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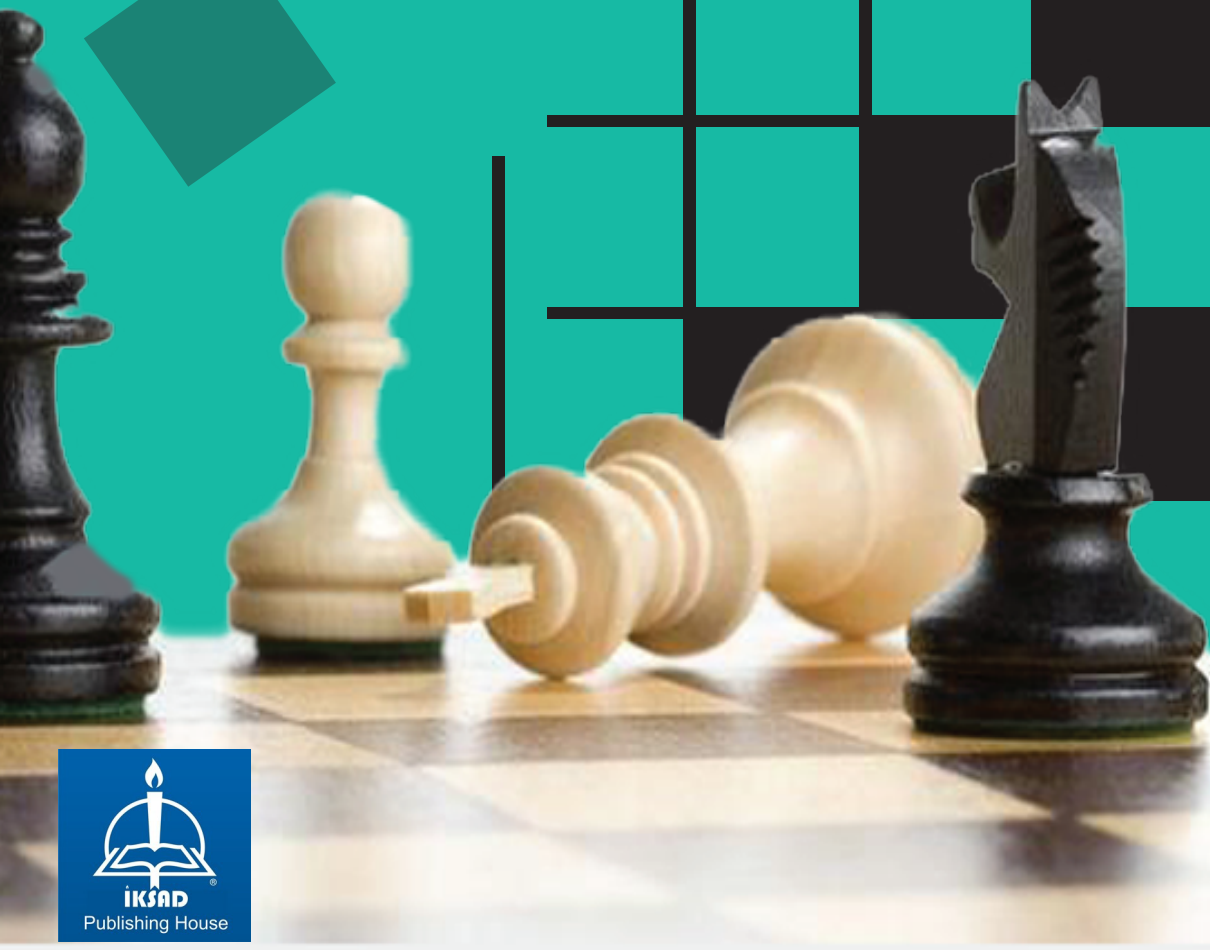
DISCUSSIONS BETWEEN ECONOMIC AGENTS:

NEW ISSUES IN THE LITERATURE



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Discussions Between Economic Agents:

New Issues In The Literature

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PREFACE

The new subject of the series “Discussion Between Economic Agents” is the New Issues in the Literature The ninth book in the series features studies in the field of economics and administrative sciences. The econometric methods used are up-to-date and exemplary for the readers. There are seven valuable papers in the book. Let me discuss shortly about the articles.

In the first chapter of the book, Muhammed SAHIN and Isminaz CINAR SAHIN prepared a study entitled “Constitutional Taxation Principles in Turkish Constitutional Court Decision.” The authors conducted a study on taxation, an authority effectively exercised by states, within the framework of constitutional criteria. The fundamental principles and rules related to taxation are enshrined in the Constitution, as taxation is a necessity for the protection of fundamental rights and freedoms and the rule of law. The study goes on to mention that the Constitutional Court's freedom to concretise taxation principles by preventing them from becoming clearly defined principles within the framework of prioritising economic conditions and fiscal policies of the period has enabled the Court to concretise these principles through its own approach and interpretation.

In the second chapter, Erinc BAYRI, in his work “Financial Inclusion and the Participation of Women in the Economy,” aimed to give importance of the financial inclusion and microfinance. Financial inclusion brings together market participants who want to invest their savings, protect their savings from inflation and earn income from their savings with market participants seeking access to funds for various reasons through an effective financial system. The author emphasises the importance of microfinance, noting that it is not only important for low-income individuals but also for those who are excluded from the financial system for various reasons. In this context, the importance of women participating in working life and socialising by taking advantage of microfinance resources was highlighted.

In the third part of the book, Hilal BUDAK BICER and Emine Dilara AKTEKIN GOK, authors of the study” The Effect of Trade Opennes and

Financial Development on Economic Growth: Evidence from E-7 Countries" analyzed trade opennes, financial development and economic growth, which were obtained from the World Bank using annual data. The author used panel data algorithms to forecast the trade opnnes and financial development effect on economic growth in G7 countries. Based on their findings, the authors concluded that trade liberalisation and financial development were not effective for the E-7 group of countries. They emphasised that trade policies and financial development needed to be improved more comprehensively in order to achieve the goal of sustainable economic growth.

In the fourth chapter of the book, Mohammad Nadimur RAHMAN conducted a study named "The Load Capacity Factor and Its Determinants: A Panel Data Analysis on Top Renewable Energy Developed Countries," which aimed to give information about the load capacity and its determinants in energy developed countries. According to the results obtained, the bidirectional causality between renewable energy consumption and economic growth shows that renewable energy consumption not only improves environmental quality in the ten countries with the highest renewable energy consumption, but also ensures economic sustainability. Since there is a unidirectional causality between financial development and renewable energy consumption, policymakers should use financial resources to promote development in the direction of renewable energy.

In the fifth chapter, Nizamettin BASARAN, Huseyin Serdar YALCINKAYA and Tuncay BELEN performed a causality analysis in the study named "The Effect of Imports od Electric Energy and Energy Resources Used in Electric Energy Production on Exchange Rate(USD): Hatemi –J Asymmetric Causality Analysis". As a result of the econometric analyses conducted by the authors, they concluded that when the amount of imported energy sources accounts for a high share of total energy sources used, the relationship between the amount of imported energy and exchange rates will strengthen. However, when the amount of imported energy sources accounts for a low share of total energy sources used, the relationship between the amount of imported energy and exchange rates will weaken.

In the sixth chapter Kubra GOGER and Bugrahan Sevket BAKIRCIOGLU in their work called "An econometric Analysis of CO_2 Emissions in Turkey: Renewable Energy, Economic Growth, and Environmental Taxes", aimed to analyse the relationship between variables in the study using annually data for the period 1995 -2021. Carbondioxide emission, taxes, renewable energy consumption and economic growth data were obtained from World Bank and IMF. Based on their findings, the authors emphasise the importance of renewable energy investments for environmental sustainability and point out the need to increase the structural effectiveness of environmental taxes.

"Evaluating the online Accessibility Performance of Individiual Rights-Seeking Channels in Turkey with Data Envelopment Analysis" is the last chapter of the book. The authors, Abdullah AYDIN and Muhammed MARUF, aim to rank institutions that accept individual complaints and applications from citizens in Turkey according to their accessibility performance in terms of online application opportunities, using performance indicators on their websites. Data envelopment analysis was used to rank alternatives according to their relative efficiency scores. The ranking results obtained based on data envelopment analysis revealed that the institution offering the most suitable accessibility conditions was the Public Supervisory Institution, followed by the Presidential Communication Centre in second place. The results obtained from this study were obtained without the need to calculate the importance weights of the criteria using any weighting method.

My sincere thanks to the authors for their dedication and contributions. All errors and references are the responsibility of the authors. I would also like to thank the IKSAD Publishing House managers and staff for their support during the publication of this book.

Prof. Okyay UCAN

CHAPTER 1

CONSTITUTIONAL TAXATION PRINCIPLES IN TURKISH CONSTITUTIONAL COURT DECISIONS

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INTRODUCTION

Taxes are economic values collected gratuitously and in accordance with the principles set by law by the state or by organizations authorized by the state to provide public services. In other words, taxes are collected in the form of money from individuals and legal entities by institutions authorized to tax them under legal obligations (Karakoç, 2013: 1259).

States are bound by economic and legal limits when exercising their taxation authority. Legal limits are the fundamental principles and foundations of the exercise of taxation authority established by the Constitution and other laws (Aliefendioğlu, 1981:596). The "taxation power", which arises from sovereign power, has been abused for social, political, and economic reasons in societies where the necessary limitations do not exist. This has led to the disruption of social order and the decline in welfare of taxpayers. The Magna Carta Declaration of 1215 is the first document that limits taxation authority. Furthermore, the Petition of Rights (1628) and the English Bill of Rights (1689) are pioneering documents in delegating taxation authority to parliament (Öncel et al., 2014: 7).

Constitutional taxation principles constitute a set of principles that encompass the general framework governing the exercise and limits of taxation authority. Legislators consider these principles when imposing tax liability on individuals liable to tax. Thus, the legislator's authority is limited and the taxpayer is protected. The Constitutional Court has jurisdiction over violations of taxation principles. According to the Constitutional Court, *"the state's taxation authority is limited by certain constitutional principles, such as legality, fiscal power, and generality in taxation. Accordingly, taxes must be regulated by law in a manner that observes the principles envisaged by the Constitution and, naturally, must also reflect fiscal power, which is the tool of implementing the principle of equality in taxation."* (Constitutional Court, E.2008/110, K.2010/55, 01/04/2010).

The inclusion of fundamental principles and foundations of taxation in the Constitution is not a new practice in the history of Turkish constitutional law. Within this scope, taxation principles were first mentioned in the Gülhane

Hat Edict and the Reform Edict, and subsequently incorporated into the Kanuni Esasi of 1876. Indeed, Article 20 of the Kanun-i Esasi stipulates taxation based on ability to pay, while Article 25 stipulates that taxes can only be levied by law.

Taxation principles, which have a significant impact on the evaluation and development of the tax system, became a frequently studied and debated topic with the emergence of fiscal science. Although the Mercantilists and Physiocrats established the relevant doctrines, the recognition of taxation principles came with Adam Smith. After Adam Smith, many individuals, including J.B. Say, J.S. Mill, Wicksell, Lindahl, and Edgeworth, conducted studies on taxation principles (Edizdoğan et al., 2011).

1. TAXATION PRINCIPLES IN THE CONSTITUTION AND CONSTITUTIONAL COURT DECISIONS

1.1. Provisions regarding tax duty in Turkish Constitutions

The 1876, 1924, 1961, and 1982 constitutions contain provisions regarding tax obligations. However, because the 1921 constitution was a transitional period constitution, it does not contain any provisions regarding tax obligations (Karakoç, 2013: 1261).

Many provisions in the constitution are indirectly related to tax law (Ortaç and Ünsal, 2019:15). In this context, provisions regarding the making of laws relate to the establishment of tax legislation; provisions regarding fundamental rights and freedoms relate to the limitation of taxation authority; provisions regarding the Constitutional Court relate to the constitutional review of tax laws and tax-related presidential decrees; provisions regarding judicial review of the administration relate to ensuring the legal compliance of taxation proceedings; and provisions regarding the budget relate to the collection and expenditure of taxes (Saraçoğlu, 2013:43). This list can be extended by the principles governing criminal law also governing tax criminal law, as well as by principles related to other branches of law, such as legal certainty and the principle of certainty related to the rule of law. However, the provisions of Article 73 of the Constitution are directly related to tax law.

The arbitrary use of the tax obligation, one of the important duties of taxpayers, must be prevented and the taxing authorities must be limited (Kumrulu, 1979: 151). Accordingly, the provisions of Article 73 of the 1982 Constitution regulated the principles of taxation, taxation, and the constitutional basis for taxing authority. According to this article:

"Everyone is obligated to pay taxes according to their financial power to meet public expenses.

The fair and balanced distribution of the tax burden is the social objective of fiscal policy.

Taxes, duties, fees, and similar financial obligations are imposed, amended, or abolished by law.

The President may be granted the authority to amend the provisions regarding exemptions, exceptions, reductions, and rates of taxes, duties, fees, and similar financial obligations, within the upper and lower limits specified by law."

Article 73 of the Constitution contains a number of constitutional principles in paragraph form. Within this framework, constitutional taxation principles such as generality, equality, the principle of payment according to financial power, and legality are achieved. In addition to these principles, the principle of legal certainty, the principle of certainty, and the principle of proportionality can also be considered among the constitutional taxation principles (Karakoç, 2013: 1263). A detailed examination of constitutional taxation principles reveals that these principles are mutually reinforcing and complementary (Ortaç and Ünsal, 2019: 15). In this context, it is impossible to explain the principles of generality of taxation, equality of taxation, proportionality, and financial power completely independently of each other. The full and effective existence of any of these principles depends on the existence and effectiveness of the other principles.

1.2. Principle of legality in taxation

The principle of legality is also of great importance in other areas of law, such as taxation, for the protection of citizens and the establishment of legal certainty. In this context, the principle of legality has been adopted in tax law, as in criminal law. The Magna Carta Libertatum stipulated that taxes would be based on law, limiting the King's taxation authority within the scope of legality. The principle of legality achieved its current place in constitutions after a long historical process involving difficult and bloody struggles (Ortaç and Ünsal, 2019:19). In Turkish law, the Tanzimat Edict and the 1876 Kanun-i Esasi (Code of Essentials) established the principle of legality of taxes. In today's democratic societies, within the framework of the separation of powers, the general holder of taxation power is the legislative body, the parliament (Gerçek and Bakar, 2017:9).

The principle of legality of taxes refers to the empowerment of the parliament, the lawmaker composed of the people's representatives, to levy taxes on the people's wealth, income, and expenditures (Karakoç, 2013:1264). In this context, the principle of legality of taxation has also been implemented, along with the principle of *"no tax without representation/no tax without law"* (Özpençe and Özpençe, 2013: 4). In the 1982 Constitution, in addition to the taxes collected by the state, financial obligations such as duties and fees imposed outside of taxes are also bound by the principle of legality (Tekin and Gümüş, 2014: 249-250).

The principle of legality indirectly expresses various principles that apply to tax laws due to the characteristics of the laws and the fundamental legal principles to which they are based (Ortaç and Ünsal, 2019: 18). In this context, since the laws do not contain specific provisions for individuals but rather general regulations, the principle of generality and other principles governing laws, such as legal certainty, certainty, prohibition of comparison, non-retroactivity, and non-extensibility through interpretation, are also included in tax laws (Saraçoğlu, 2013: 53). Within the scope of the principle of legality, the legislator is also bound by the rules regarding lawmaking contained in the Constitution. For example, despite having the status of law, the legislator cannot implement tax regulations through the budget. Indeed, according to

Article 161 of the Constitution, which states that *"no provisions other than those related to the budget may be included in the budget law",* provisions regarding the imposition, removal, or amendment of taxes cannot be included in the budget law. In one decision, the Constitutional Court annulled several provisions due to non-compliance with this rule (Constitutional Court, E.2005/146, K.2005/105, 28/12/2005).

The principle of legality is the philosophical basis for the legal remedies an individual can resort to when they believe an unlawful situation has occurred. The provision on the non-delegation of legislative power in Article 7 of the Constitution and the provisions of the third paragraph of Article 73 constitute the constitutional framework of the principle of legality (Karakoç, 2013:1265). According to these provisions, taxation embodies the element of legality. The imposition, amendment, or removal of taxes is only possible by law (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). In this respect, the 1982 Constitution applies the principle of legality of taxation to the entire process, including the imposition, amendment, and removal of taxes. However, in order for taxes to be a tool of economic policy and to rapidly adapt to changes in the economic sphere, the legislative branch can delegate some of its powers related to the taxation process, albeit limitedly, to the executive branch. Article 73, Paragraph 4 of the Constitution allows the legislator to delegate authority to the President regarding exceptions and exemptions, within the framework of constitutional conditions and limits. This ensures that the executive branch has the authority to make changes to tax policy within the limits granted to it. However, as an element of the principle of legality, this delegation of authority is limited to making changes within the upper and lower limits specified in the provisions regarding exemptions, exceptions, reductions, and rates, within the framework of the conditions required by the Constitution. This aim is to prevent the delegation of authority to the executive branch with unclear upper and lower limits. Indeed, the executive branch cannot make regulations without the legislator establishing rules regarding taxation, and the executive branch's regulatory authority is defined by the subject matter and upper and lower limits determined by the legislator (Tekbaş, 2020: 34). According to the Constitutional Court, *"in cases where it is not possible to regulate the details in law due to the nature of the issue, the executive branch may be authorized to*

take explanatory and complementary regulatory action on implementation-related matters, provided that constitutional principles are adhered to and the legal framework is established" (Constitutional Court, E.2004/14, K.2004/84, June 23, 2004).

The generality of legislative power not only grants the legislator the authority to regulate any matter in law, but also grants discretion to delegate the authority to make detailed regulations to the executive branch after the fundamental issues have been regulated. However, the authority (regulatory scope) that can be delegated to the executive branch regarding taxation is limited by Article 73/4 of the Constitution. Indeed, Article 73/4 provides a limited exception to the non-delegation of legislative power stipulated in Article 7 of the Constitution (Tekbaş, 2020: 34). As a matter of fact, according to the Constitutional Court, the executive body is given *"conditional and limited authority"* (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018).

In a decision (Constitutional Court, E.2013/66, K.2014/19, 29/01/2014), the Constitutional Court states that the Council of Ministers can only be granted authority to make changes to exemptions, exceptions, and reductions related to taxes, duties, fees, and other financial obligations by specifying their lower and upper limits. In this context, it is not possible to grant the executive branch authority beyond these limits. In other words, the authority granted to the executive branch is nothing more than a "conditional and limited" authority. For this reason, the Constitutional Court annulled the article regarding this authority, finding it contrary to Article 73 of the Constitution, because *"while the Council of Ministers was granted the authority to determine citizens who would not be charged the departure fee, the Council of Ministers was granted unlimited authority to determine the citizens in question, exceeding the authority to make changes within the upper and lower limits specified in the Constitution and without any criteria being prescribed..."*. Accordingly, the failure to regulate the lower and upper limits and principles regarding the use of the *"authority to exempt from the departure fee"* granted to the Council of Ministers not only violates the principle of the legality of the tax established by the Constitution, but also results in the executive branch being granted unlimited authority without any criteria being prescribed. Therefore, the Constitutional Court annulled the authority granted to the Council of Ministers

to determine individuals exempt from the departure fee, finding it contrary to Article 73 of the Constitution (Constitutional Court, E.2013/66, K.2014/19, 29/01/2014).

Similarly, the excessively wide lower and upper limits were also considered as violation of Constitution. It has been stated that the principle of legality of the tax is undermined. In this context, the Constitutional Court considered the change of the rule that the Council of Ministers could increase the Motor Vehicle Tax up to 20 times the rule that could be increased up to 10 times as *"an excessive regulation that leads to the delegation of legislative power and is incompatible with tax justice"*. In the same decision, the Constitutional Court stated that the authority granted to the Council of Ministers to "increase it up to twenty times" could lead to arbitrary practices and was incompatible with the principle of legal certainty (Constitutional Court, E.2001/36, K.2003/3, 16/01/2003). The expressions used by the Constitutional Court in the annulment of the rule in question, *"the authority granted to the Council of Ministers is too broad", "leading to the delegation of legislative power"*, *"incompatible with tax justice"*, *"being an excessive regulation"*, *"causing an arbitrary practice"* and *"incompatible with the principle of legal certainty"*, are among the Court's opinions regarding constitutional taxation principles. It shows the Court's approach in terms of the breadth and nature of its view of the constitutional provisions and constitutional review (Tekbaş, 2020: 37).

In one decision, the Constitutional Court ruled that granting the Council of Ministers "*the authority to make changes only within the limits set by law or to determine tax amounts for vehicles in the same age group according to a lower tier, subject to the fulfillment of the conditions stipulated in the paragraph"* was in accordance with Article 73 of the Constitution (Constitutional Court, E.2004/14, K.2004/84, June 23, 2004). In the same decision, the Constitutional Court ruled that, within the scope of the authority granted to the Council of Ministers, the Council of Ministers could even reduce certain financial obligations to zero, within the upper and lower limits. *"The reduction of a tax, duty, fee, or similar financial obligation by the Council of Ministers to zero never constitutes the removal of the obligation. In this case, the obligation in question continues as an institution, and since the Council of*

Ministers may increase this amount at any time, within the limits set by law, based on economic conditions, it cannot be said that the reduction of a tax, duty, fee, or similar financial obligation by the Council of Ministers to zero constitutes the removal of the obligation in question, nor does it constitute a violation of the principle of legality of taxation." (Constitutional Court, E.2013/66, K.2014/19, 29/01/2014).

Within the scope of the principle of legality, tax laws are expected to prevent arbitrary and discretionary practices and create a safe and specific environment that protects individual freedoms. Indeed, according to the Constitutional Court, the authority granted to the executive body *"does not pertain to the fundamental elements of taxation, but rather clarifies and complements the regulation introduced by law"*. The executive branch must remain *"within the bounds of tax laws when regulating matters related to taxation technique and details"* (Constitutional Court, E.2003/11, K.2004/49, 07/04/2004). Similarly, according to the Constitutional Court, the authority granted to the ministry to regulate technical and detail-related matters after *"the legislative body has regulated the basic elements such as the subject of the tax, the taxpayer, the event giving rise to the tax, the amount of the tax, the method and period of payment"* is not unconstitutional (Constitutional Court, E.1996/49, K.1996/46, 11/12/1996).

The principle of legality aims to ensure legal certainty (Çağan, 1980:141). Therefore, tax-related laws must include details regarding all elements of the envisaged tax liability (Tekbaş, 2010:174). In this respect, the principle of legality implies not only the imposition and removal of taxes by law, but also the detailed regulation of the obligations and procedural relationships arising from the tax. Tax laws must include fundamental aspects of taxation, such as the subject, taxpayer, tax base, tariff, and collection (Karakoç, 2013:1266). The Constitutional Court states that within the scope of legal certainty, *"norms must be predictable, and the state must avoid methods that undermine trust in legal regulations"* (Constitutional Court, E.2013/67, K.2013/164, 26/12/2013).

Because laws cannot be unconstitutional due to the hierarchy of norms, the principle of tax legality ensures that tax laws are within constitutional limits

and comply with the principles set forth by the Constitution. In this context, the principles and limits regarding the exercise of taxation authority stipulated in the Constitution must be taken into account in tax laws. Similarly, the fundamental principles of taxation articulated in the Constitution must be observed in the formulation of tax laws.

1.3. Principle of generality in taxation

The provision in Article 73, Paragraph 1, of the 1982 Constitution, *"Everyone is obliged to pay taxes according to their financial power to meet public expenses"* defines the principle of generality. The term *"everyone"* in this provision establishes the generality of the tax at the constitutional level (Ortaç and Ünsal, 2019:16). We can define the principle of generality as all economic units, regardless of social class or group, sharing the tax burden (Selen and Özen, 2011:151). The purpose of the principle of generality in taxation is to ensure that everyone, regardless of social class, pays taxes on their income, wealth, or expenses (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). Indeed, differentiating taxation based on non-economic distinctions such as religion, language, race, gender, ethnicity, or sect would violate both the principle of generality and the principle of equality (Turhan, 1998:206).

The principle of generality is an indirect consequence of the principle of legality, given the generality of regulations made by law. Since everyone can only share in the tax burden with financial power, the term "everyone" within the scope of the principle of generality should be understood as *"everyone with financial power"* (Tekbaş, 2010:182). The Constitutional Court defines the principle of generality in taxation as *"everyone with financial power, without any discrimination, should contribute to the tax burden and pay taxes"* (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). Accordingly, not collecting taxes from those without financial power is a practice that does not contradict the principle of generality (Saraçoğlu, 2013:47). According to the Constitutional Court, *"The purpose of the general principle of taxation is to ensure that everyone pays taxes on their income, wealth, or expenses, regardless of social class. However, certain individuals or incomes may be excluded from taxation for reasons necessitated by fiscal policy, social,*

economic, and tax technique." (Constitutional Court, E.2001/36, K.2003/3, 16/01/2003). In the same decision, the Constitutional Court stated that *"while an additional amount is added to the basic indicator for each touristic trip abroad, the exclusion of treatment and a single pilgrimage trip in the rule at issue"* violates the principles of taxation based on financial power and the equitable, fair, and balanced distribution of the tax burden, as well as the principle of a state governed by the rule of law, which is responsible for ensuring these.

