

Enerji Verimliliği Finansal Gelişmişliğin Nedeni midir? Yatay Kesit Bağımlılığı Altında Panel Nedensellik Analizi

Is Energy Efficiency the Cause of Financial Development? Panel Causality Analysis Under Cross-Section Dependence

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Öz: Enerji verimliliğinin sağlanması hükümet, reel sektör ve akademik kesim ekseninde önem arz eden bir konu haline gelmiş olup, enerji verimliliğinin artırılması, gelişmiş ve gelişmekte olan ekonomilerde iklim değişikliğiyle başa çıkmanın ve karbon emisyonlarını azaltmanın en etkili yollarından biri olarak kabul edilmeye başlamıştır. Daha fazla çıktı, daha az girdi stratejilerinin sadece yatırımların teknolojik alt yapıya yönlendirmesi neticesinde sağlanabileceği de su götürmez bir gerçek olarak göze çarpmaktadır. Bu durum çerçevesinde kaynakların etkin kullanılması ve bu sayede enerji verimliliğinin artırılmasına yönelik çeşitli faaliyetler ancak teknolojik yatırımlara önemli düzeyde destek olabilecek finansal gelişmişlik ile birlikte sağlanabilir. Söz konusu çalışmada da enerji verimliliği ve finansal gelişmişlik arasında bir nedensellik ilişkisinin olup olmadığı test edilmiştir. 32 Avrupa ülkesinin finansal gelişmişlik endeksi ve enerji verimliliği endeksinin 1998 ile 2017 tarihleri arasındaki yıllık verileri kullanılmıştır. Emirmahmutoğlu ve Köse (2011) panel nedensellik analizinin kullanıldığı çalışmada elde edilen bulgular panelin geneli için finansal gelişmişlik ile enerji verimliliği arasında çift yönlü nedensellik ilişkisinin söz konusu olduğuna işaret etmektedir. Analize dâhil edilen ülkelerin özeline bakıldığında ise enerji verimliliğinden finansal gelişmişliğe doğru nedenselliğin Finlandiya, Fransa, Kıbrıs Rum Kesimi, Hırvatistan, İsveç, İtalya, İzlanda, Letonya, Litvanya, Lüksemburg, Macaristan ve Norveç için geçerli olduğu tespit edilmiştir. Finansal gelişmişlikten enerji verimliliğine doğru nedenselliğin İsveç, İtalya, Polonya, Portekiz, Romanya, Slovakya ve Yunanistan için geçerli olduğu görülmektedir.

Anahtar Kelimeler: Enerji Verimliliği, Finansal Gelişmişlik, Panel Nedensellik

JEL Sınıflandırması: C50, G00, Q40

Abstract: Ensuring energy efficiency has become an important issue in the axis of the government, the real sector and the academic sector, and increasing energy efficiency has begun to be accepted as one of the most effective ways to cope with climate change and reduce carbon emissions in developed and developing economies. It is a known fact that more output and less input strategies can only be achieved as a result of directing investments to technological infrastructures. Within the framework of this situation, various activities for the effective use of resources and thus increasing energy efficiency can only be achieved with financial development that can significantly support technological investments. In this study, it is aimed to test whether there is a causal relationship between energy efficiency and financial development. Annual data of 32 European countries (financial development index and energy efficiency index between 1998 and 2017) were used. Emirmahmutoğlu and Köse (2011) used panel causality analysis, the findings obtained in the study for the panel in general indicate that there is a bidirectional causality relationship between financial development and energy efficiency. is pointing. When the specific countries included in the analysis are examined, it has been determined that the causality from energy efficiency to financial development is valid for Finland, France, Greek Cyprus, Croatia, Sweden, Italy, Iceland, Latvia, Lithuania, Luxembourg, Hungary and Norway. The causality from financial development to energy efficiency is valid for Sweden, Italy, Poland, Portugal, Romania, Slovakia and Greece.

Keywords: Energy Efficiency, Financial Development, Panel Causality

JEL Classifications: C50, G00, Q40

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1. Introduction

Globally increasing environmental problems and the consequent increase in environmental problems without slowing down cause an increase in the interest in energy efficiency and energy efficiency. However, various studies point out that institutions and organizations want to make higher profits as the reason for the noticeable increase in energy efficiency. Regardless of the purpose, energy efficiency has important benefits in many ways and in order to increase energy efficiency, it is necessary to give importance to issues such as renewable energy, economic development and financial development. (Zakari vd., 2022:2).

