were denoted in Table 2. The average primary energy consumption was 24.34 million tonnes of oil-equivalent, but considerably varied among the countries. On the other hand, the mean of financial development index was 0.33, the mean of private credits by deposit money banks and other financial institutions was 42.55% of GDP and the average financial institutions access index was 0.502 during the study duration, but the variable of private credits by deposit money banks and other financial institutions exhibited considerable variation among the countries.

Table 2. Main characteristics of the series.

| Characteristics | ENERGY | FDI | PCREDIT | FIA |
|-----------------|----------|----------|----------|----------|
| Mean | 24.22727 | 0.341942 | 42.55798 | 0.525661 |
| Median | 17.45000 | 0.320000 | 42.75970 | 0.500000 |
| Maximum | 103.4000 | 0.580000 | 102.5380 | 0.930000 |
| Minimum | 3.200000 | 0.110000 | 6.392100 | 0.150000 |
| Std.Dev. | 25.63619 | 0.111437 | 19.85068 | 0.196679 |
| Skewness | 1.827448 | 0.076805 | 0.302910 | 0.363396 |
| Kurtosis | 5.582011 | 2.103280 | 2.772085 | 2.485036 |

In making a choice among the econometric tests, the heterogeneity and cross-sectional dependence firstly should be checked. In this sense, ignoring the existence of cross-sectional dependency would probably lead to bias and size distortions in the econometric analysis [51,52]. Furthermore, the existence of heterogeneity is fundamental for econometric analyses. The homogeneity presupposition of panel parameters cannot regard the heterogeneity between the cross-sections resulting from country-specific characteristics [53].

The econometric tests of heterogeneity and cross-sectional dependence denoted the existence of heterogeneity and cross-sectional dependence among the series therefore the cointegration and causality interactions among financial development indicators, financial institutions access and primary energy use were examined by employing Westerlund and Edgerton [54] Lagrange multiplier (LM) bootstrap cointegration test and Konya [55] bootstrap Granger causality test which takes into account the cross-sectional dependence and heterogeneity. Westerlund and Edgerton [54] cointegration test counts on the cross-sectional dependence and allows heteroskedasticity and autocorrelation in the cointegration equation and also regards the possible endogeneity problem through the use of bootstrap fully modified ordinary least squares. Therefore, the cointegration produces relatively more robust results when compared with the first-generation cointegration tests.

The Konya [55] bootstrap Granger causality test is based on seemingly unrelated regression (SUR) and the critical values of the test are derived for each country through the bootstrap process. For this reason, integration levels of variables are not necessary for the test application. The causality test relies on the SUR estimations below:

$$\begin{aligned}
 y_{i,t} &= \alpha_{1,1} + \sum_{i=1}^{ly_1} \beta_{1,1,i} y_{1,t-i} + \sum_{i=1}^{lx_1} \gamma_{1,1,i} \chi_{1,t-i} + \varepsilon_{1,1,t} \\
 y_{2,t} &= \alpha_{1,2} + \sum_{i=1}^{ly_1} \beta_{1,2,i} y_{2,t-i} + \sum_{i=1}^{lx_1} \gamma_{1,2,i} \chi_{2,t-i} + \varepsilon_{1,2,t} \\
 y_{N,t} &= \alpha_{1,N} + \sum_{i=1}^{ly_1} \beta_{1,N,i} y_{N,t-i} + \sum_{i=1}^{lx_1} \gamma_{1,N,i} \chi_{N,t-i} + \varepsilon_{1,N,t}
 \end{aligned} \tag{1}$$

and:

$$\begin{aligned}
 \chi_{1,t} &= \alpha_{2,1} + \sum_{i=1}^{ly_2} \beta_{2,1,i} y_{1,t-i} + \sum_{i=1}^{lx_2} \gamma_{2,1,i} \chi_{1,t-i} + \varepsilon_{2,1,t} \\
 \chi_{2,t} &= \alpha_{2,2} + \sum_{i=1}^{ly_2} \beta_{2,2,i} y_{2,t-i} + \sum_{i=1}^{lx_2} \gamma_{2,2,i} \chi_{2,t-i} + \varepsilon_{2,2,t} \\
 \chi_{N,t} &= \alpha_{2,N} + \sum_{i=1}^{ly_2} \beta_{2,N,i} y_{N,t-i} + \sum_{i=1}^{lx_2} \gamma_{2,N,i} \chi_{N,t-i} + \varepsilon_{2,N,t}
 \end{aligned} \tag{2}$$