The general principle, which advocates that taxes should be levied on everyone, aims for justice and equality in taxation (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). The principle of generality in taxation implies that everyone with financial power should share in the tax burden and pay taxes without any discrimination. Taxation based on financial power is the imposition of taxes based on the economic and personal circumstances of taxpayers. This principle is also a tool of implementing the principle of equality in taxation (Çağan, 1980:139), requiring those with greater financial power to pay more tax than those with less financial power (Constitutional Court, E.2011/138, K.2012/94, June 15, 2012).

According to the Constitutional Court, granting exemptions from VAT on initial sales to individuals and institutions based abroad who meet certain conditions, in order to encourage domestic purchases of residential properties or offices from abroad, is a practice aimed at increasing foreign currency inflows to the country and encouraging the construction sector. In this context, the Constitutional Court did not find this tax exemption contrary to the principle of generality and equality of taxation enshrined in the Constitution. (AYM, E.2017/117, K.2018/28, 28/02/2018)

1.4. Principle of certainty in taxation

The principle of certainty can be explained as the legal determination of the amount of tax to be paid and the payment conditions, with the aim of ensuring that tax laws are understandable and clear (Özer, 1977:71, cited in Tekin and Gümüş, 2014: 246). The principle of certainty requires that *"the liability be clear and certain for both individuals and the administration, and*

that the legal rule be structured in a way that allows the relevant individuals to reasonably foresee the consequences of a particular transaction under the prevailing circumstances" (Constitutional Court, E.2004/94, K.2008/83, 20/03/2008).

The principle of certainty is related to the rule of law and the democratic state, and it indicates how individuals should behave in many situations and the sanctions they will face. This ensures that individuals act in accordance with the law. Otherwise, relations between the taxpayer and the tax office will tend to deteriorate (Can, 2005:93). The wealth tax is a prime example of this. According to this principle, also called "certainty," the tax each individual must pay must be clear, understandable, and specific in terms of payment time, payment method, amount, etc. (Edizdoğan, 2011: 247).

According to the Constitutional Court, tax legislation should be designed to enable relevant individuals to reasonably foresee the consequences of a particular transaction under current circumstances. This principle, described as the requirement of foreseeability, requires that *"the scope of discretion in the application of the law and the method of its application be regulated with sufficient clarity to protect individuals from arbitrary and unforeseen interventions"* (Constitutional Court, E.2006/61, K.2007/91, 30/11/2007). It is also possible for the administration to clarify the content and scope of a legal regulation through sub-legal regulations and court decisions. However, according to the Constitutional Court, in these cases, administrative regulations and judicial interpretations imposing obligations on taxpayers should not have retroactive effect. In this approach, the lack of a foreseeable legal basis becomes effective when the foreseeability that should be provided at the level of law is eliminated through sub-legal administrative practices and regulations or judicial precedents, which have retroactive effect (Türkiye İş Bankası Application, 2014/6192).

In a 1991 decision, the Constitutional Court characterized the "standard of living" principle, a tax control system *"introduced to arrive at a true income by assuming that the taxpayer has sufficient income to meet their living standards"* as *"granting validity to an assumption,"* and deemed the legal regulation unconstitutional because it precluded any possibility of asserting or

proving the contrary (Constitutional Court, E.1991/7, K.1991/43, 12/11/1991). However, in subsequent decisions, the Constitutional Court found the *"standard of living principle"* constitutional in terms of determining financial capacity by allowing for objections, assertions, and proof of the contrary (Constitutional Court, E.1996/43, K.1998/13, 05/05/1998).

1.5. Principle of equality in taxation

The principle of equality, as stated in Article 10, paragraph 1 of the Constitution, *"Everyone is equal before the law without distinction of language, race, color, sex, political opinion, philosophical belief, religion, sect, or similar grounds"*, constitutes one of the fundamental principles of the Constitution, which relates to all branches of law. According to the Constitutional Court, the principle of equality regulated in Article 10 is among the principles *"under which the state's taxing power is limited, along with certain constitutional principles such as legality, financial power, and generality in taxation"* (Constitutional Court, E.2006/119, K.2009/145, 15/10/2009). Although the principle of equality is regulated in Article 10 of the Constitution, it also emerges as a natural consequence of the principles of legality, generality, and financial power regarding taxation. In addition to the absolute aspect of equality, which implies that everyone is equal before the law, there is also a relative aspect, which implies that those in the same legal situation should be treated equally. In this context, applying different treatment to individuals with different legal situations falls within the scope of the principle of equality. Equality in the tax field, on the other hand, refers to applying the same treatment to individuals in the "same financial situation" (Tekbaş, 2010:153, 159).

Exceptions to the principle of equality can be established by the legislator through special exemptions for various subjects and individuals based on social, economic, fiscal, cultural, or similar reasons (Tekbaş, 2010:156). Similarly, the legislator can base its discretionary power on exemptions and exceptions in tax regulation on various justified reasons (Çağan, 1980:139). These justified reasons can include the public interest, financial power, social and economic objectives, and the better provision of public services. For these

reasons, the principles of equality, generality, and justice in taxation are reconciled.

According to the Constitutional Court, for a violation of the principle of equality to be considered, "*a law must create a distinction or privilege between those in the same legal situation"* (Constitutional Court, E.2011/138, K.2012/94, 15/06/2012). In this context, the Constitutional Court did not consider the differential taxation of capital market instruments held domestically and abroad after declaration to be a violation of the principle of equality (Constitutional Court, E.2008/116, K.2010/85, 24/06/2010). Similarly, it has been decided that there is no contradiction with the principle of equality in subjecting non-resident Turkish citizens, foreign natural and legal persons who are expected to benefit from the VAT exemption, and Turkish-resident natural and legal persons who are excluded from the scope of the rule, because their legal status and situation are not the same (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). While this approach of the Constitutional Court allows for differences in principle, it also recognizes that the source of different application cannot be based on language, religion, race, gender, philosophical belief, sect, political opinion, or similar grounds.

The principle of equality is interpreted broadly in the Constitutional Court's decisions, and in principle, the application of different provisions to taxpayers with different legal situations is generally not unconstitutional. Indeed, when we look at the practices that are the subject of the claim of inequality, regulations aiming at regional economic development and export promotion, regulations encouraging and protecting agricultural activities, regulations encouraging investment based on citizen-foreigner discrimination or regulations aiming to protect the domestic market come to the fore.

1.6. Principle of financial power

The constitution does not provide a definition of what financial power is (Ortaç and Ünsal, 2019:22). Financial power can be expressed as the sum of economic values that express the ability to pay taxes (Tekbaş, 2010:60). Financial power is also defined as the portion of income that exceeds the basic income required to cover the life of an individual and their family, if any (Ortaç

and Ünsal, 2019:22). In fiscal literature, the terms "paying power" and "financial power" are used interchangeably but have different meanings. Income is taxed in the ability to pay category, while expenditure, income, and wealth are taxed in the financial power category (Tekin and Gümüş, 2014:251). According to the Constitutional Court, *"income, wealth, and expenditure"* are indicators of financial power (Constitutional Court, E.2003/11, K.2004/49, 07/04/2004). In this respect, financial power is not only a concept related to individuals' income; it is also related to their wealth and expenditures (Çağan, 1980:145).

The principle of taxation according to financial power implies taxing individuals by taking their subjective characteristics into account. Measures such as exemptions, privilege, minimum subsistence allowances, the separation theory, and progressive taxation are utilized in the process of determining financial power (Ortaç and Ünsal, 2019:22). These are also elements that help ensure justice in taxation. Financial power is the source, basis, reason, and condition of the ability to pay. When taxing, the legislator must consider individuals' economic value and their financial capacity. Taxation according to financial power is the levy of taxes based on the economic and personal circumstances of taxpayers (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018). Within the scope of the principle of taxation according to financial power, the fact that people are liable to tax according to their financial power is a requirement of being a social state, as well as ensuring the principle of equality and generality, which are other constitutional principles (Tekbaş, 2010:154, 163).

The Constitutional Court assigns a different status to "wage income" when evaluating the criteria related to financial power. Article 55 of the Constitution, which states that *"wages are the reward for labor. The State shall take the necessary measures to ensure that employees receive a fair wage commensurate with the work they do and benefit from other social benefits"*, distinguishes "wage income" from other sources of income. In this context, it has been emphasized *that "when the principle of 'financial power' in Article 73 of the Constitution and the principle of 'obtaining a fair wage' in Article 55 are considered together, taxing wage income at the same rate as non-wage income and increasing it in a way that causes a decrease in wages without any*

precautions" undermines the principle of justice. For this reason, the Constitutional Court has deemed it unconstitutional to tax both wage and non-wage income at the same rate, devoid of any protective mechanism for wage income (Constitutional Court, E.2006/95, K.2009/144, 15/10/2009).

The personal circumstances of taxpayers must be taken into account in the law for the selection of taxable areas and the fair and balanced distribution of the tax burden. Differential taxation of capital gains compared to wages, minimum living allowances, progressive taxation, and various exemptions and exclusions are tools for equitable distribution of the tax burden and taxation based on financial power (Constitutional Court, E.2017/117, K.2018/28, 28/02/2018).

The Constitutional Court has found that the difference in taxation rates between full and limited taxpayers, regardless of the nature of their income, violates the principles of financial power and equality. In this context, according to the Constitutional Court, *"if there is no difference in the nature of the income, the taxpayer's residence cannot be the reason for the difference". "Reverse discrimination by subjecting the full taxpayer to a 15% withholding tax rate and the limited taxpayer to a 0% withholding tax rate, which are equal in terms of the same income item, is unreasonable and fair and violates the principles of 'financial power' and 'equality in taxation', which stipulate that those with the same financial power should be taxed at the same rate and those with different financial power should be taxed at different rates."* (Constitutional Court, E.2006/119, K.2009/145, 15/10/2009)

SUMMARY

Taxation is a power effectively exercised by states and constitutes an intervention in property rights. The lawful exercise of this power is only possible by adhering to the principles and criteria whose origins date back centuries and are set forth in the 1982 Constitution. The fundamental principles and principles regarding taxation, as a requirement for the protection of fundamental rights and freedoms and the rule of law, are enshrined in the Constitution. These principles and principles include principles not solely related to tax law but also to other branches of law, such as the rule of law, the

social state, and the legality of administration, whose explanation and interpretation can be linked to tax law. There are also principles related to direct taxation, as stated in Article 73 of the Constitution. Indeed, the compliance of tax regulations with the principles stipulated in the Constitution is monitored through norm review decisions of the Constitutional Court. Individual applications to the Constitutional Court assess the compliance of tax practices with constitutional taxation principles, along with other fundamental rights and freedoms. The Constitutional Court's norm review decisions and individual application decisions serve the purpose of concretizing taxation principles and ensuring tax justice in the Turkish tax system. In the Constitutional Court's norm review decisions regarding taxation principles, the purpose of the relevant law, the economic conditions of the relevant period, and the fiscal policies adopted during that period appear to influence the Court's opinions. Indeed, the Constitutional Court's freedom in concretizing taxation principles allows for the prioritization of the economic conditions and fiscal policies of the period. This prevents taxation principles from becoming clearly defined principles, allowing them to become principles embodied through the Constitutional Court's approach and interpretation.

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CHAPTER 2

FINANCIAL INCLUSION AND THE PARTICIPATION OF WOMEN IN THE ECONOMY

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INTRODUCTION

With globalization, the need of societies and states for resources is increasing day by day. However, macroeconomic indicators such as inflation, unemployment, interest rates, and countries' credit default swap (CDS) premiums not only make access to these resources more difficult each day but also cause some countries to struggle with poverty due to limited access to resources and various economic reasons.

In today's world, especially after the pandemic, the element of financial inclusion comes to the fore in low- or middle-income countries to enable sustainable economic development and to ensure fair distribution of assets and equal access to social opportunities. Today, at the micro level, it plays an important role in the fight against poverty that families and companies, and even states at the macro level, can access the needed credit and funds both easily and at an affordable cost. Fighting poverty not only allows individuals living in a country to live in more prosperous and humane conditions but also plays an important role in increasing sustainability and resilience at the economic level.

In 2024, the world population reached 8.2 billion people (Pison & Poniakina, 2024, p.1). Today, almost half of the world's population consists of women. According to official data compiled from the World Bank development indicators for 2024, the female population in the world is reported to be 4.05 billion (World Bank, 2025). However, women still cannot access these resources and cannot be included in the financial system in many countries and regions of the world. This situation actually stems from the economic indicators of countries; however, it also results from problems such as lack of equal opportunity in education, limited access to property rights, gender discrimination, and structural inequalities. This situation is particularly striking in the economies of underdeveloped or developing countries. It is especially prevalent in the African continent.

Today, a large proportion of women in the world have not yet opened a bank account or cannot access the credit they need for various reasons. In some Middle Eastern countries, South Asian countries, and Sub-Saharan African countries, inequality in access to financial resources is intensely

observed. According to the report published by the World Bank in 2021, there is still a 6% gender gap globally in terms of bank account ownership (World Bank, 2025). This difference still constitutes a barrier in some countries for women to engage in commercial activities on their own, to earn income, or to declare their economic independence.

At this point, microfinance comes into play. Microfinance is a movement aimed at delivering financial services to consumers and low-income customer groups who cannot access the traditional and next-generation banking system. Grameen Bank, established in 1976 in Bangladesh to combat poverty and granted official bank status in 1983, today operates in 81 countries and not only encourages financially disadvantaged individuals and institutions—especially poor women—to establish their own businesses by providing microloans without collateral or with low collateral amounts, but also initiated the global microfinance movement and was awarded the Nobel Peace Prize in 2006.

Today, the inclusion of women in the financial system and their ability to earn their own income is important not only individually but also socially and economically at the macro level. Again, it is observed that in various parts of the world, women who have established and grown their own businesses with limited resources and micro-supports have created employment that positively affects the livelihood of many families, especially women, and have contributed to the national economy by paying taxes and expanding their business networks to make new investments.

In addition, increasing financial literacy levels and the development of financial knowledge for both women and men positively affect individuals' investment decisions and enable them to better analyze the relationship between risk and expected return as financial literacy levels rise. Furthermore, increasing financial literacy is not limited to its positive effects on individuals only; it is also emphasized that it has positive impacts on the development of national economies and financial markets (Bayri, 2024, p.119).

This situation demonstrates how important it is to provide not only microcredits that support especially women in establishing their own businesses through microfinance, but also financial literacy training.

Keywords: Microfinance, Financial Inclusion, The Role of Women in the Economy

1. The Concept of Microfinance

In the literature, microfinance is defined as access to banking services for low-income, poor, or extremely poor segments of the population. This system, which was created to help economically disadvantaged individuals discover their potential, establish their own businesses, and access the credit they need, is referred to as microfinance.

The concepts of microfinance and microcredit are sometimes confused. The main reason for this can be considered the fact that the starting point of microfinance in the 1970s began with microcredit services. Microcredits are loans given to businesses that want to start their own enterprises or improve their existing businesses but do not have sufficient access to credit, in order to obtain the raw materials, supplies, or necessary capital they need (Christen et al., 2003, p.1).

Another reason for the confusion between the terms microcredit and microfinance is that a large portion of microfinance services consists of microcredit services. However, microcredits can be defined as a component of microfinance. While microcredit provides the capital necessary to initiate a business model for individuals to generate income, microfinance offers a broader solution framework for all financial needs of individuals. Moreover, microcredits generally serve as a short-term solution to a need, while microfinance aims for long-term economic development and financial independence of low-income individuals.

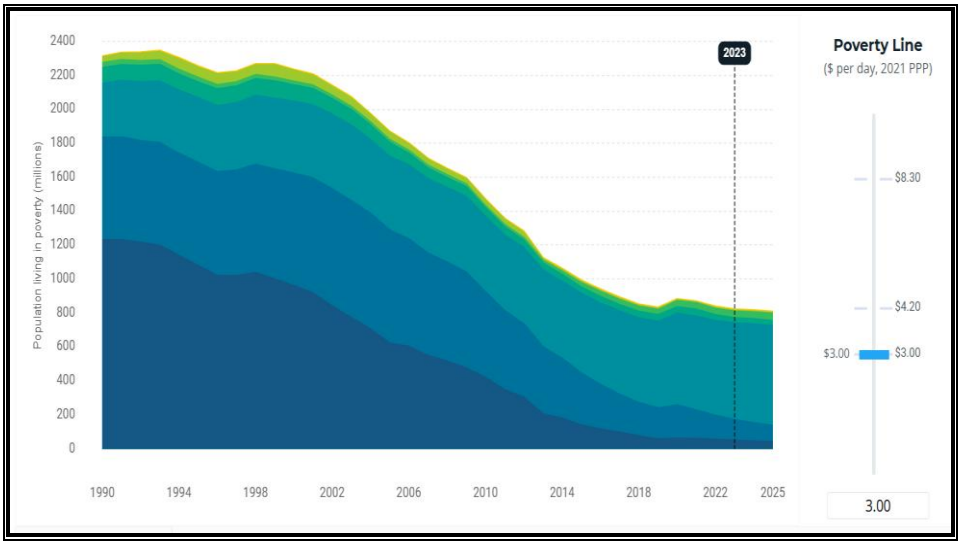
Initially, microfinance was limited only to credit, but over time, services such as savings and insurance have been added, allowing it to operate in a broader field. Based on mutual trust, this service is a strategy that does not require guarantors and supports the potential of poor or extremely poor segments to escape poverty. All the support and loans provided to individuals

who do not have access to traditional banking services such as deposits, lending, or insurance, and especially to women in rural areas who face gender discrimination or various obstacles in accessing the necessary funds to start a business, constitute microfinance.

2. Target Group of Microfinance

Individuals who fall within the target group of microfinances in the world are those with low or very low incomes who are unable to access the resources needed to start their own businesses or continue their existing ones. The fact that in various regions of the world today, there are people trying to work or sustain their lives with a daily income of less than 3 dollars indicates that these programs need to be used effectively.

Figure 1: Global Poverty Trends by the $3.00 per Day Threshold (in Millions, 2021 PPP), 1990–2023



Sources: World Bank. (2025). *Poverty and Inequality Platform*, https://pip.worldbank.org. Accessed: 16.07.2025

Figure 1 illustrates the change over time in the global population living below the international poverty line defined at the level of 3 US dollars per day in 2021 purchasing power parity (PPP) between the years 1990 and 2023.

When we look at the year 1990, it is observed that approximately 2.3 billion people worldwide were living below this poverty line, while by the year 2023, this number had decreased to between 700 and 800 million people. The data in the graph show that although global poverty has significantly declined over the past 30 years, nearly 1 billion people around the world are still trying to survive on less than 3 dollars a day. Especially since the early 2000s, poverty rates around the world have shown significant decreases. This period corresponds to the time when countries globally accelerated their social support programs and implemented rural development policies.

By 2019, with the onset of the COVID-19 pandemic and economies coming to a standstill, poverty rates began to increase again. This can also be interpreted as a reflection of the negative effects of the pandemic on the global economy. With the start of the pandemic, many businesses, especially small enterprises, suffered serious losses in income and were left without support. Likewise, unemployment rates increased during this period.

Additionally, the colors used in the graph represent the depth of poverty. The darkest colors indicate individuals and groups with the lowest income levels, while lighter tones represent those relatively closer to the poverty line. In light of all these developments, it is known that policies supporting social development and rural areas, as well as education and health expenditures and support, along with financial inclusion and economic growth, play an important role in reducing global poverty around the world. However, another striking fact is that no matter how much national economies develop, there are still millions of people in various parts of the world who do not have access to clean water and food.

When the world is examined as a whole, women occupy a significant place among the active users of microfinance globally. Among the main reasons for women's intense participation in these programs are gender discrimination, disadvantages in labor force participation, the perception that women are more responsible, the belief that microcredits will be used efficiently and repaid on time, and the low-risk perception. In addition, in some societies, women are pushed into the background. Microfinance adopts

the goal of enabling women to participate in the labor force and take an active role in society (Dişbudak & İnci, 2019, p.74).

Moreover, microfinance targets rural populations engaged in agriculture and livestock who cannot access banking services. In some countries, low-interest loans and flexible repayment terms are offered to this group. Some public banks and cooperatives take the lead in this regard, and government incentives allow these groups to maintain their commercial activities. However, in some countries, this mechanism is not well developed or does not exist at all.

3. The Concept of Financial Inclusion

Countries around the world seek to ensure that their financial systems and the use of financial instruments are widespread and reliable. Governments also aim to strengthen oversight mechanisms to ensure the smooth operation of the financial system, thereby increasing the confidence of market participants in the system and encouraging the inclusion of new participants. Financial inclusion involves the effective use and distribution of resources. An effective financial system not only enables the efficient use and allocation of resources but also facilitates the development of the financial system and the economy. In addition, the informal economy can be reduced through effective oversight mechanisms and the formation of markets. Efficient markets not only ensure the confidence of participants but also enable foreign investors to be included in the system, support capital formation, and strengthen economic development.

A financial system is considered comprehensive in three main dimensions. The first of these is physical access to the system, which refers to the availability and ease of access to financial service networks. In general, the lack or insufficiency of financial opportunities in rural areas and smaller cities can negatively affect investors. The second is usage, and the third is the quality of financial services. These involve the use of appropriate and quality financial products and services that meet the desires and needs of consumers. A financially inclusive market is one in which all three of these elements are effectively present (Ekmen, 2024, pp. 22–23).

An inclusive financial system allows everyone—regardless of gender—to access financial services equally. Individuals, depending on their means, can save and invest using banking services, make money transfers, and carry out their financial transactions as active users of the system.

According to Sethy (2016), the effective and widespread use of financial inclusion can prevent irregularities in social assistance by enabling governments to transfer aid and subsidies that support social development directly to beneficiaries' bank accounts, thereby increasing the impact of inclusive economic growth. Moreover, making financial inclusion more effective is important for the following reasons (Sethy, 2016, p.191):

1. **Economic Goals:** The economic objectives of financial inclusion include ensuring equity in income distribution and closing the gap between income and savings through the fair and efficient allocation of resources.

2. **Savings Mobilization:** Thanks to the services provided, especially to those with limited access to financial services, the savings of all segments of society can be included in the system and contribute to economic growth through investments.

3. **Creating a Broader Market for the Financial System:** After the formation of an efficient financial market, larger financial markets can be created for the more effective use of high levels of accumulated savings. Such broader markets can appeal to a wider segment of society while also supporting the growth and development of the banking sector.

4. **Social Goals:** Within the framework of social responsibility, the provision of credit by the banking sector to support the fight against poverty plays a crucial role in poverty alleviation.

5. **Sustainable Livelihoods:** The provision of supportive loans and incentives by the banking sector to low-income or poor segments of society in the fight against poverty can enable individuals to

establish their own businesses, thus creating sustainable sources of livelihood.

The development of financial systems is important for both individuals and institutions. The presence of effective financial market mechanisms facilitates the transfer of funds between savers and those who need funding for various reasons, simplifies payment and monetary transactions, and helps manage economic risks effectively. In the literature, it is frequently supported that countries with developed economies generally have effective and strong financial structures (Mengistu & Saiz, 2018, p.4).

4. Women and Microfinance from an International Perspective

Microfinance is a significant financial tool that particularly supports the economic development of women in less developed and developing countries. The Grameen Bank, established in Bangladesh, provides a substantial portion of its loans to women. In this way, women are able to establish their own businesses with the credits they receive and meet their education and health expenses. Apart from this, women working in various jobs may be subjected to low wages.

In microcredit and microfinance programs, while emphasis is placed on empowering women and ensuring that they receive the value of their labor, the gender perspective is also noteworthy. However, in some communities, due to patriarchal pressure or various restrictions, women may have difficulty accessing the funds they need to start or grow their businesses. This situation highlights the need for research aimed at resolving the social and economic problems preventing women from establishing their own businesses, along with their position in society and their role and importance within the family.

In particular, in recent years, programs and loans that aim to reduce poverty, support rural areas, and increase investments have been supported by many governments. Within these programs, there is an emphasis on women as the foundation of the family structure. Today, around the world, the concept of

microcredit and microfinance is used not only as a means of combating poverty but also as a tool for empowering women.

Microfinance advocates believe that women's access to capital will strengthen them economically and politically, and that creating a more equitable, just, and politically competitive environment in society will contribute further to the development of the economy. Some researchers argue that one of the main reasons microcredits focus on women is because women use the capital they obtain from loans for their families' livelihoods. The idea that women will spend the money they receive on necessary needs and not use it wastefully is also emphasized (Balkız, 2015, p.542).

Moreover, another reason why the concept of microfinance focuses on women is that women are more loyal to the loans they receive and have high repayment rates. In other words, it can be said that women are more committed to their debts. In some regions, women repay the loans they use at a rate of 100%, which supports the core vision of the microfinance concept. This situation strengthens the idea of microfinance advocates that women should be supported not only socially but also due to their timely repayment of loans. In addition to establishing businesses that will provide self-employment, supporting women also enables them to be involved in fundamental economic and political processes from a societal perspective (Keating et al., 2010).

Today, from an international perspective, the empowerment of women is associated with their participation in the economy by gaining independence. Undoubtedly, although research shows that when women are economically empowered, they contribute to themselves, their families, and even the national economy, it is still observed that in some patriarchal societies, women are kept in the background socially due to various forms of pressure. At this point, it is necessary for governments to expand social policies to address all segments of society and to minimize gender discrimination as much as possible. Although the main goal of policies created to combat poverty is to reach the poor in all segments of society and provide them with access to the resources they need and offer microcredit opportunities, the need for additional policies tailored specifically for women and for microcredit

opportunities for them is increasing day by day. Considering that there are still people in various parts of the world who cannot access microcredits, it becomes a priority to implement additional policies, primarily by the United Nations.