In order to increase financial development, which is a leading concept in the economic growth of developed and developing countries, ensuring financial stability is a significant criterion, and capital markets and banks must be in an effective functioning. The literature has started to be a subject since the 2000s, and in the study of Aslan and Korap (2006). Financial development is expressed in two different contexts. The first scope deals with financial expansion, while the second scope focuses on financial depth. When these two scopes are considered together, financial expansion or development indicates the development and professionalization in financial services with the expansion and increase of the financial sector. On the other hand, financial depth expressed is the increase and rise in the ratio of financial assets to income, which is the result of the said development and professionalization (Bağcı, 2018: 238-239).

When the literature is examined, it is reached that important determinants in increasing energy efficiency are tried to be determined with different variables and statistical analyzes. Financial development level has been included in these variables recently. Testing the relationship between sustainable economic development and energy efficiency, Ganda (2014), Türkoğlu and Kardoğan (2017), Jiang et al. (2021), although they are important studies that reach the existence of the relationship between sustainable economic development and energy efficiency, they do not test the impact of financial development on the environment and energy efficiency.

Although empirical studies testing the effect of financial development on energy efficiency are not common, studies such as Birdsall and Wheeler (1993), Frankel and Romer (1999), Tamazian and Rao (2010), Jalil and Feridun (2011) This indicates that there may be an increase in investments, and that these investments may have visible effects on ensuring energy efficiency. Indicators related to financial development can be related not only with energy efficiency, but also with environmental awareness, which is one of the important variables in ensuring energy efficiency, and explanations of this sensitivity. Lanoie et al. (1998), Dasgupta

et al. (2001) and Dasgupta et al. (2006) reached findings showing that there is a significant increase in market values as a result of public disclosure and rewarding of publicly traded companies that make environmentally friendly production, Dasgupta et al. (2006) also found that companies that do not produce in compliance with environmental laws may experience decreases in company values.

The need for technological infrastructure, which is gaining importance day by day, maintains its necessity at the stage of minimizing environmental pollution. The most essential factor among the driving forces of technological systems, which is an important variable in the fight against environmental pollution, is the level of financial development of countries.

Studies such as Tadesse (2005) and Claessens and Feijen (2007) show that financial development has an important role in providing new technologies to protect the environment, and in this study, the effect of financial development on energy efficiency will be tested under the assumption that savings will be directed to the economy in case of a developed financial system.

In this context, the aim of this study is to test whether there is a causal relationship between energy efficiency and financial development for 32 different countries. In this way, it is thought that it will contribute to the limited literature by testing whether financial development is a determinant of energy efficiency or whether energy efficiency is a reason for financial development.

The study consists of five parts. While the first part expresses the general purpose framework of the study, the second part includes the previous studies that test the relationship between variables such as economic growth, renewable energy and energy consumption and energy efficiency, while a limited number of studies that test the relationship between financial development and energy efficiency are included. In the third part, the statistical background of Emirmahmutoğlu and Köse (2011) panel causality analysis and assumptions is given, while the fourth part includes the findings. In the last part of the study, which is the conclusion and recommendations part, various suggestions were made by evaluating the findings and similar studies in the past.

2. Literature Review

The concept of financial development, which has become the most striking subject of recent years, is tried to be associated with many concepts. While many studies can be found on whether the concept in question is related to concepts such as economic growth, renewable energy and energy consumption, it is very difficult to reach studies that test the relationship between

financial development and energy efficiency. In fact, when empirical studies with different variables pointing to financial development using different econometric analyzes are examined, it is seen that some of the findings obtained are that variables such as economic growth, renewable energy and energy consumption have statistically significant effects on financial development, while in some studies there is a significant effect. indicates that it is not. As stated in this section, a literature review will be conducted on empirical studies using different variables that are thought to be the cause of financial development.

In the Schumpeter (1911) study, which is the first study to test the relationship between financial development and economic growth, it is emphasized that financial development supports economic development (King and Levine, 1993: 717). While this situation shows the relationship between financial development and economic growth, after the said study, numerous studies in which many different analyzes and countries have started to take their place in the literature.