In the above equations, primary energy use is represented by y , the financial development index is represented by x in the first system; y indicates the primary energy use and x indicates the financial institution access index in the second system. In this sense, a significant one-way causality from x to y is accepted if not all the $\gamma_{1,j,i}$ s are 0, but all $\beta_{2,j,i}$ s are 0. On the other hand, a significant one-way causality from y to x is accepted if all $\gamma_{1,j,i}$ s are 0, but not all $\beta_{2,j,i}$ s are 0. Lastly, a mutual causality between x and y is accepted if neither $\gamma_{1,j,i}$ s nor $\beta_{2,j,i}$ s are zero.

4. Empirical Analysis

In the applied part, heterogeneity and cross-sectional dependence were firstly checked to make a choice among the causality tests. Therefore, cross-sectional dependence was checked by using LM, LM CD (cross-section dependence), and LM_{adj.} tests, respectively developed by Breusch and Pagan [56], Pesaran [57], and Pesaran et al. [58], and the tests' findings were denoted in Table 3. The probability values of the three tests were lower than 5%, therefore, the null hypothesis of cross-sectional independence was declined and the existence of cross-sectional dependence among the countries was reached.

Table 3. Cross-sectional dependence tests' findings.

| Test | Test Statistic | Prob. (Critical Values at 5% Significance Level) |
|----------|----------------|--|
| LM | 144 | 0.0000 (11.15) |
| LM adj * | 17.95 | 0.0000 (9.50) |
| LM CD * | 8.512 | 0.0000 (5.75) |

* two-sided test.

The presence of heterogeneity is also important for causality test selection. Therefore, heterogeneity presence was checked with delta tilde tests of Pesaran and Yamagata [59], and the results of the two tests were revealed in Table 4. The probability values of the tests were lower than 5%, therefore, the null hypothesis of homogeneity was declined and heterogeneity presence was reached. In the light of the findings, employment of causality test-taking notices of heterogeneity and cross-sectional dependence help us to obtain more robust results.

Table 4. Homogeneity tests' findings.

| Test | Test Statistic | Prob. (Critical Values at 5% Significance Level) |
|-----------------|----------------|--|
| Δ | 7.598 | 0.000 (5.80) |
| $\Delta_{adj.}$ | 8.643 | 0.000 (4.20) |

The presence of unit root in the series was checked by Pesaran [60] CIPS (Cross-sectionally augmented IPS (Im, Pesaran and Shin [61])) test given the presence of cross-sectional dependence and the findings were presented in Table 5. The unit root test results indicated that all series were I(1).

The cointegrating relationship among primary energy use, indicators of financial sector development, and financial institutions access was checked by employing the LM bootstrap cointegration test of Westerlund and Edgerton [54] and the findings were exposed in Table 6. The null hypothesis of significant cointegration interaction among the series was accepted given the bootstrap probability values and the significant cointegration relationship among the variables was concluded.

Table 5. Unit root test.

| Variables | Constant | | Constant + Trend | |
|------------|----------|-------------------|------------------|-------------------|
| | Zt-Bar | Probability Value | Zt-Bar | Probability Value |
| ENERGY | 3.266 | 0.999 | 1.193 | 0.883 |
| d(ENERG) | −6.228 | 0.000 | −5.099 | 0.000 |
| FDI | 0.905 | 0.817 | −0.578 | 0.282 |
| d(FDI) | −2.929 | 0.002 | −6.482 | 0.282 |
| PCREDIT | −0.224 | 0.411 | 2.551 | 0.995 |
| d(PCREDIT) | −2.764 | 0.003 | −2.506 | 0.006 |
| FIA | −1.121 | 0.131 | −1.104 | 0.135 |
| d(FIA) | −2.774 | 0.003 | −2.414 | 0.008 |

Table 6. Panel cointegration test.

| Test Statistic | Constant | | Test Statistic | Constant and Trend | |
|----------------|------------------------------|-----------------------------|----------------|------------------------------|-----------------------------|
| | Asymptotic Probability Value | Bootstrap Probability Value | | Asymptotic Probability Value | Bootstrap Probability Value |
| 4.509 | 0.000 | 0.890 | 6.422 | 0.000 | 0.970 |

Note: Bootstrap critical values were derived from 10,000 simulations and lag and lead values were taken as 1.