5. CONCLUSION AND EVALUATION

In various parts of the world, the fight against poverty stands out as an economic, social, and political responsibility. States have been implementing various policies to combat poverty for years; while some of these policies have positive effects, others remain insufficient and cannot be fully implemented. The phenomenon of microfinance is a significant financial term that comes to the fore in the fight against poverty. Through microfinance, individuals who try to sustain their lives as poor or very poor are provided with access to the funds they need both to maintain their lives and to develop their own businesses and obtain the materials they require. Particularly in rural areas where people are far from technology and unable to access financial services, funds transferred through policies implemented in these regions are not only important for enabling people to sustain their lives but also offer opportunities for the development and advancement of those regions.

Today, while there are individuals in some parts of the world trying to work for a daily income of less than 3 dollars, it is also known that there are still people who struggle to access clean water and food sources. At this point, microfinance provides access to the needed resources without discrimination between women and men. These microcredits are often provided without guarantors and serve as an important resource to support individuals' lives. Some studies argue that microfinance should be supported especially in creating awareness for women. However, although some research shows that microfinance focuses more on women, it also reveals that microcredits are still more commonly used by men. In developing countries, female entrepreneurs are generally supported. The underlying reason for this is not only to increase women’s socioeconomic impact within society but also to reduce female poverty from a societal perspective.

Microfinance institutions should not only provide the resources needed by poor segments but also support access to knowledge and capital. At this point, financial inclusion comes into play. Thanks to efficient financial markets and instruments provided by governments, access to the financial instruments needed by all segments of society is ensured, and the national economy will also show progress. As in the fight against poverty, states have major responsibilities in the establishment of efficient and reliable financial markets. Supervisory mechanisms should operate quickly and effectively, and foreign investors should be supported.

In conclusion, financial inclusion is an important step in ensuring the effective participation of women in economic life. Enabling individuals, especially women, to access the credit they need, digital payments, and the financial system not only supports individual and societal development but also contributes to the development of national economies. Although microfinance was initially used as a first step in supporting low-income women, over time it has turned into an important program in promoting female entrepreneurship.

With globalization and technological advancements, the main goal today for sustainable economy and development is to provide access to broader financial services beyond microfinance. In the future, the reduction of the need for microfinance through various national development and economic programs, and the establishment of a more comprehensive integration that will raise the welfare levels of societies and generate income, will demonstrate that the steps taken on this path are accurate and effective.

6. SUMMARY

Financial inclusion constitutes one of the fundamental pillars of individuals' participation in economic life and access to effective financial markets. Market participants who wish to invest their savings and prevent the depreciation of their accumulations against inflation, as well as generate income from their savings, come together with market participants seeking access to funds for various reasons through an effective financial system. This situation constitutes an important part not only of social but also economic development. For this purpose, microfinance emerges as an important actor

not only for low-income individuals but also for those excluded from the financial system due to various reasons.

Through microfinance, many people have increased their productivity by establishing small-scale enterprises and have started to add value to the national economy. Women especially constitute a significant part of this system. Women, through microfinance, have not only positively affected their own lives by becoming an important part of society and the economy but have also continued to be a significant part of their families' and the country's economic development. However, the long-term development and economic growth policies of states should not rely solely on microfinance.

While micro-scale loans are important in the lives of people living in a certain region of societies, at a certain point, the implementation of macro-scale credit and economic policies becomes of great importance. The key to sustainable finance and economy is possible through supporting societies and increasing production levels. Increasing financial literacy, establishing an effective and inclusive financial system, and ensuring that every segment of society, especially women, can access the needed systems and funds without being marginalized will constitute an important part of social and economic development. At this point, the effective and equitable use of supports initiated by microfinance at the macro level and across every segment of society constitutes the key role for economic and financial development.

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CHAPTER 3

THE EFFECT OF TRADE OPENNESS AND FINANCIAL DEVELOPMENT ON ECONOMIC GROWTH: EVIDENCE FROM E-7 COUNTRIES

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INTRODUCTION

The primary goals of macroeconomics are to achieve economic growth, development, and maximize the standard of living. In this context, the effects of trade openness and financial development on economic performance have recently become a significant topic of discussion in the economics literature. It has been argued that increasing foreign trade volume and financial development can play a significant role in economic growth. Trade openness increases production efficiency, and financial development facilitates the provision of financing sources. For countries with development potential, trade openness and financial development play a significant role in achieving economic development goals.

Sustainable and inclusive economic growth cannot be achieved solely by increasing income levels. The development of labor markets, the promotion of technological innovation, and the improvement of the quality of life must accompany this income increase. In this context, the analysis of the factors affecting economic growth has long been an important research topic in the economics literature. Among these factors, the level of trade openness and the development of the financial system stand out as variables that can have structural and lasting effects on growth. Trade openness is often considered an indicator of a country's economic integration with the outside world. Trade openness enables increased international trade volume, production based on countries relative advantages, enabling technology and capital transfer, and increasing competitiveness.

Increasing social welfare requires achieving financial development and enabling financial actors to fulfill their roles. The success of the financial sector facilitates economic development by channeling social assets into efficient resources (Shiller, 2012: 18). Financial development secures financial activities and objectives, providing resources for the necessary steps to promote social welfare. Financial development is a multidimensional concept that refers to the efficiency, depth, and inclusiveness of financial markets and institutions. A developed financial system facilitates more effective investment management, entrepreneurs' access to finance, and the allocation of resources to productive areas. In this way, there are studies in the literature suggesting that financial

development accelerates growth by encouraging capital accumulation and technological advancement.

Trade openness describes the level of economic integration of a country's economy with the outside world. In this respect, it can play a role in increasing economic efficiency by enabling the efficient use of resources. Financial development, on the other hand, plays a role in facilitating capital flows and determining investment efficiency. Theoretical and empirical studies primarily focus on the relationship between economic growth, trade volume, and financial development. The primary objective of this study is to examine the effects of trade openness and financial development on economic growth for the E-7 countries, considered to be countries with high growth rates, for the period covering 1995-2020. The E-7 group of developing countries consists of China, India, Brazil, Russia, Indonesia, Mexico, and Turkey. The first section of the study examines selected studies from the existing applied economics literature examining the relationship between trade openness, financial development, and economic growth. The second section describes the data set, model, and methodology. The third section presents the empirical results of the applied econometric analysis. The conclusion section presents the empirical results and policy recommendations obtained from the study.

1.LITERATURE REVIEW

Economic growth models demonstrate the productivity-boosting effect of foreign trade through specialization and economies of scale. Technology and knowledge transfer, in turn, lead to increased capital accumulation and increased trade volume. The impact of financial development is the expansion of financial markets and, through the influence of financial intermediaries, increased economic growth. As a result, the number of studies examining the impact of trade openness and financial development has increased in recent years within the scope of economic growth studies.

Gries, Kraft, and Meierrieks (2009) examined the impact of financial deepening and trade openness on economic growth using data from the 1960s to 2003/2004 for 16 Sub-Saharan African countries. The empirical results

obtained in the study concluded that financial development and trade openness positively affect economic growth.

Menyah et al. (2014) who examined the causal relationship between financial development, trade openness, and growth for 21 African countries using panel data for the period 1965-2008, found that financial development and trade openness did not have a significant impact on economic growth.

Sakyi et al. (2014) examined the impact of trade openness on income levels and economic growth using a sample of 115 developing countries for the period 1970-2009. The study's results show that the relationship between trade openness and income levels is positive and bidirectional in the long run, while the relationship between trade openness and economic growth is in the same direction in the short run.

Polat et al. (2015) examined the impact of financial development on economic growth by incorporating trade openness into the production function, using data from South Africa for the period 1970-2011. The results concluded that financial development positively affects economic growth, while trade openness negatively affects it.

Jamel and Maktouf (2017) examined the relationship between economic growth, environmental degradation, financial development, and trade openness using annual data for 40 European economies for the period 1985-2014. The results of the panel causality test applied in the study indicated that there is a two-way causality between economic growth and environmental degradation, financial development, and trade openness.

Ayad and Belmokaddem (2017) examined the causal relationship between financial development, trade openness, and economic growth using data from 1980 to 2014 for 16 MENA countries. The analysis results showed that financial development and trade deficits did not have a significant effect on economic growth for this group of countries and period.

Elhigiamusoe and Lean (2018) examined the relationship between financial development, trade openness, and economic growth using data from 1980 to 2014 for Ghana, Nigeria, and South Africa. A long-run causality

relationship was identified. The empirical results show that financial development and trade openness are effective in accelerating growth, and that growth and financial development positively affect trade openness.

Rani and Kumar (2018) examined the relationship between foreign direct investment inflows, trade openness, and economic growth in BRICS countries using panel data analysis for the period 1993-2015. In the study testing cointegration and causality, the analysis results indicated a long-run relationship. The analysis for BRICS countries concluded that trade openness has a positive effect on economic growth and that there is a short-run bidirectional causality between foreign direct investment inflows and economic growth.

Sghaier (2021) examined the relationship between financial development, trade openness, and economic growth for four North African countries: Tunisia, Morocco, Algeria, and Egypt for the period 1991-2015. The panel data analysis results indicate a positive relationship between trade openness and economic growth, and that trade openness is a complement to financial development.

Nam and Ryu (2024) used a panel covering the period 2000-2022 in their study examining the impact of trade openness on economic growth in 10 ASEAN member countries by including variables such as financial development, employment, consumer price index, and telephone usage. The analysis results in the study show that increasing trade openness negatively affects economic growth.

2. EMPIRICAL FRAMEWORK

This section introduces the dataset used to analyze the relationship between economic growth, financial development, and trade openness. It also presents the econometric model and provides explanations regarding the methodology employed in the analysis.

2.1. Dataset

This study analyzes the relationship between economic growth, financial development, and trade openness among the E-7 countries. The analysis is based on balanced annual panel data from 1995 to 2020. Table 1 lists the variables used to examine this relationship, along with their definitions. To account for potential heteroskedasticity and autocorrelation, all variables included in the analysis have been transformed into their natural logarithmic forms. The variables presented in Table 1 were selected through a comprehensive review of relevant literature covering the 1995–2020 period on an annual basis.

Table 1: Definition of Variables Used in the Empirical Analysis

Variable	Abbreviation	Definition	Source
Economic Growth	Y	GDP per capita in constant 2010 US$	World Bank (2025)
Financial Development	FD	Financial Development Index	World Bank (2025)
Trade Opennes	TO	(Exports+Imports)/GDP	World Bank (2025)

2.2. Econometric Model

In the analyses conducted to determine the relationship between economic growth, financial development, and trade openness, different variables are incorporated into the model depending on the country group, time dimension, and analytical methods used. The econometric model in this study is structured to identify the relationship between economic growth, financial development, and trade openness. Within this framework, the panel regression model is specified as follows.

$$ln(Y_{it}) = \alpha_0 + \alpha_1 ln(FD_{it}) + \alpha_2 ln(TO_{it}) + e_{it} \quad (1)$$

The variables Y, FD, and TO in the equation represent economic growth, financial development, and trade openness, respectively. In addition, e, i, and t denote the error term, countries, and time, respectively.

2.3. Methodology

The econometric model designed to examine the relationship between economic growth, financial development, and trade openness is carried out in three main steps. First, we conduct tests for cross-sectional dependence and unit roots for the variables involved. Next, we analyze the model for cross-sectional dependence, homogeneity, and cointegration relationships. Finally, we perform the model estimation.Given the interconnectedness among the E-7 countries, it is likely that each panel series exhibits cross-sectional dependence. This dependence can result in unobserved correlations and common trends within the E-7 country group. Therefore, identifying the presence of cross-sectional dependence is essential for conducting reliable unit root tests. Various tests for cross-sectional dependence are available in the literature. In this study, both the variables and the model are assessed using the Lagrange Multiplier (LM) test established by Breusch and Pagan (1980) and the adjusted LM test (LMadj) proposed by Pesaran et al. (2008). The LM and LMadj test statistics are calculated as outlined in Equation (2) and Equation (3), respectively.

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \sim \chi^{2}_{N(N-1)/2} \qquad (2)$$

$$LM_{adj} = \left(\frac{2}{N(N-1)}\right)^{1/2}\sum_{i=1}^{N}\sum_{j=i+1}^{N}\left[\rho_{ij}^{2}\left(\frac{(T-K-1)\hat{\rho}_{ij}^{2}-\hat{\mu}_{Tij}}{\upsilon_{Tij}}\right)\right] \sim N(0,1) \qquad (3)$$

In panel data analysis, it is crucial to determine whether a variable has a unit root, as this influences the choice of an appropriate estimation method. Unit root tests in the literature are divided into two main categories. The first category includes first-generation unit root tests, which do not consider cross-sectional dependence. The second category consists of second-generation unit root tests, which take cross-sectional dependence into account. In this study, the Cross-Sectionally Extended Dickey-Fuller (CADF) unit root test developed by Pesaran (2007), which is a second generation test that addresses cross-sectional dependence, was used. After conducting the CADF regression for

each cross-section, we calculate the CIPS (Cross-Sectionally Augmented IPS) test statistics by taking the simple average of the country-specific CADF statistics. The CIPS test statistic is computed as outlined in Equation (4).

$$\text{CIPS} = \frac{1}{N}\sum_{i=1}^{n} CADF_i \quad (4)$$

Before estimating the empirical model, it is important to examine both cross-sectional dependence and parameter homogeneity. To assess slope homogeneity, this study uses the Delta test ($\tilde{\Delta}$) and the adjusted Delta-tilde test ($\tilde{\Delta}$adj) proposed by Pesaran and Yamagata (2008). These tests allow for robust inference even in the presence of cross-sectional dependence and heterogeneous slope coefficients. The corresponding test statistics are calculated as detailed in Equations (5) and (6).

$$\tilde{\Delta} = (N)^{\frac{1}{2}}(2k)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S} - k\right); \quad (5)$$

$$\tilde{\Delta}_{adj.} = (N)^{\frac{1}{2}}\left(\frac{2k(T-k-1)}{T+1}\right)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S} - 2k\right) \quad (6)$$

In the empirical analysis, we utilize the panel cointegration test developed by Westerlund and Edgerton (2007) to examine the long-term relationships among the variables. This test builds on the Lagrange Multiplier (LM) test proposed by McCoskey and Kao (1998) and uses a bootstrap approach to account for both cross-sectional dependence and serial correlation within the panel (Özcan and Arı, 2014: 47). The LM statistic introduced by Westerlund and Edgerton (2007) is calculated as shown in Equation (7).

$$LM_N^{+} = \frac{1}{NT^2}\sum_{i=1}^{N}\sum_{t=1}^{T} W_i^{-2} S_{it}^2 \quad (7)$$

The null hypothesis for this test indicates that a cointegration relationship exists, while the alternative hypothesis suggests that such a relationship does not exist. When cointegration relationships are identified in the model, it is essential to estimate the long-run coefficients. The choice of the appropriate estimation method depends on various diagnostic tests. In this study, the cointegration coefficients are estimated using the Augmented Mean Group (AMG) estimator, as proposed by Eberhardt and Bond (2009). The fundamental

equation of the AMG (Augmented Mean Group) method aims to estimate the long-run relationship at the panel level. The estimation process consists of two stages. In the first stage, common dynamics are obtained. In the second stage, the long-run relationship is estimated. The core formulation of these dynamics is calculated as shown in Equations (8), (9), (10), and (11).

$$\Delta y_{it} = b'\Delta x_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \quad (8)$$

$$\hat{c}_t \equiv \hat{u}_t \quad (9)$$

$$y_{it} = \alpha_i + b_i' x_{it} + c_{it} + d_i \hat{u}_t + e_{it} \quad (10)$$

$$\hat{b}_{AMG} = N^{-1} \sum_i \hat{b}_i \quad (11)$$

3. EMPIRICAL RESULTS

The relationship among economic growth, financial development, and trade openness has been examined for the E-7 countries, which include Brazil, China, Indonesia, India, Mexico, Russia, and Turkiye. As part of the empirical analysis, cross-sectional dependence was tested for these countries. The results of the cross-sectional dependence tests are shown in Table 2. These tests indicate that all variables exhibit cross-sectional dependence. This finding requires the use of second-generation unit root tests that take cross-sectional dependence into account. Consequently, the CIPS unit root test was applied, and its results are also presented in Table 2. According to the unit root test results, all variables show the presence of a unit root at their level values.The relationship among economic growth, financial development, and trade openness has been examined for the E-7 countries, which include Brazil, China, Indonesia, India, Mexico, Russia, and Turkiye. As part of the empirical analysis, cross-sectional dependence was tested for these countries. The results of the cross-sectional dependence tests are shown in Table 2. These tests indicate that all variables exhibit cross-sectional dependence. This finding requires the use of second-generation unit root tests that take cross-sectional dependence into account. Consequently, the CIPS unit root test was applied, and its results are also presented in Table 2. According to the unit root test results, all variables show the presence of a unit root at their level values.

Table 2: Cross-Sectional Dependence and Unit Root Test Results

Country Group→	**E-7**		
Control→	**Unit Root Test Results (Without Trend)**		
Test↓	***lnY***	***lnFD***	***lnTO***
Breusch–Pagan (1980) LM	58.723 [a] (0.005)	45.133[a] (0.003)	44.560[a] (0.002)
Pesaran–Ullah–Yamagata bias–adjusted (2008) LM	27.587 [a] (0.000)	4.719[a] (0.000)	3.821[a] (0.000)
Control→	**Unit Root Test Results (With Trend)**		
Breusch–Pagan LM	50.004 [a] (0.000)	41.648[a] (0.005)	48.228 [a] (0.000)
Pesaran–Ullah–Yamagata bias–adjusted LM	24.491 [a] (0.000)	3.931[a] (0.000)	3.537 [a] (0.000)
Control→	**Unit Root Test Results (Without Trend)**		
Test↓	***lnY***	***lnFD***	***lnTO***
CIPS (Level)	-1.524	-2.136	-1.442
CIPS (First Difference)	-2.753	-3.906	-4.289
Control→	**Unit Root Test Results (With Trend)**		
CIPS (Level)	-1.067	-2.658	-2.476
CIPS (First Difference)	-3.039	-5.445	-4.353

Note: The optimal lag lengths range between 1 and 3 and are selected based on the Schwarz criterion with a maximum lag of 5. Superscripts *a*, *b*, and *c* denote statistical significance at the 1%, 5%, and 10% levels, respectively. All variables are stationary at the I(1) level.

Table 3 shows the results of the tests for homogeneity, cross-sectional dependence, and cointegration related to the model. The findings indicate that the model is heterogeneous and shows signs of cross-sectional dependence.

Additionally, the cointegration test results confirm the presence of a long-term relationship among the variables within the model.

Table 3: Model Specification and Cointegration Test Results

Country Group→	**E-7**	
Test↓	**Test↓**	**Model**
Homogeneity Test	Pesaran–Yamagata (2008) Delta–tilde	16.788[a] (0.000)
	Pesaran–Yamagata (2008) adjusted Delta–tilde	18.251[a] (0.000)
Cross-Sectional Dependence Test	Breusch–Pagan (1980) LM	55.23 [a] (0.000)
	Pesaran–Ullah–Yamagata (2008) bias–adjusted LM	13.62 [a] (0.000)
Cointegration Test	Westerlund–Edgerton (2007) bootstrap LM: Model without Trend	4.985 (0.257)
	Westerlund–Edgerton (2007) bootstrap LM: Model with Trend	3.150 (0.924)

Note: Probability values are reported in parentheses. Superscripts a, b, and c indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Based on the empirical analysis results, the Augmented Mean Group (AMG) estimation method was utilized to estimate the model. The AMG estimation results are shown in Table 4.

Table 4: Estimation Results of Cointegration Coefficients (AMG)

	AMG Results (Without Trend)		**AMG Results (With Trend)**	
lnFD	0.125 [0.130]		0.093 [0.122]	
lnTO	-0.155[a] [0.058]		-0.100[c] [0.057]	
Country-Level Results				
Brazil	***lnFD***	0.353[a] [0.083]	***lnFD***	0.354[a] [0.085]
	lnTO	-0.354[a] [0.056]	***lnTO***	-0.358[a] [0.060]
China	***lnFD***	0.004 [0.188]	***lnFD***	0.099 [0.132]
	lnTO	-0.070 [0.045]	***lnTO***	0.019 [0.036]
Indonesia	***lnFD***	-0.269[c] [0.162]	***lnFD***	-0.322[b] [0.171]
	lnTO	-0.133 [0.141]	***lnTO***	-0.096 [0.145]
India	***lnFD***	0.395[a] [0.111]	***lnFD***	0.256[a] [0.097]
	lnTO	-0.172[a] [0.001]	***lnTO***	-0.089[b] [0.046]
Mexico	***lnFD***	0.578[a] [0.095]	***lnFD***	0.529[a] [0.070]
	lnTO	-0.266[b] [0.120]	***lnTO***	-0.124 [0.093]
Russia	***lnFD***	0.147[b] [0.072]	***lnFD***	0.052 [0.091]
	lnTO	-0.217[a] [0.022]	***lnTO***	-0.174[a] [0.034]
Türkiye	***lnFD***	-0.333[b] [0.172]	***lnFD***	-0.316[c] [0.188]
	lnTO	0.126 [0.108]	***lnTO***	0.123 [0.111]

Note: Brackets [ ] indicate standard error values. Superscripts *a*, *b*, and *c* denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4 presents the results of the AMG estimation for two models: one without a trend and one with a trend. The results from the no-trend cointegration estimator indicate that the findings for the E-7 country group (Brazil, China, Indonesia, India, Mexico, Russia, and Turkıye) are statistically significant. Specifically, an increase in trade openness is associated with a decrease in economic growth. In contrast, the impact of financial development on economic growth is not statistically significant.When analyzing the data on an individual country basis, a positive and statistically significant relationship between

financial development and economic growth is found in Brazil, India, Mexico and Russia. However, this relationship is negative and statistically significant for Indonesia and Turkıye.

Additionally, a negative and statistically significant relationship between trade openness and economic growth is observed in Brazil, India, Mexico, and Russia. The results from the trend-included cointegration estimator also show that the findings for the E-7 country group are statistically significant. Similar to the no-trend model, an increase in trade openness leads to a reduction in economic growth, while the influence of financial development remains statistically insignificant. At the country level, a positive and statistically significant relationship between financial development and economic growth is noted in Brazil, India, and Mexico. In Indonesia and Türkiye, this relationship is negative and statistically significant. Furthermore, a negative and statistically significant relationship between trade openness and economic growth is once again observed in Brazil, India, and Russia.

CONCLUSION

The relationship between economic growth, financial development, and trade openness is an important and current topic for analysis. In this context, understanding how financial development and trade openness relate is vital for shaping the economic growth of countries. This study examined the connections among economic growth, financial development, and trade openness in the E-7 countries using modern panel econometric tests. The no-trend cointegration estimator results show that the panel findings for the E-7 country group are statistically significant. Specifically, an increase in trade openness leads to a decrease in economic growth, while the impact of financial development on economic growth is not statistically significant. The results from the trend-included cointegration estimator support these findings, confirming that, again, an increase in trade openness results in a similar reduction in economic growth, with financial development still showing no significant effect.

Financial development increases the risk for foreign investments and financial development negatively affects financial development in developing

countries as it becomes difficult to ensure economic stability in the face of shocks (Yücel, 2009: 39). Especially for developing country economies, trade openness and reduction in trade barriers can negatively affect economic growth (Nam and Ryu, 2024: 8). Empirical analysis indicates that trade openness may negatively affect economic growth, and financial development does not significantly impact growth in these countries. These findings suggest that trade liberalization and financial development are not functioning effectively here. Therefore, trade policies should be reoriented to boost domestic production, prioritize high-value exports, and decrease dependence on imports. The financial system should also be strengthened to support the real economy, ensuring resources are allocated to productive investments and financial inclusion is improved. To develop a more inclusive and effective relationship among economic growth, financial development, and trade openness, integrated policy frameworks that address all three areas should be created. Furthermore, structural factors like institutional capacity, transparency, rule of law, and political stability must be fortified. These policy strategies will significantly aid in achieving sustainable growth objectives for the E-7 countries.

SUMMARY

The effects of trade openness and financial development on the economy are important among fundamental economic issues. Economic growth, a crucial topic for economic decision-makers and researchers, is one of the most frequently studied topics in the literature. Achieving resource efficiency and making sound decisions are essential steps in ensuring market efficiency. Achieving and sustaining economic growth is crucial for the E-7 group of countries, where the pace of development is high. From this perspective, determining the effects of trade openness and financial development on economic performance for the E-7 group of countries provides guidance in making economic decisions. Considering the relationship between trade openness and trade volume and the contribution of financial development to investment and economic growth, it is essential for assessing the existing potential. The introduction of the study theoretically explains the relationship between trade openness and financial development and economic growth. The

first section examines selected studies from the existing applied economics literature on this topic. The second section presents the dataset, model, and methodology, and the third section presents the empirical results of the econometric analysis. The following conclusion section presents the empirical results and policy recommendations.

The empirical results indicate that the findings for the panel cointegration relationship for the E-7 country group are statistically significant. The results of the trendless and trend-inclusive cointegration estimators are similar across the panel. Both results indicate that an increase in trade openness leads to a decrease in economic growth, while the effect of financial development on economic growth is not statistically significant. These findings indicate that trade liberalization and financial development have not been effective for the E-7 country group during the period covered by the study, from 1995 to 2020. To achieve the sustainable economic growth target, trade policies and financial development need to be improved in a more comprehensive manner.