When the studies that test the causality relationship between economic growth and financial development are examined, the current studies such as Murinde and Eng (1994), Ahmed and Ensari (1998), Luintel and Khan (1999), Al-Yousif (2002) and Dritsakis and Adamopoulos (2004), It is found that it overlaps with studies such as Chang and Caudill (2005), Raddatz (2006), Keskin and Karşıyakalı (2010), Bozoklu and Yıllancı (2013), Tunalı and Onuk (2017), Pata and Ağca (2018). On the other hand, in the study of Ayad and Belmokaddem (2017), in which panel VAR analysis is used, it is reached that there is no statistically significant relationship between financial development and economic growth. When the studies supporting the existence of the relationship between financial development and economic growth are examined, they may differ in terms of short and long-term relationships. The main reason for this is that it is due to the factors that are taken as a basis when using the financial development variable (Çağlan and Çelik, 2018: 38).

Another research topic that occupies a large place in the literature is the studies that test the relationship between renewable energy and financial development. Despite the different data, country and analysis used, Fangmin and Jun (2011), Kim and Park (2018), Ji and Zhang (2019), Eren et al. (2019), Anton and Nucu (2020), Wang et al., (2021), Doğan and Doğan (2021) are among similar studies showing the existence of a positive relationship between financial development and renewable energy. While the method applied and the indicators chosen in the determination of financial development cause differences in terms of short, medium and long-term relationships, as a result of the analyzes made on the data of the selected countries, the existence of the relationship may differ according to the period.

Panel data regression analysis was applied in the study of Fangmin and Jun (2011) and Anton and Nucu (2020). While the advancement level of monetary intermediation and sustainable power are tried in the investigation of Fangmin and Jun (2011), the sign of monetary improvement in the investigation of Anton and Nucu (2020) is the capital market, security market and banking market. Albeit the two investigations highlight a positive connection between monetary turn of events and environmentally friendly power, it is reasoned that the discoveries are in a positive relationship under a typical title yet under various factors.

Notwithstanding the examinations that test whether monetary improvement has a causal relationship as far as monetary development and environmentally friendly power, there are concentrates on that test the causality between monetary turn of events and energy utilization. Whenever the writing is inspected, a portion of the investigations highlighting the presence of the connection between monetary turn of events and energy utilization show that the connection between the two factors is negative, while the other part demonstrates that the relationship being referred to is positive. While concentrates like Sadorsky (2010), Sadorsky (2011), Omri and Kahouli (2014), Komal and Abbas (2015) demonstrate that the connection between monetary turn of events and energy utilization is positive, Mielnik and Goldemberg (2002), Tamazian et al. (2009), Tang and Tan, (2014), then again, express that the connection between monetary turn of events and energy utilization is negative. The investigations being referred to calling attention to the presence of a negative relationship, and this is clarified by accentuating that expanding monetary advancement builds energy effectiveness and decreases energy utilization.

As of late, various markers highlighting monetary advancement have been remembered for the connection between climate, energy and economy, and as expressed, concentrates on that test the connection between energy effectiveness and monetary improvement are restricted. In the investigation of Jensen (1996), which in a roundabout way focuses to the connection between monetary turn of events and energy effectiveness, it is underlined that an expansion in monetary advancement can give financing reasonable expenses for ventures and studies pointed toward safeguarding the climate. In the investigation of Chang (2015), which shows that monetary advancement markers can expand energy effectiveness, it is arrived at that the increment in energy proficiency can be acknowledged through energy utilization. Then again, in the investigation of Ahmed (2017), it was observed that monetary improvement has a positive relationship with energy effectiveness, while the discoveries got by Ziolo et al. (2020), Mills et al. (2021) and Safi et al. (2021) upholds concentrates, for example, Ahmed (2017), Ziolo et al., who showed that the connection between monetary turn of events and energy effectiveness is

positive. (2020), Mills et al. (2021) and Safi et al. (2021), Sheng et al. (2017) and Li et al. (2018) demonstrate various discoveries.