The cointegration coefficients were estimated through the Augmented Mean Group (AMG) estimator of Eberhardt and Teal [62] and were presented in Table 7. The panel-level cointegration analysis indicated that financial development proxied by the financial development index had a significant positive impact on primary energy use, but financial institutions access had a significant negative impact on primary energy use. Furthermore, the country level coefficients revealed that financial development proxied by the financial development index positively affected the primary energy use in Bulgaria, Croatia, Czechia, Hungary, and Slovenia and private credits by banks and other financial institutions also had a positive impact on primary energy use in Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, and Slovakia, but the effect of financial development index on primary energy use was found to be very higher than that of private credits by banks and other financial institutions. On the other side, the effect of financial institutions' access on primary energy use was negative in Croatia, Estonia, Hungary, Poland, and Romania, and positive only in the case of Lithuania.

The causal interaction among financial development indicators, financial institutions access, and primary energy use in a sample of EU transition economies was explored through bootstrap Granger causality test and test findings were denoted in Tables 8–10. The causality analysis between financial development index and primary energy use disclosed a unilateral causality from financial development index to primary energy use in Lithuania and Poland, and a unilateral causality from primary energy use to financial development index in Latvia, Romania, Slovakia, and Slovenia.

On the other side, the causality analysis between financial development proxied by private credits by deposit money banks and other financial institutions and primary energy use indicated a unilateral causality from private credits by banks and other financial institutions to primary energy in Latvia, a unilateral causality from primary energy use to private credits by deposit money banks and other financial institutions in Croatia, Hungary, Poland, and Slovenia, and a bilateral causality between the series in the case of Czechia.

The results of causality analysis between financial institutions access and primary energy use revealed a unilateral causality from financial institutions access to primary energy use in Romania and Slovakia, a unilateral causality from primary energy use to financial institutions access in Croatia and Lithuania and a bilateral causality in Czechia.

Table 7. Estimation of cointegrating coefficients.

| Country | FDI | PCREDIT | FIA |
|-----------|-------------|------------|--------------|
| Bulgaria | 9.3329 *** | 0.0432 * | −0.3885 |
| Croatia | 11.7707 *** | 0.0511 | −9.0606 *** |
| Czechia | 12.4426 ** | 0.0987 * | −11.4918 |
| Estonia | 14.6545 | 0.0215 ** | −6.4027 ** |
| Hungary | 29.4532 *** | 0.0804 ** | −17.4174 *** |
| Latvia | 4.3393 | 0.00071 | −0.8668 |
| Lithuania | 8.3183 | 0.1246*** | 9.107 ** |
| Poland | 31.8007 | 0.6293 * | −46.6360 * |
| Romania | 20.6391 | 0.0296 | −18.1561 * |
| Slovakia | 1.3160 | 0.0682 *** | −7.7112 |
| Slovenia | 2.0616 ** | 0.0002 | 1.4355 |
| Panel | 13.2845 *** | 0.0234 | −9.7807 ** |

***, **, and * indicates it is respectively significant at 1%, 5%, and 10%; Source: own processing.

Table 8. Causality analysis between the financial development index and primary energy consumption.