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CHAPTER 4

THE LOAD CAPACITY FACTOR AND ITS DETERMINANTS: A PANEL DATA ANALYSIS ON TOP RENEWABLE ENERGY DEVELOPED COUNTRIES[1]

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[1] The publication is original research article based on panel econometric analysis.

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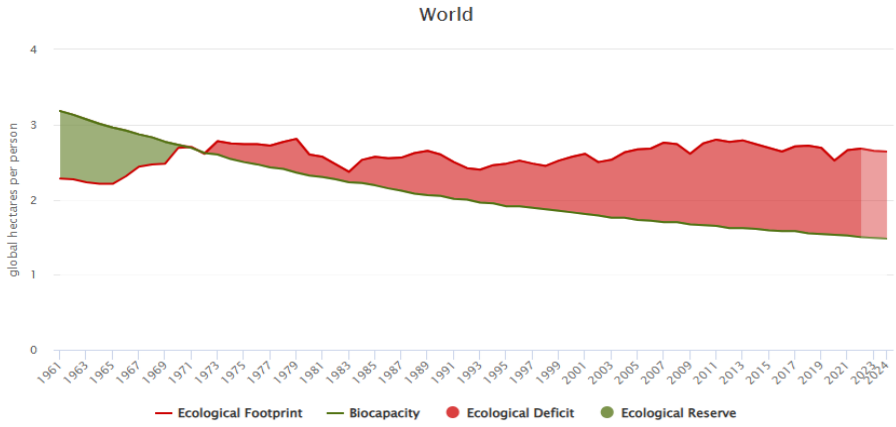
INTRODUCTION

Ensuring environmental sustainability becomes an important challenge in the modern world where environmental degradation that reduces the environmental quality is the barrier for ensuring environmental sustainability. It reduces biocapacity while increases ecological footprint consumption and as a result increase the global warming (Kendall, 2012). Based on the data provided in global footprint network indicates that the biocapacity in the allover world decreases while ecological footprint increases constantly. The graphic 1 that shows below indicates that the biocapacity per person decreases constantly increased between 1961-2024. Although ecological footprint per person was less than biocapacity per person between 1961-1971, it started becoming higher than biocapacity per person from then and as a result the ecological deficit became continuously until 2024. This indicates that environmental degradation all over the world increases continuously. Therefore, it is necessary to reduce ecological footprint per person to ensure environmental sustainability.



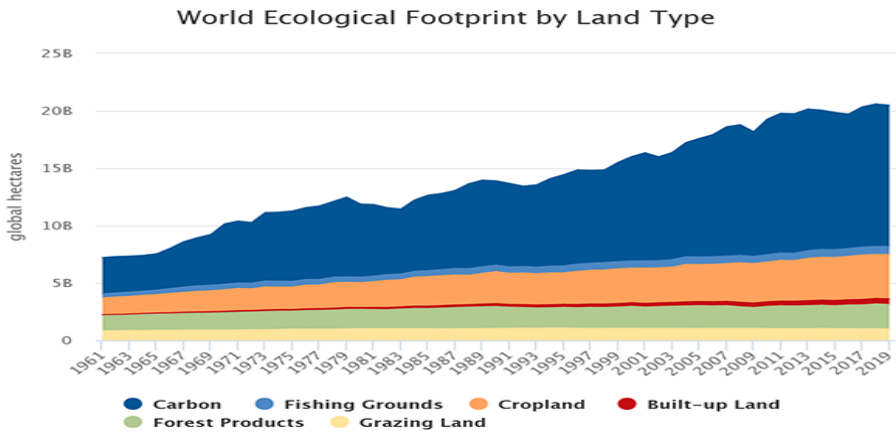
Graphic 1: Ecological footprint and biocapacity in all over the world (global hectares per person)

Source: Global Footprint Network (GFN, 2025)[3]

Ecological footprint occurs mainly because of consuming CO_2 emissions (carbon footprint), fishing, cropping, building construction, deforestation and

[3] https://data.footprintnetwork.org/?_ga=2.226939549.1452660202.1691317658-1800299705.1660133008#/countryTrends?cn=5001&type=BCpc,EFCpc

grazing land. As the above graphic shows that ecological footprint per person increase all over the world, Graphic 2 that shows below indicates that the carbon footprint is the main responsible for increasing ecological footprint that increased constantly between 1961-2019. Therefore, CO_2 emissions are the main factors for environmental degradation. While the following graphic indicates that the ecological footprint also occurs because of using cropland, deforestation and grazing land, it occurs little because of fishing and build-up land. CO_2 emissions occur mainly because of fossil related energy resources that. Besides, economic growth demands more energy use in the industrial sector that is mainly generated from fossil energy resources. As economic growth has a positive relationship with fossil energy consumption, economic growth increases CO_2 emissions and as a result increases environmental degradation. As CO_2 emissions are the main factors for ecological footprint consumption and therefore the main indicators for environmental degradation, it is necessary to control CO_2 emissions to protect biocapacity. This requires the use of alternative energy resources, especially in the industrial sectors that can replace fossil energy resources and therefore reduce CO_2 emissions and as a result there exists sustainable economic growth without generating excessive CO_2 emissions if renewable energy is used in the production process (Arouri et al., 2012; Moriarty & Honnery, 2012; Qi et al., 2014; Waheed et al., 2018).

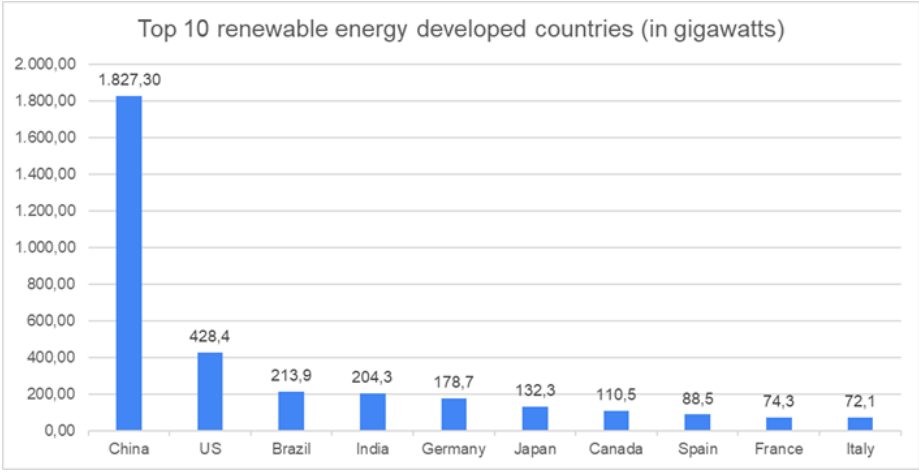


Graphic 2: Ecological footprint in all over the world (global hectares)
Source: Global Footprint Network (GFN, 2025)[4]

[4] https://www.footprintnetwork.org/resources/data/

The environment may become relatively sustainable once the biocapacity is protected by controlling ecological footprint which can be shown as the ratio of biocapacity per capita to ecological footprint per capita that is known as the load capacity factor. As renewable energy can minimize ecological footprint consumption by reducing CO_2 emissions, the current study intends to conduct an empirical study by using panel data model to investigate whether factors including economic growth, human capital, financial development, and globalization have impacts on the load capacity factor. The top 10 renewable energy developed countries for the year 2024 that includes China, United States (US), Brazil, India, Germany, Japan, Canada, Spain, France and Italy are shown below in graphic 3 where China is the mostly developed country than others.

Graphic 3: Top 10 renewable energy developed countries for the year 2024



Source: Statista (2025)[5]

The current chapter begins with discussing the theoretical framework on the load capacity factor where the concept of load capacity factor is elaborated. Furthermore, the chapter conducts a literature review based on past panel studies where different factors that affect the load capacity factor are examined. For empirical studies, the study investigates whether economic growth, human

[5] https://www.statista.com/statistics/267233/renewable-energy-capacity-worldwide-by-country/

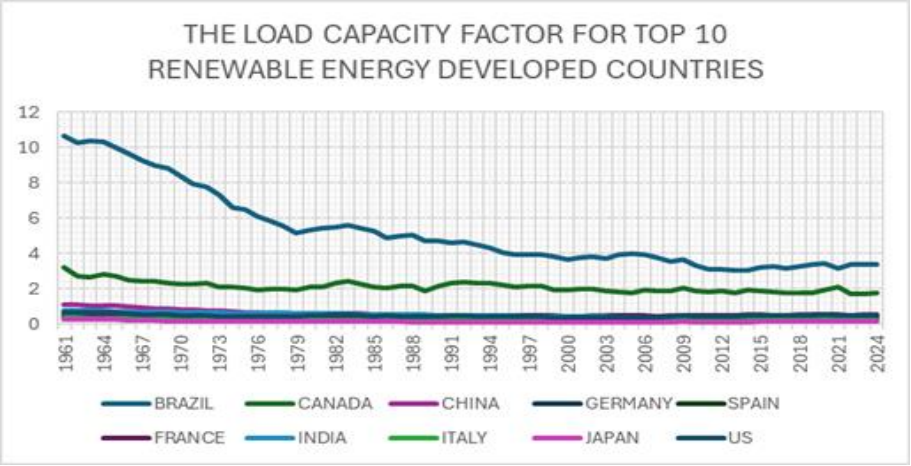
capital, financial development, globalization and renewable energy consumption affect the load capacity factor on top 10 renewable energy developed countries for the year between 1990-2021. The chapter ends with a small summary where different policy recommendations and possible studies for the future are discussed.

1. THEORITICAL FRAMEWORK ON THE LOAD CAPACITY FACTOR

The load capacity factor is mainly the ration between biocapacity and ecological footprint per capita. The load capacity factor can be explained based on the following equation:

$$Load\ capacity\ factor = \frac{Biocapacity\ per\ capita}{Ecological\ footprint\ per\ capita} \quad (1)$$

In equation 1, the load capacity can be constructed by dividing ecological footprint per capita with biocapacity per capita. Here the load capacity factor increases once ecological footprint per capita decreases while the load capacity factor decreases if ecological footprint per capita increases. On the other hand, the load capacity factor increases if biocapacity per capita increases while decreases if biocapacity per capita decreases. Therefore, the environment becomes more sustainable once the load capacity factor remains positive. However, it becomes difficult to keep biocapacity higher than ecological footprint because the ecological footprint becomes higher than biocapacity continuously in all over world where the gap between biocapacity and ecological footprint remains increasing. As ecological footprint increases because of CO_2 emissions, land use, fishing and deforesting, it is necessary to use these efficiently, especially needs to control excessive generation of CO_2 emissions. Graphic 4 shows that the load capacity for top 10 renewable energy developed countries where only Brazil and Canada have the load capacity factor of more than one indicating that these two countries have higher biocapacity than ecological footprint since the beginning.



Graphic 4: The load capacity factor for top 10 renewable energy developed countries
Source: Global footprint network (GFN, 2025)[6]

2. LITERATURE REVIEW

In this section, a literature review is conducted based on some recent past studies where panel data was used to examine the determinants that affect the load capacity factor. The panel data consists of several economies and country groups including Asian-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN), BRICS, G-7, G-8, G-20, Middle East and North Africa (MENA), next emerging countries (N-11), Organization for Economic Co-operation and Development (OECD) and many others. For panel data analysis, all these studies used different panel econometric models including augmented mean group (AMG), common correlation effects (CCE), cross-sectional autoregressive distributed lag (CS-ARDL), Driscoll and Driscoll and Kraay (D-K), dynamic least square (DOLS), fully modified ordinary least square (FMOLS), generalized method of moment (GMM) method of moments quantile regression (MMQR), non-linear autoregressive distributed lag (NARDL), Newey-West standard error (N-W), pooled mean group autoregressive distributed lag (PMG-ARDL), quantile regression (QR) and ridge regression (R-R) panel long run estimation techniques. To determine the load capacity factor, several variables including economic growth,

[6] https://data.footprintnetwork.org/?_ga=2.226939549.1452660202.1691317658-1800299705.1660133008#/countryTrends?cn=5001&type=BCpc,EFCpc

renewable energy consumption, human capital, financial development, globalization, natural resource rent and other variables were used to determine how these variables determine the load capacity factor. Moreover, panel causality test techniques proposed by Dumitrescu and Hurlin (2012) is used in several past studies including Adebayo and Samour (2024), Degirmenci et al. (2024), Zhao et al. (2023), Jahanger et al. (2024), Samour et al. (2024), Teng et al. (2024), Ya et al. (2024), Sun et al. (2024a), Sun et al. (2024b) and Savaş (2025) to see the causal relationship between the load capacity factor and other variables where the load capacity factor was found to have bidirectional relationship, unidirectional relationship and neutral relationship with other variables.

The overall literature review indicates that the variables including economic growth and natural resource rent were mostly found to have negative effects on the load capacity factor while renewable energy consumption was mostly found to have positive effect on the load capacity factor. On the other hand, variables including education expenditure and human capital were found to enhance the load capacity factor. Therefore, variables including renewable energy consumption and human capital can enhance environmental quality while economic growth is the main indicator that reduces environmental quality. Moreover, Financial development was found to be environmentally friendly that can raise environmental quality by increasing biocapacity and reducing ecological footprint. Meanwhile, almost all past studies advised to do proper investment for both green energy, energy efficiency and technological development that can enhance environmental quality. For instance, Ali et al. (2023) advised to enhance investment that can ensure environmental quality by increasing energy efficiency, renewable energy consumption as well as R&D expenditure. While Ya et al. (2024) mentioned that investment can increase environmental quality by enhancing human capital, Jin et al. (2024) added that financial development can enhance education that can further develop environmental quality. In fact, Ali et al. (2024) indicated that human capital can develop environmental quality by enhancing technological progress. Moreover, Li et al. (2023) emphasized investing more in clean energy development including both renewable energy and nuclear energy sources that further enhance environmental quality while Hasan et al. (2025) mentioned both

investment and ethics as the key determinants for ensuring environmental quality. The details of the literature review are provided below in table 1 as follows:

Table 1: Factors determining the load capacity factor (LCF)

Source	Study Area	Period	Methodology	Conclusion
Ni et al. (2022)	High resource consuming countries-11	1996-2019	CS-ARDL	DIG(+), GDP(-), GOV(+), NRR(-)
Shang et al. (2022)	ASEAN-10	1980-2018	CS-ARDL	GDP(-), HEXP(+), REC(+)
Ali et al. (2023)	MINT-4	2002-2020	D-K, QR	ACT(+), ED(+), FFC(-), TI(-)
Caglar et al. (2023)	APEC-14	1992-2018	CUP-BC, CUP-FM	ER(+), GDP(-), HC(+), REC(+), TO(-)
Zhao et al. (2023)	BRICS-6	1990-2019	CS-ARDL	GDP(-), NRR(-), REC(+), SMD(-), TI(≠)
Li et al. (2023)	N-11	1990-2018	AMG, CS-ARDL, FMOLS	DIG(+), GDP(-), GLOB(-), GSTB(+), NRR(-)
Mehmood et al. (2023)	G-8	1990-2018	AMG, CS-ARDL, FMOLS	DIG(+), GDP(-), FD(+), REC(+), TINV(+)
Pata & Samour (2023)	OECD-27	1990-2018	DOLS, FMOLS, MMQR	GDP(-), TINS(-), REC(+)
Adebayo & Samour (2024)	BRICS-5	1990-2018	NARDL	FFC(-), GE(-), GDP(-), REC(+), TXRV(+)
Ali et al. (2024)	G-20	1994-2018	D-K, MMQR, N-W, R-R	ENG(-), FDI(+), GDP(-), HC(+), LCT(+), NRR(+), REC(+)
Degirmenci et al. (2024)	High income countries-8	1990-2020	AMG, CCE	EPS(≠), GDP(-), REC(≠)

Table 1: (Continue)

Source	Study Area	Period	Methodology	Conclusion
Fatima et al. (2024)	G-11	2000-2021	CCEMG, CS-ARDL	EPS(+), GDP(-), GI(+), REC(+)
Guo et al. (2025)	N-11	2000-2022	CS-ARDL	GDP(+), NRR(+), PC(+), TINV(+)
Işık et al. (2024)	G-7	2002-2020	AMG, CS-ARDL	ECONF(-), ENVF(≠), GOVNF(+), SOCF(≠)
Jahanger et al. (2024)	Top sustainable developed countries-10	1994-2018	D-K, FMOLS, MMQR	GDP(-), GLOB(+), ETAX(+), REC(+), TI(+)
Jin et al. (2024)	G-7	1995-2022	MMQR	EDU(+), GDP(-), NRR(+), TRD(+)
Samour et al. (2024)	European countries-25	2004-2018	D-K, DOLS, FMOLS, MMQR	GDP(-), FI(+), REC(+), TI(-)
Sun et al. (2024a)	APEC-34	2002-2021	GMM	EA(-), FDI(≠), GDP (-), INV(-), NRR(-), POP(-), PS(+), RL(+)
Sun et al. (2024b)	APEC-17	1990-2019	AMG, CCE	GDP(-), ERT(+), NRR(+), REC(+), URB(+)
Teng et al. (2024)	Major nuclear power countries-5	1990-2021	CS-ARDL	GDP(-), NEC(+), REC(+), URB(-)
Uche et al. (2024)	BRICS-5	1980-2021	CS-ARDL, MMQR	GDP(-), GT(≠), LCE(+), NRR(-), URB(-)
Voumik et al. (2024)	BRICS-5	1990-2019	D-K, QR	GDP(+), GRP(+), GT(-), NRR(≠), REC(+)

Table 1: (Continue)

Source	Study Area	Period	Methodology	Conclusion
Ya et al. (2024)	BRİCS-5	1990-2018	Panel data model	EPR(+), FP(+), HC(+), NRR(-)
Hasan et al. (2025)	BRICS-5	1996-2022	CCR, FMOLS, PMG-ARDL	DEM(-), GOV(+), IND(-), URB(-)
Savaş (2025)	OECD	1990-2020	PMG-ARDL	GINI(≠), GDP(-), TO(+), REC(+)
Senturk et al. (2025)	MENA-12	2017-2022	GMM	BF(+), FF(-), FH(≠), GI(≠), GS(-), IF(+), JE(+), LF(+), MF(-), PR(-), TB(≠), TF(+)

Note: ACT = Access to clean energy and technology; BF = Business freedom; DEM = Democracy; DIG = Digitalization; EA = Energy aid; ECONF = Economic factors; ED = External debt; EDU = Education; ENG = Environmental goods; EPS = Environmental policy stringency; ER = Environmental regulations; ERP = Energy productivity; ERT = Environmental related technologies; ETAX = Environmental tax; FDI = Foreign direct investment; FF = Financial freedom; FFC = Fossil fuel consumption; FH = Fiscal health; FI = Financial inclusion; FP = Fiscal policy; GDP = Economic growth; GEXP = Government expenditure; GINI = GINI coefficient; GINT = Government integrity; GINV = Green investment; GLOB = Globalization; GOV = Governance; GOVNF = Governance factors; GRP = Geopolitical risk; GSPD = Government spending; GSTB = Government stability; GT = Green technology; HC = Human capital; HEXP = Health expenditure; IF = Investment freedom; IND = Industrialization; JE = Judicial effectiveness; LCE = Low carbon energy; LCT = Low carbon technology LE = Labor freedom; MF = Monetary freedom; NEC = Nuclear energy consumption; NRR = Natural resource rents; PC = Productive capacity; POP = Population; PR = Property rights; PS = Political stability; REC = Renewable energy consumption; RL = Rule of law; SMD = Stock market development; SOCF = Social factors; TB = Tax burden; TF = Trade freedom; TINS = Total insurance; TINV = Technological innovation; TO = Trade openness; TXRV = Tax Revenue; TRD = Trade diversification index; URB = Urbanization.

3. METHODOLOGY

3.1 Data and variable

As the current study intends to examine the effects of economic growth, human capital, financial development, globalization and renewable energy consumption on the load capacity factor in the top ten renewable energy consumed countries, the panel econometric model is applied in the study where

the study period covers for the year between 1990-2021. Variables that are used for the current study were collected from different sources including global footprint network (GFN), globalization index (KOF), international monetary fund (IMF), UNDP human development reports and world development indicators (WDI). Descriptions and sources of all variables are provided in the following table:

Table 2: Descriptions of the variables

Variable	Description of the variable	Source
LCF	Load capacity factor (Biocapacity per capita gha/ecological footprint per capita gha)	GFN (2025)
Y	GDP per capita (constant 2015 US$)	WDI (2025)
HC	Human development index	UNDP (2025)
FD	Financial development index	IMF (2025)
GLB	Globalization index	KOF (2025)
REC	Renewable energy consumption (% of total final energy consumption)	WDI (2025)

3.2 Model Specification

The study uses normal linear model to conduct empirical analysis. The linear model can be shown in the following equation:

$$LNLCF_{it} = \beta_0 + \beta_1 LNY_{it} + \beta_2 LNHC_{it} + \beta_3 LNFD_{it} + \beta_4 LNGLB_{it} + \beta_5 LNREC_{it} + \varepsilon \quad (2)$$

In equation 1, β_0 is constant while β_1, β_2, β_3, β_4 and β_5 are the coefficients of the variables. Here ε. LN is the logarithmic form of all variables that helps to examine the elasticity effects between variables. The descriptive statistics of all variables are provided in the following table. The statistics indicate that the logarithmic form of GDP contains the highest amount of mean, median, maximum, minimum and standard deviation (std. dev.) while the logarithmic form of renewable energy consumption contains the lowest amount. The rejection of Jarque Bera test for all variables indicates that the variables that are selected for the current study is not distributed normally.

Table 3: Descriptive statistics for the variables

	LNLCF	**LNY**	**LNHC**	**LNFD**	**LNGLB**	**LNREC**
Mean	-0.7683	9.7166	4.3832	4.1468	4.2448	2.5842
Median	-0.9608	10.337	4.4699	4.2478	4.3275	2.584
Maximum	1.5483	11.0508	4.5623	4.5362	4.4699	3.9703
Minimum	-2.1821	6.2765	3.7977	3.0217	3.4655	0.6931
Std. Dev.	0.9796	1.261276	0.1822	0.314	0.2038	0.8399
Skewness	0.9427	-1.359234	-1.515	-0.8664	-1.4194	-0.0671
Kurtosis	2.9699	3.58	4.3893	3.0597	4.7815	2.0779
J-Bera	47.4074***	103.0197***	148.147***	40.0841***	149.7725***	11.5757***
Prob.	0	0	0	0	0	0
Sum	-245.855	3109.313	1402.635	1326.961	1358.349	826.9582
Sm Sq. Dev.	306.1236	507.471	10.5951	31.45401	13.2557	225.054
Obs.	320	320	320	320	320	320

3.3 Panel Econometric Model

For empirical analysis, the present study applies the panel econometric model to conduct empirical analysis. As panel data might contain both cross-sectional dependence problems and slope-heterogeneity problems among variables, the study examines whether there exist both cross-sectional dependence problems and slope homogeneity problems among variables. For cross-sectional dependence, the study applies several cross-sectional dependence test techniques including Pesaran cross-sectional dependence (CD) test technique and Pesaran scaled lagrange multiplier (LM) test technique introduced by Pesaran (2007) and Breusch-Pagan lagrange multiplier (LM) test technique introduced by Breusch and Pagan (1980) are applied for the current study. Furthermore, the study uses panel slope heterogeneity test techniques that were introduced by Pesaran & Yamagata (2008).

After that the study uses secondary panel unit-root test to examine the stationary of all variables. The second-generation panel unit-root test techniques including CADF including cross-section IPS (CIPS) and cross-section augmented Dickey-Fuller (CADF) unit root test techniques introduced by Pesaran (2007) that provide robust results after considering both cross-sectional dependence problems and slope heterogeneity problems among the variables. After that, second generation cointegration test techniques introduced by Westerlund (2007) are applied to investigate whether there exists long run cointegration among variables. Like the second-generation panel unit-root test techniques, the second-generation panel cointegration test techniques also provide robust results by considering both cross-sectional dependence problems and the problems of slope-heterogeneity among variables. After confirming that there exists the long run cointegration among variables, the study applies panel quantile long-run estimation technique to investigate the effects of economic growth, human capital, financial development, globalization and renewable energy consumption on the load capacity factor. The panel quantile regression estimation techniques provide robust results in case the exist cross-sectional dependence problems and slope homogeneity problems on one hand and the estimation techniques provide results from different quantiles including lower quantiles (from 10^{th} to 30^{th} quantiles), medium quantile (50^{th} quantile) and upper quantiles (from 60^{th} to 90^{th} quantiles). While previous studies including Pata & Samour (2023), Jahanger et al. (2024), Jin et al. (2024), Samour et al. (2024), Uche et al. (2024) and Voumik et al. (2024) applied method of moments quantile regression (MMQR) that was proposed by Machado and Silva (2019), the current study applies the panel quantile estimation technique that was proposed by Koenker (2005) that were previously used by (Elheddad et al., 2021) to conduct the empirical analysis. At the end, the study applies the second-generation panel causality test technique developed by Dumitrescu & Hurlin (2012) to observe the panel causality relationship among variables.

4. EMPIRICAL ANALYSES AND DISCUSSION

Before proceeding with the panel long-run estimation analysis, the study first examines whether there exist cross-sectional dependence problems among variables. The panel cross-sectional dependence test results are provided in the

following table. Here both Breusch-Pagan LM test results, Pesaran scaled LM test results and Pesaran CD test results indicates that the null hypothesis of cross-sectional dependency of all variables were rejected at 1% level of significance. Therefore, there exists spill-over effects among variables in the existing panel group.