3. Data and Methodology

In the review, 32 European nations (Germany, Albania, Austria, Belgium, Bulgaria, Czechia, Denmark, Estonia, Finland, France, Cyprus, Croatia, Netherlands, England, Ireland, Spain, Sweden, Italy, Iceland, Latvia, Lithuania, Luxembourg, Hungary, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Turkey and Greece) yearly information of monetary improvement list and energy productivity record somewhere in the range of 1998 and 2017 are utilized. The monetary improvement file utilized in the review was made utilizing a three-stage standard methodology found in the writing on lessening complex information to a solitary synopsis record: (i) standardization of factors; (ii) adding standardized factors in sub-lists addressing a specific practical aspect; and (iii) adding the sub-files into the last file. Monetary improvement is characterized as a mix of profundity (the size and liquidity of business sectors), access (the capacity of people and organizations to get to monetary administrations) and effectiveness (the capacity of foundations to offer monetary types of assistance for minimal price and with economical incomes and the degree of movement of capital business sectors) (Svirydzenka, 2016). The monetary advancement list is taken from the authority site of the IMF. Another variable energy capability list used in the not entirely set in stone by isolating the complete public result (GDP) by the gross local energy use for a given timetable year. The rundown appraises the viability of energy use and shows how much energy use is segregated from GDP advancement (Eurostat).

In the review, cross-sectional reliance and homogeneity tests were performed for the factors before the unit root and causality breaks down. Cross-area reliance and homogeneity test results are significant in choosing unit root tests and causality tests to be utilized in the examination. The cross-segment reliance depends with the understanding that all nations are impacted by a shock to any of the units that make up the board, and that different nations that make up the board may likewise be impacted by a macroeconomic shock that happens in any of the nations. It is contended that the outcomes got in board information breaks down disregarding the cross-sectional reliance might be one-sided and conflicting. Consequently, prior to beginning the examination in a review, it is important to test whether there is a cross-segment reliance (De Hoyos & Sarafidis, 2006:482; Mercan, 2014:235; Menyah et al. 2014:389).

Regardless of whether there is a reliance between cross-areas (nations) for cross-sectional reliance LM (Lagrange Multiplier) test created in Breusch and Pagan (1980) review and CD_{LM} , CD, test created in Pesaran (2004) review and LM_{adj} created in Pesaran et al., (2008) tried with the test. Disc and CD_{LM} tests are favored when the cross-area aspect is bigger than the time aspect, while the LM and LM_{adj} tests are favored when the time aspect is bigger than the cross-segment aspect (Menyah et al., 2014; Kar et al., 2011). With the Slope Homogeneity test created in the investigation of Pesaran and Yamagata (2008), it was tried whether the coefficients of the informative variable changed starting with one cross-area then onto the next. Second era unit root tests were utilized to decide if the information were fixed by the cross-sectional reliance and homogeneity test results. In the test, individual consequences of each cross-segment are gotten with the CADF measurements, and the outcomes for the general board are acquired with the CIPS (Cross sectionally IPS) insights, which are extended by taking the cross-sectional midpoints. The CADF test created in the investigation of Pesaran (2007) is liked under the presumption of cross-sectional reliance. CADF test can be utilized in both $N>T$ and $T>N$ circumstances (Pesaran, 2007:269).

Using the meta-analysis of Todo and Yamamoto (1995) causality test adapted to the panel and developed in the Fisher (1932) study, Emirmahmutoglu and Kose (2011) causality analysis is used even if the variables are not stationary at the same level. Another advantage of this test is that it also takes into account the horizontal section dependence and can be used even though the cointegration relationship cannot be determined (Emirmahmutoglu and Kose, 2011). Since the test also has a heterogeneous structure, it can provide results for both the general panel and for each horizontal section (Kurt and Köse, 2017:306). In this test, equations (4 and 5) showing a causality relationship based on a two-variable VAR model can be established as follows (Emirmahmutoglu and Kose, 2011:872).

$$x_{i,t} = \mu_i^x + \sum_{j=1}^{k_i+dmax_i} A_{11,ij} x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} A_{12,ij} y_{i,t-j} + \mu_{i,t}^x \quad (4)$$

$$y_{i,t} = \mu_i^y + \sum_{j=1}^{k_i+dmax_i} A_{21,ij} x_{i,t-j} + \sum_{j=1}^{k_i+dmax_i} A_{22,ij} y_{i,t-j} + \mu_{i,t}^y \quad (5)$$

$$i = 1, 2, \dots, N \text{ ve } j = 1, 2, \dots, k$$

the variables x_i and y_i denote the error term μ_i , the constant effects matrix A , the delay k_i , the maximum integration value for each horizontal section $dmax_i$, horizontal sections i , the time period t .