| Countries | H ₀ : FDI Is Not the Cause of Energy | | | | H ₀ : Energy Is Not the Cause of FDI | | | |
|-----------|---|------------------------|----------|----------|---|-------------------------|----------|----------|
| | Wald St. | Bootstrap Critic Value | | | Wald St. | Bootstrap Critic Values | | |
| | | 1% | 5% | 10% | | 1% | 5% | 10% |
| Bulgaria | 0.4006 | 26.67847 | 13.55287 | 9.00102 | 2.2946 | 39.06666 | 19.72467 | 12.79664 |
| Croatia | 0.7018 | 34.51029 | 16.45071 | 10.77189 | 2.7336 | 26.86199 | 14.97572 | 10.21100 |
| Czechia | 5.3645 | 31.95752 | 16.96166 | 11.44204 | 0.2666 | 33.10591 | 17.81830 | 12.22203 |
| Estonia | 9.6069 | 37.75689 | 19.86430 | 13.40915 | 1.9819 | 36.81016 | 20.08998 | 13.78954 |
| Hungary | 5.3296 | 28.74907 | 15.98021 | 10.85757 | 6.3971 | 35.82092 | 18.03127 | 12.48281 |
| Latvia | 2.8344 | 33.85149 | 17.77009 | 11.58308 | 9.0389 * | 24.96835 | 12.90118 | 8.64302 |
| Lithuania | 13.162 * | 33.28920 | 17.28678 | 12.13703 | 1.8850 | 32.76813 | 17.96951 | 12.17321 |
| Poland | 13.635 * | 35.83556 | 18.66600 | 12.72647 | 3.4616 | 36.02957 | 18.54708 | 12.68043 |
| Romania | 0.1885 | 35.88219 | 17.99552 | 12.24344 | 25.584 ** | 37.26994 | 20.63097 | 14.30034 |
| Slovakia | 0.3006 | 28.65764 | 13.88025 | 9.35830 | 21.065 ** | 28.85599 | 16.30899 | 11.08176 |
| Slovenia | 2.8032 | 36.13179 | 18.04382 | 11.82997 | 13.805 ** | 29.10432 | 15.54230 | 11.07975 |

**, * respectively indicates that it is significant at 5%, 10%.

Table 9. Causality analysis between private credits and primary energy consumption.

| Countries | H ₀ : Pcredit Is Not the Cause of Energy | | | | H ₀ : Energy Is Not the Cause of Pcredit | | | |
|-----------|---|------------------------|----------|----------|---|-------------------------|----------|----------|
| | Wald St. | Bootstrap Critic Value | | | Wald St. | Bootstrap Critic Values | | |
| | | 1% | 5% | 10% | | 1% | 5% | 10% |
| Bulgaria | 0.2176 | 27.63072 | 14.68623 | 10.07791 | 1.5707 | 32.94590 | 16.63359 | 11.08531 |
| Croatia | 2.1805 | 28.26325 | 15.22205 | 10.49066 | 12.724 * | 32.86288 | 16.63140 | 11.18377 |
| Czechia | 46.236 *** | 40.19300 | 20.69382 | 14.23874 | 53.862 *** | 35.79637 | 18.11481 | 12.63455 |
| Estonia | 5.6867 | 37.08983 | 18.90815 | 13.20339 | 1.1105 | 37.03863 | 19.38042 | 13.50000 |
| Hungary | 2.3175 | 36.17370 | 19.13005 | 13.30780 | 76.384 *** | 38.53119 | 20.26179 | 14.08773 |
| Latvia | 9.2645 * | 24.30420 | 12.64270 | 8.66469 | 0.1669 | 37.87162 | 20.44536 | 14.46659 |
| Lithuania | 4.7854 | 31.62632 | 17.16496 | 11.69833 | 11.560 | 37.72914 | 20.39363 | 14.23688 |

Table 9. Cont.

| Countries | H ₀ : Pcredit Is Not the Cause of Energy | | | | H ₀ : Energy Is Not the Cause of Pcredit | | | |
|-----------|---|------------------------|----------|----------|---|-------------------------|----------|----------|
| | Wald St. | Bootstrap Critic Value | | | Wald St. | Bootstrap Critic Values | | |
| | | 1% | 5% | 10% | | 1% | 5% | 10% |
| Poland | 8.1733 | 37.59888 | 21.50852 | 15.01293 | 8.9713 * | 23.85979 | 12.53312 | 8.39434 |
| Romania | 8.7325 | 32.94564 | 18.07043 | 12.29582 | 12.881 | 41.45920 | 22.49262 | 15.55226 |
| Slovakia | 1.4713 | 36.94018 | 18.53431 | 12.56840 | 8.8233 | 35.80409 | 19.78699 | 13.60470 |
| Slovenia | 2.7451 | 28.14703 | 15.29530 | 10.66410 | 29.586 ** | 41.49527 | 21.86419 | 14.85829 |