Table 4: Results for cross-sectional dependence test techniques

Variable	**Breusch-Pagan LM**	**Pesaran scaled LM**	**Pesaran CD**
	Statistic	**Statistic**	**Statistic**
LNLCF	583.3076***	56.74260***	2.741832***
LNGDP	1109.343***	112.1916***	32.65994***
LNHC	1393.778***	142.1736***	37.33074***
LNFD	1052.381***	106.1872***	32.17655***
LNGLOB	1367.841***	139.4397***	36.98011***
LNREC	710.7609***	70.17736***	5.950999***

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

Like cross-section dependency problems, there may exist slope heterogeneity problems among variables in panel data model. For this, the study tests whether there exist slope heterogeneity problems among variables. Results from both delta and adjusted delta show that the null hypothesis of slope homogeneity was rejected that is significant at 1% level of significance. This indicates that there exist slope homogeneity problems among variables in the existing panel model.

Table 5: Results for slope-homogeneity test techniques

LNLCF as a dependent variable	
Delta	**Adjusted Delta**
15.546***	17.589***

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

As both cross-sectional dependence and slope homogeneity test results indicate that there exist both cross-sectional dependence and slope homogeneity problems among variables, the study uses second-generation panel unit-root test techniques to investigate the stationarity of the variables

which provide robust results even in case there exist cross-sectional dependence and slope homogeneity problems among variables. Results that were obtained from both CADF and CIPS test techniques indicate that all variables are fully significant at first difference at 1% significant level. For instance, the logarithmic form of economic growth was found to be significant at level at 10% significant level in CADF test technique while insignificant at level in CIPS test technique. On the other hand, the logarithmic form of human capital was found to be significant at a level at 10% significant level in CIPS test technique while insignificant at level in CADF test technique. Although the logarithmic form of globalization was found to be significant at level in CIPS test technique, it was found to be insignificant at level in CADF test technique. All this information implies that the variables that were selected to conduct the current study are stationary at first difference or I (1).

Table 6: Results for second-generation panel unit-root test techniques

	CADF		**CIPS**	
Variable	**Level**	**1st Difference**	**Level**	**1st Difference**
LNLCF	0.455	-8.202***	-1.848	-5.501***
LNGDP	-1.442*	-3.341***	-1.743	-3.597***
LNHC	-0.815	-2.398***	-2.338**	-3.955***
LNFD	-0.977	-7.983***	-2.186	-5.309***
LNGLOB	-0.518	-5.404***	-2.585***	-5.355***
LNREC	2.564	-5.349***	-0.835	-4.698***

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

After confirming that variables are stationary at first difference, the study applies the second-generation panel cointegration test techniques to investigate whether there exists long run cointegration among variables. Like second generation panel unit-root test techniques, the second-generation panel cointegration test techniques also provide robust results in case variables have cross-sectional dependence and slope homogeneity problems in the model. All cointegration test techniques including Gt, Ga, Pt and Pa indicate that the null hypothesis of no cointegration among variables were rejected implying that there exists long run relationship among variables that were selected for running the empirical analysis. Here the result was found to be at 1% significant

level Gt test technique while the results were found to be significant at 5% significant level in Ga, Pt and Pa test techniques.

Table 7: Results for second-generation Westerlund (2007) cointegration test techniques

	LNCF as a dependent variable			
	Value	**Z-value**	**P-value**	**Robust P-value**
Gt	-3.672	-3.404	0.000	0.000***
Ga	-12.860	0.811	0.792	0.030**
Pt	-11.343	-3.552	0.000	0.010**
Pa	-14.101	-1.057	0.145	0.020**

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

After confirming that there exists the long run cointegration among variables, the study conducts the long run estimation where the study applies the pooled ordinary least squares (P-OLS) and Koenker (2005) panel quantile estimations. The panel quantile long-run estimation method is more robust as compared to the pooled ordinary least squares estimation method in a sense that the panel quantile estimation technique provides robust results in case there exists cross-sectional dependence problem, slope homogeneity problem and during the time when there exists multicollinearity and heteroscedasticity problems in the panel model. Moreover, the panel quantile estimation technique provides at different quantiles including lower, medium and upper quantiles unlike other panel long-run estimation that provide results on average. The overall pooled ordinary least squares (P-OLS) panel estimation technique indicates that economic growth and renewable energy consumption have positive effects on the load capacity factor while human capital, financial development and globalization have negative effects on the load capacity factor.

After estimating robustness, the panel quantile estimation technique indicates that economic growth has significant positive effect on the load capacity factor from first quantile until eighth quantile whereas renewable energy consumption was found to have positive impact on the load capacity factor in all quantiles. While the positive effect of renewable energy consumption was found to be higher as compared to the effect of economic growth, the positive effects of both economic growth and renewable energy

consumption were found to increase from first quantile until the sixth quantile while decrease from seventh to ninth quantile. Here renewable energy consumption was found to be significant at 1% significant level in all quantiles while economic growth was found to be significant at 1% significant level until seventh quantile. In the eighth quantile, economic growth was found to be significant at 10% significant level while the positive effect was found to be insignificant in the last quantile. While the overall literature review that are discussed above indicates that economic growth mainly affects negatively to the load capacity factor, the positive effect of economic growth on the load capacity factor the was revealed from the current study is consistent with Guo et al. (2023) and Voumik et al. (2024) where economic growth was found to have positive impact on the load capacity factor. However, the positive impact of renewable energy consumption on the load capacity factor is consistent with the literature review that renewable energy consumption can contribute to increase the load capacity factor and therefore can ensure environmental sustainability.

While human capital was found to have a significant negative effect on the load capacity factor from first to sixth quantile, the effect was found to be significantly positive in eighth and ninth quantiles. Here the negative effect of human capital was found to increase from first quantile to third quantile while the negative effect starts decreasing from fourth until sixth quantiles. The negative effect of human capital is significant at 1% significant level from first to fourth quantile while the negative effect was found to be significant at 5% significant level and 10% significant level in fifth and sixth quantiles. In the seventh quantile the negative effect was found to be insignificant. In eighth and ninth quantiles, the effect of human capital on the load capacity factor was found to be significantly positive in eighth and ninth quantiles where the positive effect was found to be higher in the highest quantile. Here the positive effect was found to be significant at 10% significant level in eighth quantile while the effect was found to be significant at 1% significant level in ninth quantile. The positive effect of human capital on the load capacity factor in the highest quantile is consistent with Ali et al. (2024) and Ya et al. (2024) that revealed positive effect of human capital on the load capacity factor.

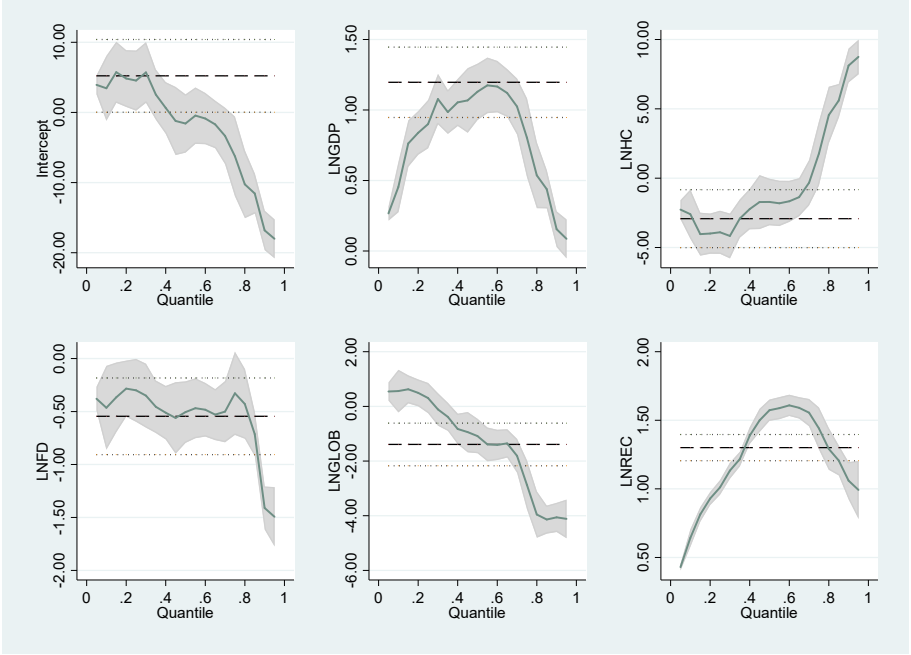
The overall panel quantile results indicate that both financial development and globalization have negative effects on the load capacity factor. Here financial development was found to have significant negative effects in every quantile except eighth quantile while globalization was found to have significant negative effects from fourth to ninth quantiles. Here globalization was found to have significantly positive impact on the load capacity factor only in the second quantile. In the eighth and ninth quantiles, the positive elasticity effect of human capital in increasing the load capacity factor was found to be highest than the positive effect of both economic growth and renewable energy consumption. However, renewable energy consumption was found to have the highest negative effect on the load capacity factor from first to seventh quantiles.

The figure that is shown below in graphic 5 indicates the Pooled Ordinary Least Squares (P-OLS) and Koenker (2005) panel quantile regression estimates for the load capacity factor. Here, the horizontal thick dashed lines represent the OLS estimates with 95% confidence intervals while the bold lines represent the quantile regression estimates. The shaded gray areas plot the 95% confidence intervals for the quantile regression estimates.

Table 8: Results for panel long-run estimation techniques

	LNCF as a dependent variable				
	LNGDP	**LNHC**	**LNFD**	**LNGLOB**	**LNREC**
P-OLS	1.1964*** (0.1269)	-2.9210*** (1.0611)	-0.5447*** (0.1840)	-1.3922*** (0.3962)	1.3008*** (0.0486)
Koenker (2005) panel quantile estimation test techniques					
10th Quantile	0.4537*** (0.1233)	-2.5958*** (0.7106)	-0.4642*** (0.1434)	0.5592 (0.4660)	0.6422*** (0.1103)
20th Quantile	0.8382*** (0.0826)	-3.9931*** (0.6185)	-0.2836** (0.1161)	0.4951* (0.2987)	0.9298*** (0.0889)
30th Quantile	1.0777*** (0.0675)	-4.1634*** (0.5672)	-0.3500*** (0.1110)	-0.1104 (0.2993)	1.1334*** (0.1003)
40th Quantile	1.0541*** (0.0669)	-2.2253*** (0.4945)	-0.5110*** (0.0932)	-0.8261*** (0.3072)	1.3883*** (0.0920)
50th Quantile	1.1296*** (0.0854)	-1.7151** (0.7957)	-0.5054*** (0.1228)	-1.0845*** (0.3209)	1.5737*** (0.0679)
60th Quantile	1.1663*** (0.1084)	-1.6660* (0.9774)	-0.4823*** (0.1352)	-1.4079*** (0.3985)	1.6089*** (0.0506)
70th Quantile	1.0244*** (0.1644)	-0.3298 (1.4361)	-0.5009*** (0.1864)	-1.8090*** (0.5759)	1.5559*** (0.0761)
80th Quantile	0.5367* (0.3011)	4.5540* (2.6607)	-0.4280 (0.3078)	-3.9550*** (0.8129)	1.2915*** (0.1180)
90th Quantile	0.1547 (0.2194)	8.1211*** (1.8820)	-1.4105*** (0.3662)	-4.0589*** (0.6903)	1.0601*** (0.0691)

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.



Graphic 5: Koenker (2005) panel quantile estimation test techniques

The panel causality test results indicate that there exists unidirectional causality from economic growth, human capital, financial development and globalization to the load capacity factor while there exists bidirectional causality relationship between renewable energy consumption and load capacity factor. Moreover, renewable energy consumption was found to have bidirectional causality relationship between economic growth and globalization while unidirectional causality relationship from human capital and financial development. Here the unidirectional causality effect from human capital was found to be more significant that was valid at 1% significant level.

Table 9: Results for Dumitrescu and Hurlin (2012) panel causality test technique

Null Hypothesis	**W-Stat.**	**Z-Stat.**	**Prob.**
LNGDP does not homogeneously cause LNLCF	4.5538	6.8064	0.0000***
LNLCF does not homogeneously cause LNGDP	1.2700	0.3780	0.7054
LNHC does not homogeneously cause LNLCF	4.5971	6.8911	0.0000***
LNLCF does not homogeneously cause LNHC	1.6278	1.0784	0.2809
LNFD does not homogeneously cause LNLCF	2.1111	2.0245	0.0429**
LNLCF does not homogeneously cause LNFD	1.5397	0.9058	0.3650

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

Table 9: (Continue)

Null Hypothesis	W-Stat.	Z-Stat.	Prob.
LNGLOB does not homogeneously cause LNLCF	4.2813	6.2730	0.0000***
LNLCF does not homogeneously cause LNGLOB	1.6650	1.1513	0.2496
LNREC does not homogeneously cause LNLCF	7.3280	12.2372	0.0000***
LNLCF does not homogeneously cause LNREC	2.1881	2.1752	0.0296**
LNREC does not homogeneously cause LNGDP	2.0264	1.8586	0.0631*
LNGDP does not homogeneously cause LNREC	2.6853	3.1486	0.0016***
LNREC does not homogeneously cause LNHC	0.37946	-1.3654	0.1721
LNHC does not homogeneously cause LNREC	5.08614	7.8484	0.0000***
LNREC does not homogeneously cause LNFD	1.05423	-0.0444	0.9646
LNFD does not homogeneously cause LNREC	1.96090	1.7305	0.0835*
LNREC does not homogeneously cause LNGLOB	1.9671	1.7426	0.0814*
LNGLOB does not homogeneously cause LNREC	3.8869	5.5008	0.0000***

The subscript ***, ** and * represent 1%, 5% and 10% levels of significance, respectively.

SUMMARY

The current study intends to examine the effects of economic growth, human capital, financial development, globalization and renewable energy consumption on the load capacity factor. As it is very common that panel data contains both cross-section dependence and slope homogeneity problems, the current study also identified that the panel data model for the current study also has cross-sectional dependency problem and the problem of slope homogeneity among variables. As both second-generation unit-root test techniques and second-generation cointegration test techniques provide robust results after considering both cross-sectional dependence and slope homogeneity problems, the study used the second-generation unit-root test techniques to examine the stationarity of the variables and the second-generation cointegration test techniques to confirm the long-run cointegration among variables. After the second-generation test results indicate that all variables are stationary at first difference, the study applied the second-generation cointegration techniques that confirm the long run cointegration among variables. After confirming that there exists the long run cointegration among variables, the study then applied panel long run estimation techniques to conduct the empirical analysis where the empirical results were mainly discussed based on panel quantile estimation technique.

The empirical results indicate that economic growth increases the load capacity factor in both lower quantile and upper quantile while the effect becomes insignificant in the highest quantile. On the other hand, renewable energy consumption increases the load capacity factor in all quantiles. However, the results indicate that the positive effects of both economic growth and renewable energy consumption on the load capacity factor increase from lower quantile to medium quantile while the positive effect decreases once it moves to upper quantile. This implies that the positive effects of economic growth and renewable energy consumption on the load capacity factor decrease once the load capacity becomes higher. Although human capital is shown to reduce the load capacity factor in lower quantile and in medium quantile, the results indicate that human capital increases the load capacity factor in the highest quantiles that is in eighth and ninth quantiles. On the other hand, both financial development and globalization were found to reduce the load capacity

factor in almost every quantile implying that these two factors are the main elements in the top ten renewable energy countries that reduce the environmental quality and therefore increase environmental degradation. Moreover, the bidirectional causality relationship between renewable energy consumption and economic growth indicates that renewable energy consumption does not only increase the load capacity, but the load capacity further increases renewable energy consumption. In fact, the bidirectional causality between renewable energy consumption and economic growth indicates that renewable energy consumption does not only improve environmental quality in the top ten renewable energy consumption countries but also ensures economic sustainability. As financial development has unidirectional causality to renewable consumption, policymakers can take necessary steps to utilize financial resources for renewable energy development.

The study also contains several limitations. For instance, the study used the overall financial development index to investigate its effect on the load capacity. However, financial development can be separated as banking sector financial development and stock market financial development to investigate their effects on the load capacity. Therefore, future studies can be conducted to analyze the effects of both banking sector financial development and stock market financial development separately on the load capacity. Moreover, future studies can be conducted to investigate different renewable energy sources including bioenergy, solar and wind energy separately to examine their effects separately on the load capacity.

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CHAPTER 5

THE EFFECT OF IMPORTS OF ELECTRIC ENERGY AND ENERGY RESOURCES USED IN ELECTRIC ENERGY PRODUCTION ON EXCHANGE RATE (USD): HATEMI-J ASYMMETRIC CAUSALITY ANALYSIS

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INTRODUCTION

The most fundamental element that enables life and even the entire universe to function is energy. The absence of energy will cause the destruction of all working systems. Of course, since each of the economic elements is part of a working system, the absence or scarcity of energy will cause the entire economic system to break down. Although this dependence on energy can be eliminated from a wide variety of sources, different energy sources are mostly used in the economy by converting them into the form of electrical energy in order to turn them into economic use. As with all economic resources, energy resources are not homogeneously distributed in the world. Heterogeneous distribution of energy resources causes economic inequalities between countries. Countries with more energy resources earn lower-cost rent revenues, while other countries have to earn higher-cost revenues. In order to eliminate the economic imbalance due to this cost differential, countries focus on producing high value-added products, which leads to a country's need for more energy. As a result of this cycle, countries with insufficient energy resources turn into energy dependent countries. Countries that are dependent on energy have to establish different political and especially economic relations with each other (Erdal and Karakaya, 2012:108). Of course, there is a great need for energy for economic development, but countries with insufficient domestic energy resources will turn to foreign trade in energy, which will make the country's economy more fragile and weaken its political power (Özdemir and Yüksel, 2006: 2). As energy imports and energy prices increase, the cost of energy used also increases. In macroeconomic terms, negative effects are observed in terms of inflation, exchange rate, current account deficit and economic growth (Soydal, Mızrak and Çetinkaya, 2012: 131, Acaravcı, Yıldız: 2018). Among the micro and macro problems that countries may face in case of insufficient energy resources, exchange rate problems of countries have a great place. The existence and structure of the relationship between energy prices and exchange rates have been the subject of many studies. When the literature is analyzed, it is understood that the economic relationship between oil prices and exchange rates is mostly analyzed in these studies.

Krugman (1980) and Golub (1983) are among the pioneering studies on the relationship between oil prices and exchange rates. In these preliminary studies, they argued that an increase in oil prices in energy-deficit countries would lead to a decline in the exchange rate of that country, while oil-exporting countries, on the contrary, would increase their currencies. Amano and Van Norden (1998) analytically argue that oil price fluctuations can effectively explain exchange rate fluctuations. While these studies concluded that oil prices affect exchange rates, subsequent studies have shown that changes in exchange rates will cause changes in oil prices. One of these studies is Bloomberg and Harris (1995), which assumes that oil trade is realized in US Dollars and accordingly, a depreciation of the US Dollar against a foreign currency will lead to a relative decrease in oil prices and an increase in oil demand in that country. In this case, while the purchasing power of the country increases, the demand for oil will increase and a general increase in oil prices will be expected. This theory of Bloomberg and Harris is found to be valid in Sadorsky (2000), Indjehagopian et al. (2000), Akram (2009), Özsöz and Akinkunmi (2011), Hassan and Zahid (2011) and Şahbaz et al. (2014). Zhang et al. (2008), on the other hand, argue that such a relationship will be valid in the short run but will disappear in the long run. Some of the studies in the literature on the subject claim that there is a bidirectional relationship between the variables (Adıgüzel, Bayat and Kayhan: 2016, 243). In conclusion, studies have generally analyzed the relationship between energy prices and exchange rates. The impact of energy use and especially the use of imported energy resources on exchange rates has not been investigated. It is thought that this study will fill an important gap in the literature.

LITERATURE

Studies on energy resources and exchange rate investigate the effect of changes in the price of energy resources on the exchange rate. There are many researchers and articles that investigate this effect and some of these studies are presented below.

Altıntaş (2013) investigated the existence of a relationship between oil prices and foreign exchange using quarterly data between 1987-2010. In the

study, bidirectional causality was found between oil prices and foreign exchange.

Uçan (2015) in his study titled "An Empirical Approach to the Energy-Growth Relationship", the relationship between energy use and exchange rate was investigated by causality analysis using data from 1990 to 2011. According to the results obtained, a causality relationship from the exchange rate variable to energy use was detected.

Lebe and Akbaş (2015) investigated the relationship between oil prices, current account deficit and exchange rates by using the data between 1991-2012. According to the results, oil prices were found to be a cause of the current account deficit while exchange rates were not.

Kaplan and Aktaş (2016) investigated the relationship between oil prices and exchange rates using data for the US, China, Canada, Mexico and Russia for the period 1995-2014. As a result of the study, while the exchange rates of the US and China are not affected by oil prices, Canada and Mexico are positively affected and Russia is negatively affected.

Adıgüzel et al (2016) analyzed monthly real exchange rates (TL/US Dollar) and oil prices as variables between 2009-2015 and conducted asymmetric causality analyses on these variables. As a result of the analyzes, it was determined that oil prices are the cause of the exchange rate in line with the data obtained.

Doğan and Gürbüz (2017) conducted a causality study between energy expenditures and current account deficit between 2002 and 2015. According to the results obtained, it was determined that there is a bidirectional causality structure between energy expenditures and current account deficit in Turkey.

Sinan (2021) in his study titled "The Relationship between YEKDEM and Exchange Rate, Electricity Consumption in Turkey" concluded that there is a long-run relationship between monthly realized unit prices of Renewable Energy Resources Support Mechanism (YEKDEM), monthly total electricity consumption and monthly USD exchange rate. However, there is no explanation about the direction of the relationship.

Bilgin (2023) investigated the relationship between oil prices and inflation in Turkey between 2014 and 2022. In the study, causality analysis was performed using oil prices, TL/USD exchange rate and inflation data. According to the results obtained, a causality from oil prices to TL/USD Dollar index was determined.

Şişeci and Yamaçlı (2020) in their study titled "The Relationship between Energy Imports, Exchange Rate and Economic Growth" concluded that a 1% increase in real GDP increases real energy imports by 0.2%, and a 1% increase in the real effective exchange rate index increases real energy imports by 3.7%. In fact, according to the results obtained from the findings of the study, the effect of the real effective exchange rate index on real total energy imports in the long run is stronger than the effect of real GDP on real total energy imports.

Başaran (2023) conducted various analyses between Turkey's daily electricity foreign trade differentials and the TL/USD exchange rate between 2015 and 2023. Chaos data were created over daily data and asymmetric causality analysis was performed on these data. As a result of the study, no relationship between the variables was detected when Turkey captured positive differences in electricity foreign trade, but in the section with negative differences, electricity foreign trade is the cause of the exchange rate.

DATA SET AND METHODOLOGY

For the purpose of the study, the energy resources imported to be used in daily electricity generation were obtained from the Enerji Piyasaları İşletme AŞ (EPİAŞ) Transparency Platform internet database in units of Mw/h. Imported energy sources used in electricity generation are natural gas, fuel oil and imported coal. In addition to the aforementioned energy sources, direct electricity imports are also needed in the index data, and exported electricity energy should also be excluded from the index. After all these calculations, the annual energy import index is as follows.

Table-1: Annual Electricity Consumption with Imported Energy Sources

	Total Energy Use (Mw/h)	Energy Used from Imported Energy Sources (Mw/h)	Percentage of Imports in All Energy Use
2014	229690527.9	140429803.9	61.14%
2015	241216688.7	125188558.4	51.90%
2016	254201830.5	125247370.6	49.27%
2017	273174508.4	145513967.7	53.27%
2018	282571168.6	140219016.2	49.62%
2019	280972677.1	102816862.2	36.59%
2020	282392521.8	117384470.5	41.57%
2021	307392138.9	147724058.6	48.06%
2022	307044261.2	127545466.3	41.54%
2023	306987724.1	132548324.5	43.18%

As seen in Table-1, a large portion of Turkey's electricity consumption is met from imported energy sources. However, it is seen that the ratio of imported energy sources used in recent periods has been on a downward trend. In 2014, the ratio of imported energy sources was 61, while it decreased to 43.18% in 2023. US Dollar data, the other variable used in the research, was obtained from the CBRT database.

In order to perform the necessary analyses on the obtained time series, it is necessary to eliminate the specific problems of time series. The most common problem in analyzing time series is the unit root problem. The easiest way to eliminate this problem is the logarithmic difference method of the time series. In this study, in order to avoid the unit root problem, logarithmic differences (Ln(P0/P1)) of the time series were taken and new time series were created.

Graph-1, which shows the daily logarithmic differences (LnEnergy) of electricity generated from imported energy sources, is as shown below.

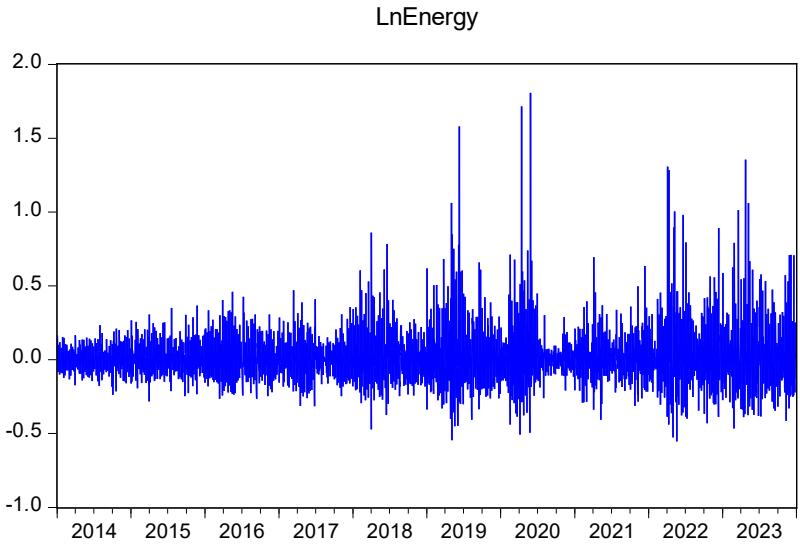

Chart-1: Logarithmic Differenced Imported Energy Sources Time Series

When the obtained LnEnergy time series is analyzed, it is observed that volatility increased in 2017, 2019, 2021 and the last quarter of 2022. As with the energy data, the logarithmic differences of the other variable, the TL/US Dollar exchange rate data, were taken and a new LnUS index was created and shown in Chart-2.