4. Findings

Descriptive statistics of the variables were calculated first of all from the study. Descriptive statistics on financial development and energy efficiency are given in Table 1.

Table 1. Descriptive Statistics

| Variables | Mean | Minimum | Maximum | St. Error | Skewness | Kurtosis | Jarque – Bera |
|-----------|--------|---------|---------|-----------|----------|----------|---------------------|
| FinGel | 0.5441 | 0.1114 | 0.9388 | 0.2089 | -0.2337 | 1.8183 | 43.0644 (0.0000) |
| EnVer | 5.8615 | 1.1810 | 18.2800 | 2.9001 | 0.7211 | 3.5022 | 62.1845 (0.0000) |

When the descriptive statistics in Table 1 are evaluated, it is seen that the volatility in the energy efficiency index is higher than the volatility in the financial development index. Horizontal decisional dependence, homogeneity and unit root tests of variables should be performed before the causality relationship between variables. In order to make a choice about which of the unit root tests to use, cross-sectional dependence and homogeneity tests of the variables were performed. The results for the related tests are given in Table 2.

Table 2. Horizontal Section Dependence and Homogeneity Test Results

| Test | Test Statistics | p – value |
|-------------------------|-----------------|-----------|
| LM | 2357.191* | 0.000 |
| CD _{LM} | 59.093* | 0.000 |
| CD | 40.333* | 0.000 |
| LM _{adj.} | 99.010* | 0.000 |
| $\check{\Delta}$ | 44.2548* | 0.000 |
| $\check{\Delta}_{adj.}$ | 49.1864* | 0.000 |

*1% is significant at the significance level.

Table 2 horizontal sectional dependence and homogeneity between the variables of the model in the results of testing cross-sectional dependence and it has been found that has a heterogeneous structure. In Table 3, the results of the unit root test, which takes into account the assumptions of cross-sectional dependence and homogeneity, are given.

Table 3. Unit Root Test Results

| Variables | CADF | | CIPS | |
|-----------|----------|------------------|----------|------------------|
| | Constant | Constant & Trend | Constant | Constant & Trend |
| FinDev | -2.515* | -5.973* | -2.643* | -3.486* |
| EnEf | -3.709* | -2.167** | -4.526 * | -4.659* |

*1% is significant at the significance level.

According to the results of the unit root test, it was found that the relevant variables are stationary. Table 4 shows the results of the panel causality analysis developed in the study of

Emirmahmutoglu and Kose (2011) in order to decipher the relationship of causality between variables.

Table 4. Panel Causality Test Results

| Countries | H0: Energy Efficiency is Not the Reason for Financial Development. | | H0: Financial Sophistication Is Not the Reason for Energy Efficiency. | |
|---------------------|--|-----------|---|-----------|
| | Lag | Wald test | Lag | Wald test |
| Germany | 1 | 0.007 | 1 | 0.160 |
| Albania | 1 | 0.066 | 1 | 0.171 |
| Austria | 1 | 0.021 | 1 | 0.726 |
| Belgium | 1 | 0.102 | 1 | 0.399 |
| Bulgaria | 2 | 1.801 | 2 | 0.233 |
| Czechia | 2 | 3.303 | 2 | 0.376 |
| Denmark | 2 | 3.837 | 2 | 0.864 |
| Estonia | 2 | 3.201 | 2 | 0.771 |
| Finland | 1 | 3.134*** | 1 | 0.323 |
| France | 1 | 3.915** | 1 | 0.518 |
| South Cyprus | 1 | 2.863*** | 1 | 0.705 |
| Croatia | 1 | 2.963*** | 1 | 1.233 |
| Netherlands | 1 | 0.938 | 1 | 0.250 |
| England | 1 | 1.990 | 1 | 0.000 |
| Ireland | 1 | 1.747 | 1 | 0.051 |
| Spain | 1 | 2.255 | 4 | 0.016 |
| Sweden | 4 | 16.294* | 4 | 7.670*** |
| Italy | 4 | 19.585* | 4 | 10.428** |
| Iceland | 4 | 23.137* | 4 | 7.401 |
| Latvia | 4 | 19.765* | 4 | 6.073 |
| Lithuania | 4 | 10.751** | 3 | 5.090 |
| Luxembourg | 3 | 18.329* | 3 | 1.959 |
| Hungary | 3 | 10.748** | 3 | 3.037 |
| Norway | 3 | 8.480** | 3 | 2.429 |
| Poland | 3 | 2.963 | 3 | 7.772** |
| Portugal | 3 | 4.363 | 3 | 9.403** |
| Romania | 3 | 2.705 | 3 | 6.262*** |
| Serbia | 3 | 3.134 | 3 | 4.132 |
| Slovakia | 3 | 4.021 | 3 | 7.525*** |
| Slovenia | 3 | 1.494 | 3 | 3.139 |
| Turkey | 3 | 1.553 | 3 | 5.053 |
| Greece | 3 | 0.714 | 3 | 7.457*** |
| Panel Fisher | | 158.605* | Panel Fisher | 79.204*** |