******, ******, * indicates that it is significant at 1%, 5% and 10%.

Table 10. Causality analysis between financial institutions accesses and primary energy consumption.

| Countries | H ₀ : FIA Is Not the Cause of Energy | | | | H ₀ : Energy Is Not the Cause of FIA | | | |
|-----------|---|------------------------|----------|----------|---|------------------------|----------|----------|
| | Wald St. | Bootstrap Critic Value | | | Wald St. | Bootstrap Critic Value | | |
| | | 1% | 5% | 10% | | 1% | 5% | 10% |
| Bulgaria | 3.0605 | 25.96186 | 13.90103 | 9.67348 | 2.1632 | 30.27421 | 16.07647 | 10.61107 |
| Croatia | 2.8364 | 30.03195 | 15.07134 | 10.43451 | 15.729 ** | 29.03331 | 15.05772 | 10.22306 |
| Czechia | 14.343 * | 36.28749 | 19.47985 | 13.28411 | 11.582 * | 28.38119 | 14.71876 | 9.84669 |
| Estonia | 0.3065 | 40.99779 | 21.76701 | 14.64907 | 8.2643 | 36.04422 | 19.21063 | 13.36456 |
| Hungary | 8.3000 | 35.28400 | 18.85081 | 13.08202 | 2.2852 | 26.80771 | 14.16399 | 9.55937 |
| Latvia | 4.8194 | 24.07212 | 13.34364 | 8.95185 | 2.4580 | 31.98911 | 16.12541 | 11.22346 |
| Lithuania | 3.0451 | 32.82661 | 16.87194 | 11.75151 | 11.1823 * | 29.59585 | 15.52793 | 10.64909 |
| Poland | 5.4631 | 41.41375 | 21.77966 | 14.83314 | 0.1232 | 26.53811 | 13.94197 | 9.21189 |
| Romania | 15.844 * | 35.76161 | 18.13337 | 12.42248 | 0.9986 | 38.38235 | 19.02732 | 13.09244 |
| Slovakia | 21.285 ** | 29.48135 | 16.11610 | 11.38036 | 3.6843 | 28.59840 | 14.69981 | 9.57808 |
| Slovenia | 3.1894 | 27.99279 | 15.33151 | 10.70887 | 0.8259 | 36.28547 | 17.78769 | 12.03944 |

******, * indicates that it is respectively significant at 5% and 10%.

5. Discussion

The panel-level cointegration coefficients revealed that financial development proxied by the financial development index had a positive impact on primary energy use, but private credit by deposit money banks and other financial institutions did not have a significant effect on primary energy use. The financial development index is calculated based on the access, depth, and efficiency of financial markets and institutions, but private credit by deposit money banks and other financial institutions is a bank-based indicator. Therefore, the financial development index reflects all the aspects of the financial system. On the other side, the country level coefficients revealed that financial development proxied by the financial development index positively affected the primary energy use in Bulgaria, Croatia, Czechia, Hungary, and Slovenia and financial development proxied by private credits by banks and other financial institutions also had a positive impact on primary energy use in Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, and Slovakia, but the effect of financial development index on primary energy use was found to be higher than that of private credits by banks and other financial institutions. So, the country-level cointegration coefficients also verify that the financial development index is more inclusive than the variable of private credit.

A well-functioning financial system can provide funds to the economic units at reasonable rates and maturity and this can contribute to production expansion that in turn will raise energy consumption. On the other side, a well-developed financial system may increase the access of the consumers to the credit markets to buy more energy consumer products that obviously will influence energy consumption. Furthermore, the findings of cointegration analysis were found to be compatible with the empirical findings of Kakar et al. [12], Bekhet et al. [13], Ma and Fu [14] Mukhtarov et al. [15], and Kahouli [25].

However, our findings were not consistent with Çoban and Topcu [28] that analyzed the same issue in a sample of EU states during 1990–2011 by dynamic regression analysis. We evaluated that the contradiction can result from different financial development indicators, study duration, and methods.