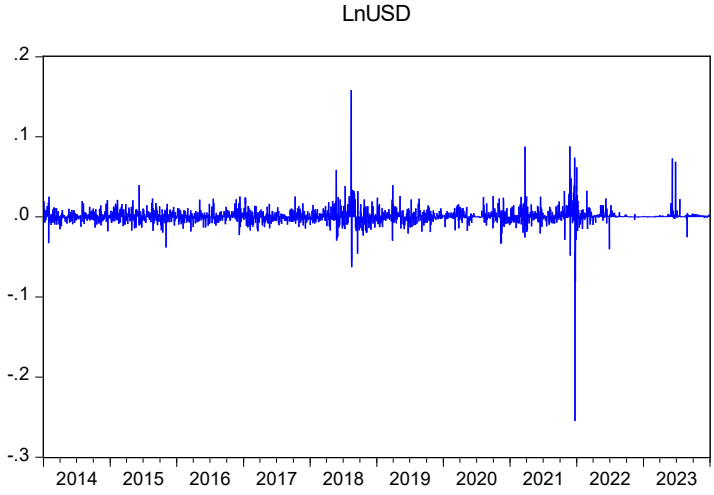

Chart-2: Logarithmic Differenced US Dollar Time Series

When the obtained LnABD time series are analyzed, the presence of large volatility in 2018, 2020, 2021 and 2023 is easily observed.

PP (Philiphs & Perron) and ADF (Augmented Dickey-Fuller) models were deemed sufficient to test for the presence of a unit root problem on the logarithmically differenced time series. The results of the unit root tests of the variables subject to analysis are shown in Table-2a and descriptive statistics are shown in Table-2b:

Table-2a: Unit Root Test Results

PP Birim Kök Testi			
	At Level	LnUSD	LnEnergy
With Constant	t-Statistic	-54.2740	-95.2848
	Prob.	***0.0001***	***0.0001***
		***	***
With Constant & Trend	t-Statistic	-54.3140	-95.2620
	Prob.	***0.0000***	***0.0001***
		***	***
Without Constant & Trend	t-Statistic	-54.0526	-95.3053
	Prob.	***0.0001***	***0.0001***
		***	***
ADF Birim Kök Testi			
	At Level	USD	TIELEK
With Constant	t-Statistic	-54.5480	-14.6390
	Prob.	***0.0001***	***0.0000***
		***	***
With Constant & Trend	t-Statistic	-54.5895	-14.6371
	Prob.	***0.0000***	***0.0000***
		***	***

Table-2b: Descriptive Statistics

	LnEnergy	**LnUSD**
Mean	0.013051	0.000763
Median	0.002061	0.000000
Maximum	1.807336	0.158431
Minimum	-0.552966	-0.254704
Std. Dev.	0.172427	0.009328
Skewness	2.102246	-3.134750
Kurtosis	16.69773	194.5144
Jarque-Bera	31232.10	5585583.
Probability	0.000000	0.000000
Sum	47.65013	2.787088
Sum Sq. Dev.	108.5182	0.317603
Observations	3651	3651

As can be seen from the results of Table-2a, there is no unit root problem in the LnEnergy and LnUSD time series. The next step is to perform causality analysis on the time series. There are many causality analyses in the literature. However, it was decided to use Hatemi-J asymmetric causality analysis in order to prevent erroneous or incomplete results in case the volatility on the time series is asymmetric. By calculating negative and positive shocks on time series separately, Hatemi derived two different time series, negative and positive, from a time series. By performing VAR (Vector Autoregressive) analysis on these derived time series, causality results based on positive and negative shocks are obtained (Hatemi, 2012: Mert and Çağlar, 2019; 350). Since the theoretical structure of the Hatemi_J Asymmetric Causality Analysis has been explained in detail in many studies, this study will not include a detailed explanation of the model. In accordance with the Hatemi-J asymmetric causality analysis, LnEnergy and LnABD were transformed into positive and negative time series and the causality relationship between the four different time series was investigated. The results of the analysis are shown in Table-3.

Table-3: Hatemi-J Asymmetric Causality Analysis Results

	Wstat	**%1**	**%5**	**%10**
LnEnerji (+) ---→ LnABD (+)	26.207***	11.817	7.891	6.218
LnABD (+) ---→ LnEnerji (+)	49.307 ***	11.706	7.987	6.404
LnEnerji (+) ---→ LnABD (-)	2.863	20.406	6.385	4.264
LnABD (-) ---→ LnEnerji (+)	1.531	7.128	1.318	0.245
LnEnerji (-) ---→ LnABD (+)	1.306	11.236	4.629	3.034
LnABD (+) ---→ LnEnerji (-)	0.529	0.025	0.000	0.000
LnEnerji (-) ---→ LnABD (-)	1.436	9.928	4.899	3.312
LnABD (-) ---→ LnEnerji (-)	1.217	0.000	0.000	0.000

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

Table-3 shows that as the use of imported energy increases, the exchange rate also increases. To put it more clearly, an increase in the use of imported energy resources for electricity consumption leads to an increase in the USD exchange rate. A similar causality relationship emerges when we read the same variables in reverse. In other words, when the exchange rate increases, the use of imported energy resources also increases. Although this finding seems to be out of expectation and inconsistent with the basic economic models at the first stage, similar results have been found in the literature. This may be due to the increase in production and indirectly electricity consumption due to the advantage in exports due to the exchange rate change. No causality relationship was found between the variables in the negative movements of both time series. Therefore, the decrease in electricity consumption does not have any effect on the USD, and the depreciation of the USD does not have any effect on electricity consumption from imported energy sources.

DISCUSSION

As a result of the analysis, the USD appreciated in periods when imported energy resources increased, while no change was detected in the USD value in periods when imported energy resources decreased. This finding is partially consistent with the general literature. The fact that the USD exchange rate is not affected by the decrease in the use of imported energy resources reveals the existence of an asymmetric relationship between the two variables.

Another finding is that an increase in the USD exchange rate increases the amount of imported energy resources. This result is not fully consistent with the general literature. It is thought that there may be two reasons for this inconsistent situation:

- The time period used for the analysis consists of daily logarithmic difference values between 2014 and 2023. In such a long time period, different causal relationships may have emerged in any period, but the model may not have detected them.

- It is thought that the appreciation in the USD exchange rate may have led to an increase in exports, which in turn may have led to an increase in production and indirectly energy consumption.

Based on these findings, it has become necessary to test each proposition separately. First, the possibility of misleading results due to the use of long-term data will be investigated. In order to conduct the necessary analyses, the data for the years 2014 - 2023 were reconstructed with each year separately and Hatemi-J Asymmetric Causality tests were performed between the electricity energy obtained from imported energy sources of each year and the USD data for the same period. The results obtained are explained below for each year separately.

Table-4: Hatemi-J Asymmetric Causality Analysis Results for 2014

2014	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 9.197**	10.729	6.14	4.622
LnUSD (+) ---> LnEnergy (+)	Wstat = 13.720***	9.89	6.069	4.593
LnEnergy (+) ---> LnUSD (-)	Wstat = 13.251***	12.328	8.116	6.357
LnUSD (-) ---> LnEnergy (+)	Wstat = 14.575***	12.498	8.172	6.357
LnEnergy (-) ---> LnUSD (+)	Wstat = 2.148	9.384	6.115	4.691
LnUSD (+) ---> LnEnergy (-)	Wstat = 0.131	9.082	5.881	4.44
LnEnergy (-) ---> LnUSD (-)	Wstat = 2.667	9.583	6.092	4.572
LnUSD (-) ---> LnEnergy (-)	Wstat = 0.667	9.293	5.872	4.521

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

Positive shocks to imported energy use affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive shocks of imported energy use, but not the negative shocks.

USD negative shocks affect the positive shocks of imported energy use, but not the negative shocks.

When the 2014 results are analyzed, the increase in the use of imported energy sources causes both negative and positive fluctuations in USD. Any movement in the USD exchange rate causes an increase in the use of imported energy, but has no effect on the decrease. Although these results are partially consistent with the results of the analysis over all time, it is noteworthy that negative shocks to the USD also increase imported energy use. In 2014, when

the share of electricity generated from imported energy resources in total electricity generation was 61.14%, the decrease in the use of imported energy resources was not reflected in a decrease in the exchange rate.

Table-5: Hatemi-J Asymmetric Causality Analysis Results for 2015

2015	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 21.657***	10.542	6.232	4.625
LnUSD (+) ---> LnEnergy (+)	Wstat = 17.233***	9.854	6.183	4.713
LnEnergy (+) ---> LnUSD (-)	Wstat = 13.458***	13.123	8.158	6.358
LnUSD (-) ---> LnEnergy (+)	Wstat = 13.983***	12.916	8.316	6.358
LnEnergy (-) ---> LnUSD (+)	Wstat = 2.287	10.411	6.264	4.634
LnUSD (+) ---> LnEnergy (-)	Wstat = 7.854**	10.486	6.303	4.697
LnEnergy (-) ---> LnUSD (-)	Wstat = 3.997	9.924	6.13	4.697
LnUSD (-) ---> LnEnergy (-)	Wstat = 3.612	10.082	6.22	4.571

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

Positive shocks to imported energy use affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive shocks of imported energy use, but not the negative shocks.

USD negative shocks affect the positive shock of imported energy use, but not the negative shock.

The 2015 analysis results are close to the 2014 results, but it is understood that USD negative shocks affect the use of electricity from imported energy sources negatively, albeit at a less reliable level. In this period, the ratio of energy obtained from imported energy sources in total energy was realized as 51.90% and the increase in the amount of energy obtained from imported energy sources caused both positive and negative movements in the USD exchange rate and increased the volatility of the USD.

Table-6: Hatemi-J Asymmetric Causality Analysis Results for 2016

2016	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 0.821	9.459	5.999	4.594
LnUSD (+) ---> LnEnergy (+)	Wstat = 16.129***	10.119	6.286	4.834
LnEnergy (+) ---> LnUSD (-)	Wstat = 3.442	11.948	8.088	6.391
LnUSD (-) ---> LnEnergy (+)	Wstat = 16.277***	12.365	8.047	6.391
LnEnergy (-) ---> LnUSD (+)	Wstat = 3.661	9.59	6.12	4.694
LnUSD (+) ---> LnEnergy (-)	Wstat = 7.366**	9.48	6.014	4.608
LnEnergy (-) ---> LnUSD (-)	Wstat = 0.512	9.591	6.217	4.662
LnUSD (-) ---> LnEnergy (-)	Wstat = 7.135**	9.579	6.177	4.654

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.
**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

Positive shocks to imported energy use do not affect USD positive and negative shocks

Negative shocks to imported energy use do not affect USD positive and negative shocks

Positive shocks to USD affect positive and negative shocks to imported energy use

Negative shocks to USD affect positive and negative shocks to imported energy use

When the analysis results for 2016 are analyzed, any change in energy use from imported energy sources does not have an effect on USD. On the other hand, both directional movements in USD cause volatility in energy use from imported energy sources in both directions. In sum, exchange rate volatility affects the volatility of imported energy use, while the volatility of imported energy use does not cause volatility in the exchange rate. This finding diverges sharply from the results of previous analyses. Moreover, in this period, the ratio of electricity generated from imported energy sources to total electricity used fell below 50% for the first time and was realized as 49.27%.

Table-7: Hatemi-J Asymmetric Causality Analysis Results for 2017

2017	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 25.783***	11.826	8.048	6.4
LnUSD (+) ---> LnEnergy (+)	Wstat = 20.583***	12.078	8.169	6.361
LnEnergy (+) ---> LnUSD (-)	Wstat = 18.846***	12.016	8.094	6.307
LnUSD (-) ---> LnEnergy (+)	Wstat = 21.585***	12.252	8.214	6.307
LnEnergy (-) ---> LnUSD (+)	Wstat = 0.008	9.5	6.072	4.531
LnUSD (+) ---> LnEnergy (-)	Wstat = 2.894	9.771	6.281	4.864
LnEnergy (-) ---> LnUSD (-)	Wstat = 4.225	9.575	6.022	4.596
LnUSD (-) ---> LnEnergy (-)	Wstat = 0.869	9.738	6.158	4.707

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

Positive shocks to imported energy use affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive shocks of imported energy use, but not the negative shocks.

USD negative shocks affect the positive shock of imported energy use, but not the negative shock.

The 2017 analysis results are similar to the results before 2016. Increases in the use of electricity from imported energy sources cause both negative and positive movements in the USD, while positive or negative increases in the USD exchange rate cause increases in the use of electricity from imported energy sources. In this period when this difficult-to-understand determination was made, the ratio of electricity energy obtained from imported energy sources to the total electricity energy used rose above 50% again and was determined as 53.27%.

Table-8: 2018 Hatemi-J Asymmetric Causality Analysis Results

2018	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 2.516	12.039	6.359	4.609
LnUSD (+) ---> LnEnergy (+)	Wstat = 11.564***	11.168	6.143	4.521
LnEnergy (+) ---> LnUSD (-)	Wstat = 0.291	10.165	4.078	2.402
LnUSD (-) ---> LnEnergy (+)	Wstat = 3.087*	10.09	3.96	2.402
LnEnergy (-) ---> LnUSD (+)	Wstat = 3.644	12.567	8.066	6.288
LnUSD (+) ---> LnEnergy (-)	Wstat = 14.715***	13.106	8.06	6.333
LnEnergy (-) ---> LnUSD (-)	Wstat = 0.084	12.804	6.546	4.691
LnUSD (-) ---> LnEnergy (-)	Wstat = 2.540	12.311	6.561	4.626

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

*: H_0 hypothesis rejected, H_1 hypothesis accepted at 90% confidence interval.

Positive shocks to imported energy use do not affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive and negative shocks of imported energy use.

USD negative shocks affect the positive shocks of imported energy use, but not the negative shocks.

According to the 2018 analysis results, the increase or decrease in the use of electricity generated from imported energy sources does not have an effect on the USD exchange rate. Positive increases in the USD exchange rate cause positive and negative volatility in imported energy use, while decreases in the USD exchange rate cause an increase in imported energy use. The results obtained in this period are seen as a healthier economic structure compared to other periods, and another interesting finding is that the ratio of electricity generated from imported energy sources to the total electricity used decreased below 50% and was determined as 49.62%.

Table-9: 2019 Hatemi-J Asymmetric Causality Analysis Results

2019	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 4.346	11.007	6.157	4.485
LnUSD (+) ---> LnEnergy (+)	Wstat = 11.684***	11.122	6.464	4.573
LnEnergy (+) ---> LnUSD (-)	Wstat = 2.708	10.41	6.36	4.74
LnUSD (-) ---> LnEnergy (+)	Wstat = 14.999***	10.166	6.169	4.74
LnEnergy (-) ---> LnUSD (+)	Wstat = 1.891	10.339	6.029	4.612
LnUSD (+) ---> LnEnergy (-)	Wstat = 2.138	10.271	6.05	4.614
LnEnergy (-) ---> LnUSD (-)	Wstat = 1.659	10.276	6.179	4.647
LnUSD (-) ---> LnEnergy (-)	Wstat = 3.582	9.726	6.17	4.588

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

Positive shocks to imported energy use do not affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive shocks of imported energy use, but not the negative shocks.

USD negative shocks affect the positive shock of imported energy use, but not the negative shock.

In 2019, the ratio of electricity generated from imported energy sources to total electricity used fell to its lowest level of 36.59% and the use of electricity generated from imported energy sources had no effect on USD exchange rates in this period. However, positive and negative movements in the USD exchange rates had an increasing effect on the use of imported energy. In this case, energy foreign trade policies have no effect on exchange rate policies.

Table-10: Hatemi-J Asymmetric Causality Analysis Results for 2020

2020	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 11.275**	11.293	6.212	4.537
LnUSD (+) ---> LnEnergy (+)	Wstat = 3.090	11.19	6.222	4.56
LnEnergy (+) ---> LnUSD (-)	Wstat = 0.297	7.219	3.715	2.65
LnUSD (-) ---> LnEnergy (+)	Wstat = 2.180	7.825	3.811	2.65
LnEnergy (-) ---> LnUSD (+)	Wstat = 0.038	7.362	3.756	2.598
LnUSD (+) ---> LnEnergy (-)	Wstat = 0.823	7.861	3.875	2.609
LnEnergy (-) ---> LnUSD (-)	Wstat = 0.419	7.157	3.671	2.552
LnUSD (-) ---> LnEnergy (-)	Wstat = 1.709	6.926	3.729	2.544

**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

Positive shocks of imported energy use affect USD positive shocks but not negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks do not affect the positive and negative shocks of imported energy use.

USD negative shocks do not affect the positive and negative shocks of imported energy use.

When the 2020 analysis results are analyzed, only the increase in the amount of electricity generated from imported energy sources causes an increase in the USD exchange rate. The positive and negative movements of other variables do not affect each other. This result is quite understandable, as an increase in the use of imported energy leads to an increase in the exchange rate. On the contrary, a decrease in imported energy use leads to a decrease in the exchange rate. Compared to the previous year, the ratio of electricity generated from imported energy sources to total electricity used in 2020 increased slightly to 41.13%.

Table-11: Hatemi-J Asymmetric Causality Analysis Results for 2021

2021	**Wstat**	**1%**	**5%**	**10%**
LnEnergy (+) ---> LnUSD (+)	Wstat = 8.885*	17.159	9.107	6.387
LnUSD (+) ---> LnEnergy (+)	Wstat = 5.246	17.632	9.232	6.589
LnEnergy (+) ---> LnUSD (-)	Wstat = 13.796**	18.654	9.590	6.588
LnUSD (-) ---> LnEnergy (+)	Wstat = 3.175	18.766	9.477	6.588
LnEnergy (-) ---> LnUSD (+)	Wstat = 0.000	8.328	3.856	2.589
LnUSD (+) ---> LnEnergy (-)	Wstat = 0.014	7.904	3.774	2.591
LnEnergy (-) ---> LnUSD (-)	Wstat = 2.839	9.334	3.754	2.344
LnUSD (-) ---> LnEnergy (-)	Wstat = 0.119	8.638	3.761	2.436

**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

*: H_0 hypothesis rejected, H_1 hypothesis accepted at 90% confidence interval.

Positive shocks to imported energy use affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks do not affect the positive and negative shocks of imported energy use.

USD negative shocks do not affect the positive and negative shocks of imported energy use.

According to the 2021 analysis results, increases in the use of electricity generated from imported energy sources increased both positive and negative movements of the USD exchange rate. In this period, when the ratio of electricity generated from imported energy sources to total electricity used increased by 48.06% compared to the previous year, exchange rates had no effect on the amount of imported energy use, and the decrease in imported energy use did not affect exchange rates in any way.

Table-12: Hatemi-J Asymmetric Causality Analysis Results for 2022

2022	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 8.460*	13.682	8.386	6.387
LnUSD (+) ---> LnEnergy (+)	Wstat = 6.985*	13.61	8.269	6.272
LnEnergy (+) ---> LnUSD (-)	Wstat = 1.739	7.81	3.712	2.522
LnUSD (-) ---> LnEnergy (+)	Wstat = 1.894	8.523	3.851	2.522
LnEnergy (-) ---> LnUSD (+)	Wstat = 3.967	10.364	6.126	4.545
LnUSD (+) ---> LnEnergy (-)	Wstat = 0.182	9.982	6.217	4.609
LnEnergy (-) ---> LnUSD (-)	Wstat = 1.479	10.292	6.012	4.506
LnUSD (-) ---> LnEnergy (-)	Wstat = 4.051	10.573	6.226	4.688

*: H_0 hypothesis rejected, H_1 hypothesis accepted at 90% confidence interval.

Positive shocks of imported energy use affect USD positive shocks but not negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks affect the positive shocks of imported energy use, but not the negative shocks.

USD negative shocks do not affect the positive and negative shocks of imported energy use.

According to the 2022 analysis results, it is understood that the positive increase in energy use from imported energy sources and the positive increase in the USD exchange rate affect each other at a very low level. In this period, when there was no causality relationship between other variables, the ratio of electricity obtained from imported energy sources to total electricity used was 41.54%.

Table-13: Hatemi-J Asymmetric Causality Analysis Results for 2023

2023	Wstat	1%	5%	10%
LnEnergy (+) ---> LnUSD (+)	Wstat = 0.364	10.988	4.446	2.225
LnUSD (+) ---> LnEnergy (+)	Wstat = 2.194	10.423	4.376	2.269
LnEnergy (+) ---> LnUSD (-)	Wstat = 2.006	14.105	7.193	4.746
LnUSD (-) ---> LnEnergy (+)	Wstat = 0.562	13.869	6.988	4.746
LnEnergy (-) ---> LnUSD (+)	Wstat = 0.758	13.044	6.644	4.581
LnUSD (+) ---> LnEnergy (-)	Wstat = 2.220	13.444	6.691	4.522
LnEnergy (-) ---> LnUSD (-)	Wstat = 0.675	11.841	6.361	4.531
LnUSD (-) ---> LnEnergy (-)	Wstat = 0.654	11.641	6.297	4.459

*: H_0 hypothesis rejected, H_1 hypothesis accepted at 90% confidence interval.

Positive shocks to imported energy use do not affect USD positive and negative shocks.

Negative shocks of imported energy use do not affect USD positive and negative shocks.

USD positive shocks do not affect the positive and negative shocks of imported energy use.

USD negative shocks do not affect the positive and negative shocks of imported energy use.

In 2023, the weakly reliable causality relationship detected in 2022 completely disappears and imported energy resource utilization and USD exchange rate become two independent variables. In the 2023 period, the ratio of electricity generated from imported energy sources to total electricity used was realized as 43.18%.

Considering all the periods obtained, the asymmetric interaction between the use of imported energy resources in electricity generation and the USD exchange rate raises the suspicion that there may be a relationship with the ratio of electricity generated from imported energy resources in total electricity energy. For a better understanding of this suspicion, the summary information shown in Table-14 should be examined.

Table-14: Summary of Hatemi-J Asymmetric Causality Analysis Results for All Years

Yıllar	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
İthal Enerji / Toplam Enerji	61.14 %	51.90 %	49.27 %	53.27 %	49.62 %	36.59 %	41.57 %	48.06 %	41.54 %	43.18 %
LnEnergy (+) --> LnUSD (+)	**	***		***			**	*	*	
LnUSD (+) ---> LnEnergy (+)	***	***	***	***	***	**			*	
LnEnergy (+) --> LnUSD (-)	***	***		***				**		
LnUSD (-) ---> LnEnergy (+)	***	***	***	***	*	**				
LnEnergy (-) ---> LnUSD (+)										
LnUSD (+) ---> LnEnergy (-)		**	**		***					
LnEnergy (-) ---> LnUSD (-)										
LnUSD (-) ---> LnEnergy (-)			**							

***: H_0 hypothesis rejected, H_1 hypothesis accepted at 99% confidence interval.

**: H_0 hypothesis rejected, H_1 hypothesis accepted at 95% confidence interval.

*: H_0 hypothesis rejected, H_1 hypothesis accepted at 90% confidence interval.

From 2014 to 2018, positive and negative movements of the USD exchange rate have a mostly increasing effect on imported energy use. In this period, the volatility of the USD exchange rate in any direction also increases the volatility of energy imports. After 2019, this relationship disappears. Between 2014-2018, an increase in the use of imported energy resources positively affected the USD exchange rate, while a decrease in the use of imported energy resources had no effect on the USD exchange rate. It is understood that the share of electricity generated from imported energy sources in total electricity energy was close to or above 50% during these periods.

In 2019 and beyond, the reliability of the causality relationship between the variables decreases dramatically, but the increase in the USD exchange rate has no effect on the amount of imported energy use. In addition, the positive effect of the increase in imported energy use on the USD exchange rate also decreases, and there is no relationship between the two variables in 2023. It is also noteworthy that during this period, the share of electricity generated from imported energy sources in total electricity energy is 40%, well below 50%.

The results of the causality analysis conducted on all data for the years 2014-2023 show that the anomaly of the positive movement of the USD exchange rate increasing imported energy use persisted until 2018 (partially 2019) and disappeared in the following years. However, the new analysis results have raised different questions: Does the share of electricity generated from imported energy sources in total electricity energy affect the causality between energy imports and the exchange rate?

In order to find an answer to this new problem, a regression test was conducted by adding the energy obtained from imported energy source / total energy (ImE/TE) data to the previously available data on USD and imported energy use (Mkw).