* 1%, **5% and ***10% are significant at the importance level.

According to the results of the panel causality analysis, it was determined that there is a two-way causality between financial decency and energy efficiency. When looking at countries

specifically, it was found that the causality from energy efficiency to financial development applies to Finland, France, the Greek Cypriot part, Croatia, Sweden, Italy, Iceland, Latvia, Lithuania, Luxembourg, Hungary and Norway. The causality from financial development to energy efficiency was found to be valid for Sweden, Italy, Poland, Portugal, Romania, Slovakia and Greece.

5. Conclusion and Recommendations

The presence of a created monetary framework is significant for diverting reserve funds into the economy. In the event that monetary advancement is communicated as the improvement of monetary business sectors, monetary establishments and monetary instruments; the higher the monetary turn of events, the higher the pace of move of assets made in the monetary area to the genuine area will be. Alongside monetary turn of events, circumstances, for example, the powerful working of the monetary framework, the accessibility of monetary instruments and the viable utilization of financial assets come to the front. Powerful utilization of assets is particularly significant according to the perspective of energy assets. The way that energy assets are restricted and the development of nations, as well as the increment in energy needs, requires the effective utilization of energy assets. Taking into account that proficiency is one of the marks of monetary turn of events, regardless of whether energy productivity affects monetary advancement has been the subject of this review. In this unique circumstance, 32 European countries utilizing yearly information somewhere in the range of 1998 and 2017, the causality connection between energy effectiveness and monetary improvement record was tried by Emirmahmutoğlu and Köse (2011) board causality examination. As indicated by the discoveries of the examination applied, it was observed that there is a bidirectional causality between monetary turn of events and energy proficiency in the board. Considering the nations remembered for the examination, the causality from energy proficiency to monetary improvement is critical for Finland, France, Greek Cyprus, Croatia, Sweden, Italy, Iceland, Latvia, Lithuania, Luxembourg, Hungary and Norway. The causality from monetary advancement to energy productivity is critical for Sweden, Italy, Poland, Portugal, Romania, Slovakia and Greece. Applied model of Emirmahmutoğlu and Köse (2011) in which the board causality model is utilized backings the investigations of Ahmed (2017), Ziolo et al. (2020), Mills et al. (2021) and Safi et al. (2021) while later investigations of Ziolo et al. (2020), Mills et al. (2021) and Safi et al. (2021) are somewhat not the same as this review.

One of the indicators of financial development is efficiency. In this context, an increase in resource efficiency will allow it to develop in financial institutions in this market. On the other

hand, as financial development increases, financial institutions such as the bank will be able to transfer more resources to projects and technologies that will increase productivity. It is expected to be supported in this context in investments aimed at more efficient use of the most needed energy globally. As a result, both given to projects that will improve energy efficiency, increase investments and financial sophistication feed each other with will be the creation of a process, thus, a decrease in energy costs with countries that will contribute to increasing energy demands of the process will be demonstrated. As financial development increases, financial institutions will provide more support to the efficiency projects of enterprises and may lead to the transfer of resources to these projects. In this case, especially projects that will ensure energy efficiency will also receive a share of this resource transfer.

The application of different econometric models in future studies, the fact that the variables that will indicate financial development include different indicators, and studies on the differences that arise in particular will contribute to the literature in terms of generalizing the results.

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