The cointegration analysis revealed that financial institutions' access negatively affected the primary energy use at panel level and in a series of countries like Croatia, Estonia, Hungary, Poland, and Romania, but positively affected only Lithuania. So, the findings indicated that financial institutions access enabled the economic units to make more energy-efficient investments and buy more energy-efficient products.

The bootstrap Granger causality analysis disclosed a unilateral causality from financial development index to primary energy use in Lithuania and Poland, and a unilateral causality from primary energy use to financial development index in Latvia, Romania, Slovakia, and Slovenia. On the other side, a unilateral causality running from private credits by banks and other financial institutions to primary energy was noticed in Latvia, and a unilateral causality from primary energy use to private credits by deposit money banks and other financial institutions was found in Croatia, Hungary, Poland, and Slovenia. A bilateral causality between series was reported in Czechia. Furthermore, the causality analysis between financial institutions access and primary energy use revealed a unilateral causality from financial institutions access to primary energy use in Romania and Slovakia, a unilateral causality from primary energy use to financial institutions access in Croatia and Lithuania and a bilateral causality in Czechia. The causality direction varied from country to country depending on country-specific characteristics, the results being similar with other empirical findings: Furuoka [40], Çağlar and Kubar [41], Çetin [42], Fernandes and Reddy [45], Shahbaz et al. [46], and Gungor and Uzoamaka Simon [47].

6. Conclusions

Energy is a vital resource for all economic sectors and for all the economic units. Therefore, identifying the major factors which affect energy consumption is important for designing and implementing the right policies for the public and private sector. Improving the standard of living is the key to sustainable development but this can result in an increased demand for goods and services that in turn will increase energy consumption. Investments in energy-efficient technologies, development of energy-efficient products must be the solution for sustainable development, but this implies that all involved stakeholders understand and sustain the transition to a sustainable future. Right policies and regulations imposed by governments, combined with subsidies to promote renewable energy production and consumption, incentives for investments in renewable energy technologies, low-interest loans for renewable energy projects can have a major impact on a future country's development.

In this sense, this research analyzed the causality among financial development indicators, financial institutions access, and primary energy use in EU transition states during 1996–2017 through LM bootstrap cointegration and bootstrap Granger causality tests. The causality analysis between financial development indicators and primary energy use revealed a unilateral causality from financial development index to primary energy use in Lithuania and Poland, a unilateral causality from private credits by banks and other financial institutions to primary energy in Latvia, a unilateral causality from primary energy use to financial development index in Latvia, Romania, Slovakia, and Slovenia, a unilateral causality from primary energy use to private credits by deposit money banks and other financial institutions in Croatia, Hungary, Poland, and Slovenia, and a bilateral causality between private credits by deposit money banks and other financial institutions and primary energy use in Czechia.

The panel-level cointegration analysis disclosed that the financial development index had a significant positive impact on primary energy use, but private credits by banks and other financial institutions did not have a significant effect on primary energy use and financial institutions' access had a significant negative impact on primary energy

use. Furthermore, the country-level cointegration coefficients revealed that the financial development index positively affected the primary energy use in Bulgaria, Croatia, Czechia, Hungary, and Slovenia and the variable of private credits by banks and other financial institutions also had a positive impact on primary energy use in Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, and Slovakia, but the effect of financial development index on primary energy use was found to be higher than that of private credits by banks and other financial institutions. Lastly, the effect of financial institutions' access on primary energy use was found to be negative in Croatia, Estonia, Hungary, Poland, and Romania, but positive in Lithuania.

The positive effect of two financial development indicators on primary energy use verified that a well-functioning financial sector is an important factor for the economies given the finance-energy nexus. Furthermore, the financial sector also enables the economic units to hedge against the volatility in energy prices in the globalized world. However, the negative effect of financial institutions' access on primary energy use indicated that the increasing financial institution's access fosters investments in energy-efficient technologies and influences purchases of energy-efficient products. Primary energy use affects the financial development in some countries from our sample by increasing the amount of funds required for energy efficiency investments, for purchasing energy-efficient products, etc.

The policy-makers can develop an optimal environment that helps the financial system to operate efficiently and encourage the economic units to use different financial services and, in turn, raise the access, depth, and efficiency of this sector. Furthermore, a developed financial sector can also contribute to economic growth through the energy–finance nexus.

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