Table-15: Descriptive Statistics of Daily Data Set

	LnEnergy	**ImE/TE**	**LnUSD**
Mean	0.013051	0.006408	0.000763
Median	0.002061	0.002214	0.000000
Maximum	1.807336	1.307909	0.158431
Minimum	-0.552966	-0.522458	-0.254704
Std. Dev.	0.172427	0.119642	0.009328
Skewness	2.102246	2.211030	-3.134750
Kurtosis	16.69773	21.43926	194.5144
Jarque-Bera	31232.10	54698.23	5585583.
Probability	0.000000	0.000000	0.000000
Sum	47.65013	23.39528	2.787088
Sum Sq. Dev.	108.5182	52.24646	0.317603
Observations	3651	3651	3651

The main issue sought through this new data set is to find an answer to the questions of whether the ImE/TE variable has a “significant relationship” with the other two variables and if there is a “significant relationship, what is its direction”. For this purpose, a regression model was developed with LnEnergy and LnUSD variables and a joint time series of the two variables was created according to this new model. The result of the analysis is as presented in Table 16.

Table-16: LS Analysis Result

Dependent Variable: LnEnergy+LnUSD				
Method: Least Squares				
Sample (adjusted): 1/02/2014 12/31/2023				
Included observations: 3651 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.013815	0.002861	4.829144	0.0000
R-squared	0.000000	Mean dependent var		0.013815
Adjusted R-squared	0.000000	S.D. dependent var		0.172852
S.E. of regression	0.172852	Akaike info criterion		-0.672485
Sum squared resid	109.0544	Schwarz criterion		-0.670786
Log likelihood	1228.621	Hannan-Quinn criter.		-0.671880
Durbin-Watson stat	2.083503			

Based on this model, a new time series with the common characteristics of the two variables was created and the basic statistical data of this new time series are presented below.

Table-17: Descriptive Statistics of the Common Time Series

	LnEnergy+LnUSD
Mean	0.013815
Median	0.001983
Maximum	1.807850
Minimum	-0.552966
Std. Dev.	0.172852
Skewness	2.078265
Kurtosis	16.46876
Jarque-Bera	30224.85
Probability	0.000000
Sum	50.43722
Sum Sq. Dev.	109.0544
Observations	3651

A regression model was established between this time series and the ImE/TE variable and the results are presented in Table-18.

Table-18: LS Analysis Result with New Time Series

Dependent Variable: LnEnergy+LnUSD				
Method: Least Squares				
Sample (adjusted): 1/02/2014 12/31/2023				
Included observations: 3651 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ImE/TE	-0.025714	0.010822	-2.376042	0.0176
C	0.017517	0.005243	3.341301	0.0008
R-squared	0.830232	Mean dependent var		0.013815
Adjusted R-squared	0.830139	S.D. dependent var		0.172852
S.E. of regression	0.071240	Akaike info criterion		-2.444715
Sum squared resid	18.51389	Schwarz criterion		-2.439618
Log likelihood	4465.827	Hannan-Quinn criter.		-2.442900
F-statistic	8920.105	Durbin-Watson stat		2.227475
Prob(F-statistic)	0.000000			

According to the result obtained, the existence of a significant negative weak relationship between the common regression line values of imported energy resource utilization and USD exchange rate variables and the ratio of electricity generated from imported energy resources in total electricity energy (ImE/TE) has been confirmed. As a result of the suspicion arising from the asymmetric causality analysis results; as the ratio of imported energy resources in total energy decreases, the relationship between the use of imported energy resources and the exchange rate decreases.

In the first part of the study, we stated that the result that the increase in exchange rates increases the use of imported energy resources is not fully consistent with the literature. Accordingly, we suggested that the analysis may have been different due to the fact that the time series was too long, or that the use of imported energy resources to meet energy needs may have increased due to the increase in foreign trade due to the increase in exchange rates. The first

proposition was investigated in the previous section and the existence of different results for shorter time periods was proved. For the second proposition, the necessary answers were sought through a literature review without further econometric analysis. In the literature review, it was found that there is a bidirectional relationship between exchange rate and energy resource utilization in developing countries that import energy resources (Eregha & Mesagan; 2017, Deka, Çavuşoğlu, Dube; 2022, Sahah, Ullah, et al.;2022, Çelik & Danişoğlu; 2023, Aslanova &Mammadova; 2023, Hong, Lou, et al.; 2024).

CONCLUSION

The relationship between energy imports and exchange rates, which has been extensively researched in the literature, reveals results in three main ways: First, there is no significant relationship between energy imports and exchange rates in developed countries (Li, 2011, Yürük, 2022). Secondly, in energy resource exporting countries, energy use and prices have a very limited effect on the national exchange rate (Aslanova & Mammadova; 2023). In developing countries that do not have energy resources, energy resource utilization and indirectly energy imports have a bidirectional causality relationship between national exchange rates. In this study, it is investigated how the amount of electricity generated by Turkey through imported energy sources affects the Turkish Lira (₺) - USD exchange rate. In the research, it is tried to find out the existence of asymmetry between time series and if there is asymmetry, which variable affects other variables in which directions by using Hatemi-J Asymmetric Causality analysis.

First, two time series were created and analyzed with the data on the amount of energy generated as a result of daily imported energy resource use and daily USD exchange rates between 2014 and 2023. The analysis revealed that there is asymmetric causality between the two time series. In addition, an increase in the amount of imported energy use leads to an increase in the USD exchange rate, while an increase in the USD exchange rate leads to an increase in the amount of imported energy use. Another result obtained is that negative movements of the variables have no effect. Although these results are partially consistent with the literature, we investigated why the increase in the USD

exchange rate increases the use of imported energy resources with two different propositions.

First, since the time series used in the analysis are very long, the data set was divided into annual time series and asymmetric causality analyses were repeated. In the repeated analyses; the causality results for the annual period from 2014 to 2018 partially coincide with the results of the first analysis covering the whole period. However, in this period, an increase in the amount of imported energy use has both a positive and a negative effect on the USD exchange rate, but a decrease in the amount of imported energy use has no effect on the USD exchange rate. Moreover, in the same period, both negative and positive movements of the USD exchange rate increase imported energy use.

In 2019 and later periods, the causality relationship between the variables has changed dramatically. Changes in the USD exchange rate have limited or no effect on the amount of imported energy resource utilization. The effect of the increase in imported energy use on the USD exchange rate decreased and in some periods completely disappeared. When the reason for the dramatic change between these two periods is questioned, the changes in the ratio of the annual amount of electricity generated from imported energy sources to the total amount of electricity used stand out. Before 2019, this ratio was close to and above 50%, while after 2019 it was 40%. Based on this determination, it was investigated whether the main factor determining the relationship between energy imports and the exchange rate is the ratio of the amount of imported energy to the total amount of energy used (E/ET). As a result of the regression tests, it is found that the E/ET ratio has a negative effect on the existence of the relationship between USD and imported energy use.

In the light of the econometric results and literature findings: If the amount of imported energy resources has a high share in total energy resources used, the relationship between the amount of imported energy and exchange rates is strengthened. If the amount of imported energy resources has a low share in total energy resources used, the relationship between the amount of imported energy and exchange rates weakens.

SUMMARY

While different energy sources such as coal and petroleum have been the focus of economic research, especially after the industrial revolution, electrical energy has come to the forefront in today's economies. However, the electricity obtained today is not a primary energy source, but is obtained indirectly through primary energy sources. Therefore, while investigating the effects of electricity use on the economy, all primary energy sources such as coal, petroleum, nuclear, hydroelectric, solar, wind and similar sources should not be ignored. We know that these primary energy sources are not distributed evenly across the world. This unbalanced distribution is tried to be balanced by foreign trade of energy resources. Energy-related foreign trade causes volatility in international foreign exchange markets. In Turkey, which is not so fortunate in terms of primary energy resources, a significant portion of the primary energy resources required for electricity generation is supplied through imports.

In this study, we investigated whether the primary energy sources imported for electricity generation (Natural Gas, Imported Coal and Fuel Oil) and directly imported electricity have an impact on exchange rates. The data used in the study are taken from the EPİAŞ database, which is the Transparency Platform of the Energy Market Regulatory Authority. Within the boundaries of the EPİAŞ database, the daily electricity generation and direct imported electricity (Mwh) values obtained from different energy sources between 01/01/2014 and 31/12/2023 and the daily USD exchange rate data used extensively in energy foreign trade constituted the data set of the research. The effect of the positive and negative fluctuations in the daily amounts of imported energy sources on the daily positive and negative fluctuations in the exchange rate is tested with Hatemi-J Asymmetric Causality analysis. As a result of the tests, if the ratio of energy resources imported for electricity generation / total energy resources is above a certain level, increases in energy imports affect the increases in the exchange rate, while decreases in energy imports do not have a positive or negative effect on the exchange rate. When the ratio of energy resources imported for electricity generation to total energy resources is below a certain level, the relationship between these variables decreases or even disappears.

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CHAPTER 6

AN ECONOMETRIC ANALYSIS OF CO_2 EMISSIONS IN TURKEY: RENEWABLE ENERGY, ECONOMIC GROWTH, AND ENVIRONMENTAL TAXES

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INTRODUCTION

In the 21st century, global climate change is among the most important environmental problems. Global climate change directly affects sustainable development goals, especially for developing countries. The rapidly increasing greenhouse gas emissions since the Industrial Revolution have brought the carbon dioxide (CO_2) concentration in the atmosphere to critical points. This situation has caused negative and irreversible effects on the climate system. CO_2 emissions are caused by human activities and constitute the largest part of greenhouse gas emissions. CO_2 is based on fossil fuel consumption in key sectors such as transport, industry, energy production, and housing. At this point, reducing carbon emissions is of great importance both in terms of environmental sustainability and social welfare, economic stability, and public health.

For developing countries such as Turkey, environmental problems have a more complex structure. While energy demand is continuously increasing in order to sustain economic growth, the environmental costs of growth are also reaching a point that cannot be ignored. Turkey's energy consumption is largely based on fossil fuels. Therefore, it has a carbon-intensive economic structure. However, there has been a significant increase in renewable energy investments recently, and this increase is seen as promising from an environmental point of view. In particular, the increase in the share of alternative energy sources such as solar, wind, and hydroelectricity has a potential impact on reducing carbon emissions.

Tax instruments implemented within the scope of environmental policies also have an important role in the environmental transformation process. Environmental taxes are financial obligations levied on environmentally damaging activities. Through these obligations, it is aimed to increase public revenues and reduce environmental impacts. Theoretically, environmental taxes can direct economic actors towards more sustainable choices by increasing the costs that harm the environment.

The main objective of this study is to determine how renewable energy consumption and environmental tax affect CO_2 emissions in the Turkish

economy. At this point, time series analysis is used for the period 1995-2021. In the rest of the study, a literature review summarising the subject is given. The data set and the model are introduced, followed by the econometric methodology. After the results of the econometric analysis are reported in tables, the findings obtained are interpreted economically in the conclusion section.

1. LITERATURE

Renewable energy can directly limit emissions by providing the function of reducing fossil fuel dependency in the energy supply. Environmental taxes are used as a regulatory fiscal instrument designed to internalise negative externalities through the price mechanism. The impact of these two policy instruments on emissions has been analysed in many studies with different periods, country groups, and methods. In the following, the studies in the relevant literature that have been examined in this context and in which both variables are included at the same time are reported in chronological order.

Sümerli Sarıgül and Altay Topcu (2021) preferred FMOLS, DOLS, and CCR estimation methods by using the Johansen cointegration approach for the Turkish economy for the period between 1994 and 2015. The effects of environmental taxes, economic growth, and renewable energy consumption on CO_2 emissions were analysed. The Johansen cointegration test shows that there is a long-run relationship between the variables. In the long-run estimations made with FMOLS, DOLS, and CCR methods, it was found that environmental taxes have a statistically significant and negative effect on CO_2 emissions. Renewable energy consumption is also found to have a strong and negative effect on CO_2 emissions.

Wolde-Rufael and Mulat-Weldemeskel (2022) identified 18 Latin American and Caribbean countries as the panel group in their study. Using the 1994-2018 period interval, the authors analysed the impact of environmental tax and renewable energy consumption on CO_2 emissions. In addition to the MMQR methodology, AMG, DOLS, and Driscoll-Kraay estimators were also

used for comparative analysis. As a result of the analysis, it is concluded that the effect of environmental tax and renewable energy on reducing emissions is more evident in countries with high emission levels. The effect of renewable energy on emissions is found to offer a stronger mitigating effect compared to the environmental tax. In addition, it is emphasised that the environmental tax encourages the use of renewable energy.

Bozatlı and Akca (2023) examined the effects of environmental taxes and renewable energy consumption on ecological footprint in OECD countries for the period 1994-2018. They utilised AMG, DCCE, and CS-ARDL approaches to have an idea about this effect. The results of the analysis show that environmental taxes and renewable energy consumption significantly reduce the ecological footprint. The results argue that environmental taxes and renewable energy policies are critical for environmental sustainability.

Atılgan (2024) analysed the impact of environmental taxes and renewable energy consumption on carbon emissions. G7 countries were used as the panel group in the study, in which the 1994-2014 year interval was preferred. Pesaran (2006) CCE method was used the method. As a result of the analysis, the effect of renewable energy consumption on emissions was found to be insignificant across the panel. It is significant and negative only in Germany. Environmental tax has a negative and statistically significant effect on CO_2 emissions. In country-based results, the emission-reducing effect of the environmental tax is significant in Canada, Italy, Japan, and the UK.

He (2024) aimed to examine the effects of renewable energy consumption and environmental taxes on CO_2 emissions in OECD countries. For this purpose, the period between 1990 and 2022 was used in the study, and CS-ARDL was preferred in order to model both short and long-term relationships in panel data. As a result of the analysis, it was found that renewable energy consumption reduces CO_2 emissions in the long run. Similarly, environmental taxes have also been found to reduce CO_2 emissions, and these effects have also been observed to persist in the short run.

Kafeel et al. (2024) analysed the impact of renewable energy consumption, environmental tax, and environmental innovation on CO_2 emissions for 21 OECD countries using the period between 2006 and 2020. GMM, 2SLS, and the Quantile regression approach were used as methods. As a result of the analysis, the effect of renewable energy consumption and environmental innovation on CO_2 emissions was found to be statistically and mitigatively significant. Environmental tax is found to reduce emissions in general, but its effect varies according to the method. This result shows that renewable energy use and environmental innovation are effective in improving environmental quality, but the effect of environmental taxes may vary according to contextual factors.

Li, Liu, and Li (2024) analysed the factors affecting carbon neutrality in BRICS countries. For this purpose, FMOLS and Driscoll-Kraay estimators were used in the study, for which the 1990-2021 year interval was preferred. The main findings show that renewable energy and environmental taxes have an increasing effect on carbon neutrality. It is recommended that BRICS countries reduce their dependence on fossil fuels and increase renewable energy investments.

Rabhi, Soujaa, and Parsons (2024) examined the mitigation function of environmental taxes and renewable energy consumption on CO_2 emissions. They used the period 1994-2018 as the year range. In the study on 36 developing countries, the CS-ARDL panel data method was preferred as the method. As a result of the analysis, it was found that renewable energy consumption has a significant effect on CO_2 emissions in the short and long run. The study concluded that environmental tax has no significant effect on emissions and is associated with institutional constraints and inadequate practices.

Savranlar, Ertas, and Aslan (2024) wanted to analyse the impact of environmental taxes on environmental quality in EU-27 countries. They also included renewable energy consumption and urbanisation in the model. The period range is 1995-2018. In the study using the PVAR approach as a method, it was determined that environmental taxes reduce CO_2 emissions.

Although the effect of renewable energy consumption and urbanisation variables on emissions is also negative, only the effect of urbanisation is found to be statistically significant.

Leitão (2025) analysed the effect of renewable energy consumption and environmental tax on CO_2 emissions in 38 OECD countries. For this purpose, FMOLS, DOLS, Quantile regression, and GMM-system methods were preferred in the study using the period between 1995 and 2022. As a result of the analysis, renewable energy consumption has a negative and significant effect on CO_2 emissions. This result confirms that renewable energy reduces emissions. Environmental tax, on the other hand, has a positive and significant effect in the study. This finding shows that although environmental taxes are theoretically intended to protect the environment, they create negative externalities and may increase carbon emissions.

In the literature, the effects of environmental taxes and renewable energy consumption on CO_2 emissions are mostly negative and significant. The renewable energy variable consistently shows emission-reducing effects in both developed and developing country samples. The effect of environmental taxes, on the other hand, varies depending on the country group, implementation efficiency, and methodology. In some studies, environmental tax is also considered a complementary policy instrument that encourages the use of renewable energy. In general, the findings indicate that environmental performance can be improved by integrating environmentally friendly policy sets.

2. DATA SET, AND MODEL

Environmental sustainability and climate change have recently been the main agenda items of economic policies. At this point, it is important to evaluate the effectiveness of policy instruments to reduce carbon emissions on a country-specific basis. In this study, the effects of renewable energy consumption, environmental tax, and economic growth on CO_2 emissions are analysed by the time series method using the period range of 1995 and 2021 in the Turkish economy.

The main measure of environmental degradation, CO_2 emission, is taken as the dependent variable. This variable is obtained from the World Bank database. The first independent variable, environmental taxes, is a policy instrument that aims to internalise environmental externalities. Environmental taxes encourage environmentally friendly consumption and production by reflecting the costs of environmentally damaging activities. This variable is taken from the International Monetary Fund (IMF) database. The other independent variable is renewable energy consumption. This variable is an important indicator that contributes to environmental sustainability by minimising the use of fossil fuels. The data on the variable obtained from the World Bank database ends in 2021. For this reason, the period after 2021 is excluded from the study to ensure data integrity. In addition, the economic growth variable is included in the model as a control variable. Economic growth is represented by Gross Domestic Product (GDP) per capita. This variable is also taken from the World Bank database and added to the analysis to control for the environmental effects of growth. With the data set obtained, it is aimed to reveal to what extent Turkey's environmental performance is shaped in the context of market-based taxation mechanisms and sustainable energy use. The explanations and abbreviations of the variables used in the study are given in the table below.

Table 1: Introduction of the Data

Variables	Description	Source
CO_2	Carbon Dioxide Emission Per Capita (t CO_2e/capita)	World Bank*
ET	Environmental Taxes (Percent of GDP)	IMF**
REC	Renewable Energy Consumption (%of Total Final Energy Consumption)	World Bank*
GDP	Economic Growth (GDP Per Capita Constant 2015 US$)	World Bank*

Note:*:https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?end=2021&start=1960;**:https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS

Source: Created by the authors

The functional and econometric model constructed with the variables considered is given below.

$$CO_2 = f(ET, REC, GDP) \quad (1)$$

$$CO_{2t} = \beta 0 + \beta 1 ET_t + \beta 2 REC_t + \beta 3 GDP_t + u_t \quad (2)$$

The 't' sub-index in the model refers to the 1995-2021 period interval considered. 'β1' indicates the change of one unit increase in environmental taxes on CO_2 emission. The expectation is negative (β1<0). 'β2' represents the effect of a unit increase in renewable energy consumption on CO_2 emission. There is a negative expectation (β2<0). The effect of a unit increase in GDP per capita on CO_2 emission is expressed by 'β3'. The expectation is that it can be both negative and positive (β3<0; β3>0). The EViews econometric package programme was used in the analysis of the variables. In addition, annual data of the variables were preferred.

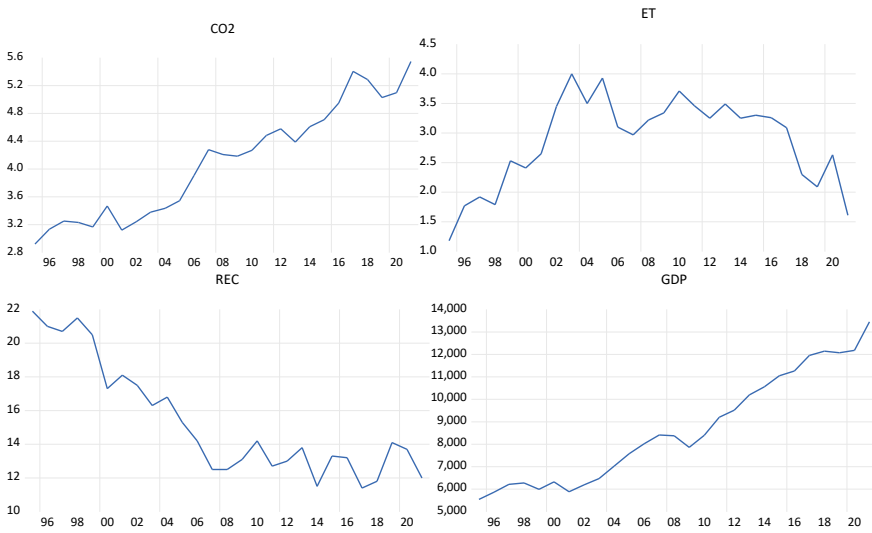
3. ECONOMETRIC METHOD, AND RESULTS

In this study, the effects of ET, REC, and GDP variables on CO_2 for the Turkish economy for the period 1995-2021 are analysed by time series analysis. Firstly, level value graphs are included in order to observe the change of variables over time. The Augmented Dickey Fuller-ADF (1979) unit root test was applied to understand the degree to which the variables are integrated. As a result of the unit root test, Johansen (1988) cointegration test was performed to see whether there is a long-run relationship between the series. It was found that the series did not move together in the long run, and the series was made stationary at the level by taking the difference of the series. In addition, the analysis was structured to reveal the short-run dynamics. Ordinary Least Squares - OLS was preferred in the short-run analysis.

In order to test the reliability of the short-run model, certain diagnostic tests were applied. The Breusch-Godfrey Lagrange Multiplier (Serial Correlation LM Test) was used to see whether there is an autocorrelation

problem in the analysis. The White (1980) test was applied to detect the problem of heteroscedasticity. Ramsey RESET test was applied to test the accuracy of the functional form of the established model. In addition, CUSUM and CUSUMSQ tests were used to examine the structural stability of the model. Finally, to see whether the residuals of the model have a normal distribution, they are analysed with the Jarque-Bera normality test.

Figure 1. Spread Diagram of Variables



Source: Created by the authors

When the results of Figure 1 are evaluated, it is seen that CO_2, REC, ET, and GDP variables have an initial point different from zero. Therefore, it is understood that the series has an intercept feature. In addition, it is seen that the variables exhibit a continuous increase or decrease, and it is determined that the series are under the trend effect. Within this information, the ADF unit root test was applied. The results of the test are given in Table 2.

Table 2: Unit Root Test Result

ADF Unit Root Test Result					
Level (CO_2)			**1. Difference (ΔCO_2)**		
Statistic: -2.90	Prob: 0.17		Statistic: -3.96	Prob: 0.00***	
Level (ET)			**1. Difference (ΔET)**		
Statistic: -1.43	Prob: 0.82		Statistic: -5.35	Prob: 0.00***	
Level (REC)			**1. Difference (ΔREC)**		
Statistic: -2.12	Prob: 0.51		Statistic: -5.35	Prob: 0.00***	
Level (GDP)			**1. Difference (ΔGDP)**		
Statistic: -1.64	Prob: 0.74		Statistic: -2.31	Prob: 0.02**	
Critical Values	1%	-4.35	**Critical Values**	1%	-2.66
	5%	-3.59		5%	-1.95
	10%	-3.23		10%	-1.60

Note:*** denotes 1% significance level, ** denotes 5% significance level. 'Schwarz' is chosen as the information criterion, and the lag length is set as '3' since the study is annual.
Source: Created by the authors

The null hypothesis of the ADF test used in the application states that the series contains a unit root. When the results of Table 2 are evaluated, the null hypothesis cannot be rejected, although the probability value for CO_2, REC, ET, and GDP variables is greater than 0.05. This conclusion can be reached by the fact that the calculated values of the series are smaller than the considered (5%) table values. Therefore, it is understood that the series used in the model contains a unit root. In order to see the degree to which the variables are stationary, first differences were examined. It was observed that the probability values in the first difference were less than 0.05 for the four series considered. Therefore, it is understood that the series is stationary at the first degree. Again, this conclusion can also be reached by the fact that the calculated values of the series are greater than the considered (5%) table values. After it is understood that the variables are integrated at the first order, a cointegration test was performed to investigate the long-run relationship. The findings of the test are summarised in the table below.

Table 3: Determination of Lag Length and Cointegration Test Results

Result of Lag Length						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-277.77	-	72460.38	22.54	22.73	22.59
1	-200.57	123.52*	553.45*	17.64*	18.62*	17.91*
2	-185.24	19.61	654.08	17.69	19.45	18.18

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized	**Eigenvalue**	**Trace Stat.**	**0.05 Critical Value**	**Prob**
None	0.54	47.14	47.85	0.05
At most 1	0.51	27.46	29.79	0.09
At most 2	0.27	9.62	15.49	0.31
At most 3	0.05	1.50	3.84	0.21
The trace test indicates no cointegration at the 0.05 level.				

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized	**Eigenvalue**	**Trace Stat.**	**0.05 Critical Value**	**Prob**
None	0.54	19.67	27.58	0.36
At most 1	0.51	17.84	21.13	0.13
At most 2	0.27	8.12	14.26	0.36
At most 3	0.05	1.50	3.84	0.21
Max-eigenvalue test indicates no cointegration at the 0.05 level.				

Source: Created by the authors

Considering the null hypotheses of the Johansen test used in the application, 'None' means that there is no cointegration between the series. The probability of both the Trace and Max-eigenvalue tests is less than 0.05, and we cannot reject the null hypothesis. Therefore, there is no long-run relationship between the variables. For this reason, in order to see the short-run relationship, all four variables were differenced and made stationary at the level. In addition, the Ordinary Least Squares method was preferred. The results of the short-run analysis are presented in the table below.

Table 4: Short-Term Analysis Result

Dependent Variable: ΔCO₂				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
C	0.0035	0.0319	0.1114	0.9123
ΔET	-0.0454	0.0563	-0.8068	0.4284
ΔREC	-0.0886	0.0197	-4.4786	0.0002***
ΔGDP	0.0002	7.41E-05	2.8588	0.0091***
R^2: 0.69			**Adjusted R^2**: 0.65	
F-statistic: 16.64			**Prob (F-statistic)**: 0.000007	

Note: *** denotes 1% significance level.
Source: Created by the authors

When Table 4 is analysed, it is seen that ΔREC variable is significant although the probability value is less than 0.05. Therefore, when the coefficient interpretation of the series is analysed, a unit increase in ΔREC variable decreases ΔCO_2 variable by 0.0886 units on average. This situation was found to meet the expected hypothesis. Similarly, ΔGDP variable was found to be significant in the model with a probability value of 0.0091. A one-unit increase in ΔGDP variable increases ΔCO2 variable by 0.0002 units on average. ΔET is found to be insignificant in the model since its probability value is greater than 0.05. Therefore, coefficient interpretation could not be made.

When the R^2 value, which expresses the explanatory power of the model, is analysed, it is seen that environmental tax, renewable energy consumption, and economic growth variables explain carbon dioxide emission by 69%. This result is considered appropriate. The probability value of the F Test result, which expresses the significance of the model as a whole, is less than 0.05, indicating that the model is significant as a whole.

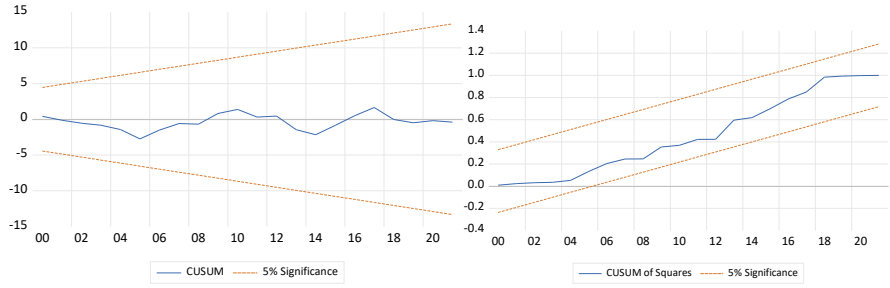
Table 5: Post Estimation Test Results

Heteroskedasticity Test: White			
Null hypothesis: Homoskedasticity			
F-statistic	1.71	**Prob. F(9,16)**	0.16
Obs*R²	12.76	**Prob. χ^2(9)**	0.17
Scaled explained SS	6.43	**Prob. χ^2((9)**	0.69
Breusch-Godfrey Serial Correlation LM Test			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.86	**Prob. F(2,20)**	0.43
Obs*R²	2.06	**Prob. χ^2 (2)**	0.35
Ramsey RESET Test			
	Value	**Df**	**Prob**
t-statistic	0.53	21	0.59
F-statistic	0.29	(1,21)	0.59
Likelihood ratio	0.35	1	0.54

Source: Created by the authors

When the results of the table are analysed, autocorrelation and changing variance tests are included for the diagnostic tests performed on short-term forecasting. According to the results of the changing variance test, although the probability value is greater than 0.05, the null hypothesis stating that there is no heteroscedasticity problem cannot be rejected. Therefore, the problem of heteroscedasticity was not encountered. When the autocorrelation test result is evaluated, the probability value is greater than 0.05, and the null hypothesis stating that there is no autocorrelation cannot be rejected at 5% significance level. In other words, no autocorrelation problem was encountered in the analysis. In addition, the Ramsey RESET test result, which has the null hypothesis stating that the model is correctly established, also indicates that the model is correctly established with a probability value greater than 0.05.

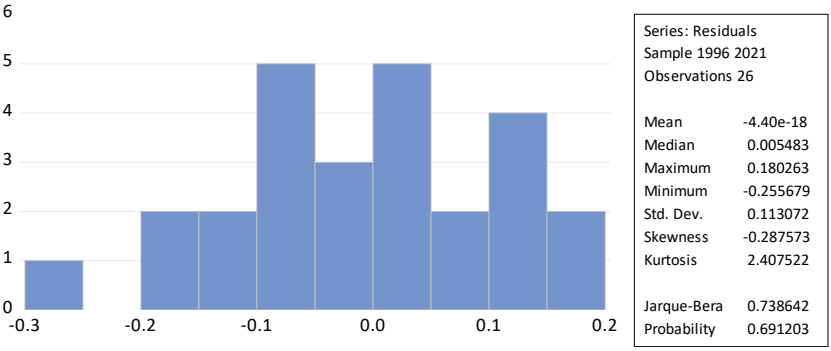
Figure 2. Structural Fracture Analysis



Source: Created by the authors

The CUSUM and CUSUMSQ tests to examine the structural stability in the model are given in the figure below. It is understood that both CUSUM and CUSUMSQ lines are within the upper and lower critical limits given at the 5% significance level, so there is no structural break in the structure of the model. The regression coefficients are stable over time, indicating that the reliability of the model is stable over time. Finally, the result of whether the residuals of the model are normally distributed is given by the Jarque-Bera normality test as follows.

Figure 3. Normality Test Result



Source: Created by the authors

The Jarque-Bera result, which tests whether the residuals of the model have a normal distribution, shows that the probability value is 0.69. The null hypothesis of this test states that the residuals have a normal distribution.

Therefore, the null hypothesis could not be rejected at 5% significance level. This result indicates that there is a normal distribution and no problem is encountered.

CONCLUSION

Reducing carbon dioxide emissions is a critical issue at the intersection of energy policies and macroeconomic strategies in line with sustainable development goals. Especially for developing countries, whose energy supply is still largely based on fossil fuels, the main problem is how to balance economic growth targets with environmental sustainability. In this context, this study focuses on the Turkish economy and analyses the short-run determinants of per capita CO_2 emissions using annual data for the period 1995-2021.

The cointegration test conducted after determining that all of the series are stationary at first order in the analysis revealed that there is no long-run relationship between the variables. Therefore, the first differences of the variables were taken, and the model analyzing the short-run relationships was estimated by the OLS (Ordinary Least Squares) method. The explanatory power of the model is found to be high, and the F-statistic confirms that the model is statistically significant in general. The results obtained from diagnostic tests (autocorrelation, heteroscedasticity, Ramsey RESET, Jarque-Bera) revealed that there is no structural problem in the model.

The main findings of the study can be summarised under two headings: (i) renewable energy consumption has a significant and negative effect on CO_2 emissions; (ii) economic growth increases emissions, but this effect is relatively limited. These two results, which seem contradictory at first glance, actually reflect the current structural duality of the Turkish economy. On the one hand, the share of renewable resources in the energy sector is increasing; on the other hand, the sectors leading economic growth are still based on carbon-intensive activities. This shows that the impact of energy policies on reducing environmental pressure may remain limited unless the transformation in the production structure is realised. Although the low level

of the impact of economic growth on emissions gives the impression that the pressure is weak, the existence of high carbon intensity in the production composition cannot be ignored. The policies proposed at this point are summarised below.

- Continued investments in renewable energy will further reinforce the environmental benefits of this sector.
- The transformation of carbon-intensive sectors is inevitable to reduce the negative impacts of growth on the environment.
- Energy efficiency policies and the transition to green technologies play a critical role in balancing growth and environmental sustainability.
- The transition to a low-carbon economy should not be reduced to the energy sector alone; sectoral harmonisation should be ensured to cover areas such as industry, transport, and construction.

In conclusion, although Turkey has made significant progress in reducing carbon dioxide emissions, this process should not be limited to energy supply policies. In order to achieve truly sustainable development, it is essential to restructure the growth model and energy policies with a holistic approach.

SUMMARY

This study aims to examine the main economic and environmental determinants affecting carbon dioxide (CO_2) emissions in Turkey for the period 1995-2021. In the analysis, CO_2 emissions per capita are taken as the dependent variable, while environmental tax, renewable energy consumption, and economic growth are included in the model as independent variables. The stationarity levels of the series were analysed using unit root tests, and although the variables were integrated to the same degree, no cointegrated relationship was found. Therefore, the first differences of the variables were taken, and short-term relationships were estimated by the OLS method.

The empirical findings reveal that renewable energy consumption is effective in reducing CO_2 emissions. On the other hand, economic growth has an increasing effect on emissions, but the strength of this effect is found to be weak. The environmental tax variable was not found to be statistically significant in the model. This suggests that environmental taxes are not used as an effective policy instrument in limiting carbon emissions in Turkey. In conclusion, the study emphasises the importance of renewable energy investments for environmental sustainability and points out that the structural effectiveness of environmental taxes should be increased.

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CHAPTER 7

EVALUATING THE ONLINE ACCESSIBILITY PERFORMANCE OF INDIVIDUAL RIGHTS-SEEKING CHANNELS IN TURKEY WITH DATA ENVELOPMENT ANALYSIS

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INTRODUCTION

Analyzing the relationships between the individual, groups, society and the state or authority is the main subject of social sciences and especially political science. While political science uses a high level of qualitative research methods in doing so, recently political science has also used quantitative methods in order to increase the level of provability and differentiate itself. In this study, data envelopment analysis method was used.

With the expansion of the definition and boundaries of democracy, the individual has become more demanding from the state and has expected it to provide him/her with the means to claim his/her rights on certain issues. In the case of Turkey, these rights-seeking methods or the means of directly conveying their demands, notices and complaints to the relevant institutions of the state have developed rapidly in the last 20 years. In particular, developments in information and communication technologies have enabled individuals to reach out to a wider environment beyond their immediate surroundings, and they have even been able to convey their requests, demands and complaints to the highest levels of the state. Although CIMER (Presidential Communication Center) is the first and foremost of these digital channels, many different institutions fulfill this function with different dimensions. In this context, the study is firstly a literature review, followed by the introduction, application and analysis of the relevant rights-seeking channels, and then concluded with a conclusion.

1. LITERATURE REVIEW

The first thing that attracted attention in the literature review was the excess of the works written about the field. When analyzed in this context, it is noticeable that the use of quantitative research methods in the studies is low. In a field with so many studies, only two articles on each of the institutions were examined. However, there is no source in the literature on the Ministry of Interior Human Rights Violation Allegation Application Center.

Selvi et al. (2019) focused on CIMER in their study. In their study, they focused more on public relations and the functioning and transformation of CIMER as an e-government application. In particular, they mentioned the aims

of Public Relations, application areas, historical process, e-government applications and CIMER as an e-government application.

In their study, Durmuşoğlu and Genel (2022) focused on CIMER as an e-consultation service and a public relations activity. In order to analyze the role of CIMER in citizens' communication with public institutions, information was provided by interviewing the Public Relations Department of CIMER, and then, in order to understand the perception of CIMER from the citizen's perspective, people who applied to CIMER from Istanbul and Ankara were interviewed. Within the framework of the Situational Publics Theory, how the participants described the role of CIMER in these communication processes and in which situations it turned into an active stakeholder were observed and transferred in the form of narrative analysis. It was understood that CIMER is the most reliable and accessible source of information for all participants in defining a situation, and a communication channel preferred by citizens to put pressure on public institutions in order to solve problems.

In his study, Alyanak (2023) focuses on the Human Rights and Equality Institution of Turkey (TİHEK), which was established in 016 with Law No. 6701. He states that persons subjected to discrimination and persons deprived of their liberty within the framework of the national prevention mechanism can apply to TIHEK. This article focuses on the admissibility requirements for individual applications to TIHEK in terms of ratione personae, ratione materiae, ratione temporis and ratione loci. The admissibility conditions are examined in light of the decisions of TIHEK and a comparison is made between the nature of the application to TIHEK and the nature of the applications to the Ombudsman Institution and the Constitutional Court on the protection of fundamental rights.

In his article, Albayrak (2021) focuses on the question “Will the Human Rights and Equality Institution of Turkey (TİHEK) play an effective role in preventing human rights violations in Turkey?” as the main problematic. The research question based on this question is the claim that “TIHEK plays an important role in the adoption of human rights and prevention of human rights violations in Turkey”. In the study, the basic concepts are explained, followed by an analysis of the institutional structure and duties of TIHEK, and finally, a

general evaluation is made and criticisms and recommendations are made regarding national human rights institutions.

Aydın (2011) examines the constitutional (Article 148) and legal provisions (Articles 45-51 of Law No. 6216) regulating individual application to the Turkish Constitutional Court. Within this framework, the fundamental rights and freedoms protected through individual application, the function and qualifications of individual application, those who are entitled to individual application, the acts and omissions of public power against which individual application can be made, the concept of violation, the capacity to apply, the stages of the application (admissibility, examination and decision) are evaluated and discussed by considering some possible practical problems that may arise.

In their study, Kahraman and Şahin (2020) examined the finality and binding nature of the decisions of the Constitutional Court on individual applications and the obligation of the courts of first instance to fulfill the requirements of the violation decisions within the framework of the Constitution, the provisions of the relevant legislation and the decisions of the Constitutional Court.

Yılmaz and Şahyar Akdemir (2021) focus on the Ombudsman Institution in their study. In the study, taking into account the decisions made by the institution, the institutional effectiveness of the institution in the context of criteria such as sanction power, specialization area, mediation role, establishing justice, and protecting the public is discussed.

In their study, Yatkın and Taşer (2016) examined the understanding of Ombudsman in Turkey, and tried to develop problems and solution suggestions encountered in understanding and practice. Within the framework of this understanding, the European Union Ombudsman practices were investigated, comparatively discussed and good practice models were discussed.

2. OVERVIEW OF RIGHTS SEEKING CHANNELS

In this section, an overview of the individual rights-seeking channels discussed in the study is provided. In this framework, information on CİMER,

TİHEK, the Constitutional Court Individual Application Right, the Ombudsman Institution and the Ministry of Interior Human Rights Violations Allegation Application Center is provided.

2.1 CİMER

CİMER, "Presidential Communication Center", is the world's largest public communication platform created to facilitate the exercise of the constitutionally guaranteed rights to petition and obtain information. Established in 2015, CİMER is a web service that provides a portal through which citizens of the Republic of Turkey can exercise their rights under Law No. 4982 on the Right to Information and Law No. 3071 on the Exercise of the Right to Petition. In addition to online applications, applications can also be made by phone and letter. The applications can be tracked with the application number automatically generated by the system. As of July 9, 2018, it was merged with BIMER service (Cumhuriyet, 2025).

CİMER is a public service carried out under the responsibility of the Public Relations Department of the Presidential Communication Presidency. CİMER is the name of the electronic system where applications are made and monitored, and applications are sent to the relevant public institution from approximately 60 thousand administrative units registered in the system, processed and responded to by the processing institution. CİMER is a platform where all kinds of opinions and suggestions on public policies can be submitted within the framework of the "participatory governance" approach, as well as the use of petition and information rights (cimer, 2025).

2.2. TİHEK

The Turkish Human Rights and Equality Institution (TIHK) was established by Law No. 6701, which entered into force upon publication in the Official Gazette No. 29690, dated April 20, 2016. Based on recommendations in European Union progress reports for the establishment of an institutional structure aligned with the Paris Principles, and the influence of central and local experience since the 1990s, the Turkish Human Rights Institution (TIHK) was established by Law No. 6332, dated June 21, 2012. With the establishment of

TİHK, the existence of the previous units affiliated with the Prime Ministry was terminated. According to the provisional articles of the aforementioned law, provincial and district human rights boards would serve as the Institution's offices until the Institution's offices were established. The establishment of an equality institution to effectively combat the prohibition of discrimination, as stipulated in Article 10 of the Constitution and the fundamental human rights conventions to which Turkey is a party, was addressed within the framework of both more effective work in this area and harmonization with the EU acquis. In this context, the Turkish Human Rights and Equality Institution was established by Law No. 6701, which entered into force upon publication in the Official Gazette No. 29690 dated April 20, 2016, with the aim of increasing the institutional capacity and effectiveness of the Turkish Human Rights Institution, revising the fundamental legal framework and institutional structure regarding the prohibition of discrimination and equal treatment, and enhancing the effectiveness and functionality of the national preventive mechanism against torture and ill-treatment. This institution was based on the Paris Principles, the relevant EU acquis, and international examples, particularly from EU member states. With the establishment of the Turkish Human Rights and Equality Institution, the Turkish Human Rights Institution, established by Law No. 6332, was abolished (tihek, 2025).

2.3. Constitutional Court Individual Application Right

The Republic of Turkey became a party to the European Convention on Human Rights in 1954; it accepted the right of individual application to the European Court of Human Rights in 1987 and compulsory jurisdiction in 1990. With the constitutional amendment made in 2004, international treaties related to fundamental rights and freedoms, particularly the European Convention on Human Rights, to which Turkey is a party, were given a value above that of laws. The final link in the chain of amendments referring to “universal standards” for fundamental rights was the 2010 constitutional amendment that opened the way for individual applications to the Constitutional Court. With the implementation of individual applications, constitutional judicial review of rights violations caused by individuals and institutions exercising public power began on September 23, 2012. Accordingly, as of September 23, 2012, anyone

can apply to the Constitutional Court on the grounds that any of their fundamental rights and freedoms guaranteed by our Constitution or covered by the European Convention on Human Rights have been violated by public authorities (Constitution, 2025).

2.4. Public Ombudsman Institution

The Public Ombudsman Institution (KDK) is an institution that examines, investigates, and makes recommendations regarding all actions, transactions, attitudes, and behaviors of the public administration in Turkey in terms of their compliance with human rights, justice, law, and fairness. Pursuant to the Public Ombudsman Institution Law No. 6328, published in the Official Gazette No. 28338 on June 29, 2012, and entered into force, the institution examines, investigates, and makes recommendations regarding all actions, transactions, attitudes, and behaviors of the administration; The Public Ombudsman Institution, which is affiliated with the Grand National Assembly of Turkey and has a special budget, was established to examine, investigate, and make recommendations regarding the legality and fairness of all actions, transactions, attitudes, and behaviors of the administration in accordance with human rights and justice. Complaints began to be accepted on March 29, 2013 (ombudsman, 2025).

2.5. Ministry of Interior Human Rights Violation Allegation Application Center

The task of conducting work aimed at protecting, developing, and preventing violations of human rights; combating torture and ill-treatment; examining complaints and applications and following up on their results; and taking initiatives to resolve problems was assigned to the Turkish Human Rights Institution by Law No. 6332 dated 21/06/2012. The Ministry of Interior, through the Ministry of Interior Human Rights Violation Claims Investigation Office established by the approval of the Ministry dated February 27, 2004, evaluates reports and complaints from individuals who have been subjected to human rights violations by law enforcement agencies (Police, Gendarmerie, Coast Guard). This application center is considered to be a less frequently used and less well-known channel compared to others (e-icisleri, 2025).

3. DATA ENVELOPMENT ANALYSIS

Data envelopment analysis (DEA) is a linear programming-based method that aims to measure the relative efficiency of organizational units that produce a large number of similar inputs and outputs. (Tütek et al., 2012: 223). Within the basic logic of data envelopment analysis, the efficiency score is calculated as follows.

Efficiency = Total Weighted Outputs / Total Weighted Inputs

The efficiency scores obtained from DCA range between "0" and "1." A low score indicates low efficiency. A decision-making unit with an efficiency value equal to "1" is considered efficient (Kelly et al., 2012: 65). When data envelopment models are applied with the aim of obtaining the highest output with a fixed input, the model created is referred to as "output-oriented," and when applied with the aim of obtaining a specific output with the least input, the model created is referred to as "input-oriented" (Günay, 2015: 18).

Although the basic principles of data envelopment analysis were first proposed by Farrell (1957), its mathematical basis was developed by Charnes, Cooper, and Rhodes (1978) (Ayrıçay and Özçalıcı, 2014: 248). Charnes, Cooper, and Rhodes expanded on Farrell's definition of relative technical efficiency to develop a data envelopment model that enables the analysis of the relative efficiency of decision-making units with multiple inputs and outputs (Savaş, 2015: 205). The model developed by the aforementioned authors, which performs efficiency analysis based on the assumption of constant returns to scale, is referred to as the CCR model, while the model developed by Banker, Charnes, and Cooper, which measures efficiency based on the assumption of variable returns to scale, is referred to as the BCC model (Aytekin and Kahraman, 2015: 293). There are numerous data envelopment analysis models in the literature. Cooper et al. (2006) have determined that there are numerous DEA models that vary according to their intended use and the definition of the number of models (Kauppinen, 2016: 97).

In data envelopment analysis, efficiency measurement is performed for a specific time period, but in some cases, the conversion of inputs into outputs may take longer. Data envelopment analysis determines relative efficiency

scores, but it is not possible to reach a conclusion about the absolute efficiency of decision-making units. Additionally, there is no random error term in the method, meaning that the method is quite sensitive to errors (Savaş, 2015: 209).

$$Maks\ \eta_k = \sum_{r=1}^{s} \mu_r y_{rk} \qquad (1)$$

Restrictions:

$$\sum_{i=1}^{m} w_i x_{ik} = 1$$

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} w_i x_{ij} \leq 0 \quad (j = 1 \ldots . n)$$

$$\mu_r, w_i \geq \varepsilon > 0 \quad (r = 1 \ldots . . s) \ ve \ (i = 1 \ldots . m)$$

In the model, the ε value in the last constraint is accepted as a value such as 10^{-5} or 10^{-6} and is used to ensure that the weights take a value other than zero in the positivity constraint of the weight values (Tütek et al., 2012: 233).

4. APPLICATION

The purpose of this study is to rank official institutions that allow citizens to lodge complaints and appeals through individual applications based on their accessibility criteria for online applications. For this purpose, the Human Rights and Equality Institution of Turkey (TİHEK), the Presidential Communication Center, the Constitutional Court, the Ministry of Interior, and the Public Supervisory Authority (KDK), which provide citizens with the right to personal applications and complaints, were ranked according to their accessibility criteria. Data envelopment analysis was chosen for the ranking process. While rankings can also be achieved using a single-criteria decision-making method, the main reason for choosing this method is that the DEA method does not require weighting criteria as in multi-criteria decision-making methods. Although the small number of decision-making units ranked by the relative

efficiency analysis in the DEA method is considered a disadvantage because it leads to an increase in the number of decision-making units that are deemed effective, it is anticipated that this disadvantage will not pose a problem for this study, as the primary objective of this study is not to calculate efficiency but to rank the institutions. The accessibility criteria for the institutions are as follows: The presence of application information on the website and the availability of an animated application information option were chosen as the first two criteria for user guidance. The word count in the application information text was considered the third criterion for assessing the comprehensiveness of the application information. The availability of the application link on the homepage, the number of steps required to access the online application, and the number of steps required to complete the application were also added to the criteria for ease of application. The inclusion of criteria for diverse groups to apply included enabling applications from disadvantaged groups and the availability of applications for foreigners. Thus, a ranking was made based on a total of eight criteria. The identified criteria and criterion numbers are listed below.

C1: Is There an Application Information?
C2: Is There an Animated Information?
C3: Application Information Word Count
C4: Access to the Application Link from the Home Page
C5: Application Opportunity for Disadvantaged Groups
C6: Application Opportunity for Foreigners
C7: Number of Moves Required to Complete the Application
C8: Number of Moves Required to Reach the Application

The data matrix containing the criteria values determined for the data envelopment analysis is given in Table 1.

Table 1. Table 1: Determined Criteria Values

Institution	C1	C2	C3	C4	C5	C6	C7	C8
TİHEK	1	0	790	1	1	1	11	5
CİMER	1	0	2000	1	1	1	7	2
Constitutional Court	1	1	2000	1	0	1	15	5
Ministry of Interior	1	0	167	0	0	0	7	6
KDK	1	1	2000	1	1	1	8	4

Source: created by the authors

Based on the data in Table 1, the values for criteria C1, C2, C4, C5, and C6 were determined to be "1" if the response was "Present" and "0" if the response was "Absent." Because criteria C1-C6 were the criteria targeted for maximization, they were treated as output variables in the DEA model. Because variables C7 and C8 were the criteria targeted for minimization, they were treated as input variables in the DEA model. Using the data in Table 1, the data envelopment analysis model for TİHEK, the number 1 decision-making unit, was constructed as follows.

Objective Function:

$$Maks\ \eta_k = \sum_{r=1}^{s} \mu_1 + 0\mu_2 + 790\mu_3 + \mu_4 + \mu_5 + \mu_6 \qquad (1)$$

Restrictions:

$$\sum_{i=1}^{m} 11w_1 + 5w_2 = 1$$

$$\mu_1 + 0\mu_2 + 790\mu_3 + \mu_4 + \mu_5 + \mu_6 - (11w_1 + 5w_2) \leq 0$$

$$\mu_1 + 0\mu_2 + 2000\mu_3 + \mu_4 + \mu_5 + \mu_6 - (7w_1 + 2w_2) \leq 0$$

$$\mu_1 + \mu_2 + 2000\mu_3 + \mu_4 + 0\mu_5 + \mu_6 - (15w_1 + 5w_2) \leq 0$$

$$\mu_1 + 0\mu_2 + 167\mu_3 + 0\mu_4 + 0\mu_5 + 0\mu_6 - (7w_1 + 6w_2) \leq 0$$

$$\mu_1 + \mu_2 + 2000\mu_3 + \mu_4 + \mu_5 + \mu_6 - (8w_1 + 4w_2) \leq 0$$

$$\mu_r, w_i \geq \varepsilon > 0 \quad (r = 1 \ldots . s) \;\; ve \;\; (i = 1 \ldots . m)$$

$$\mu_r = Weight\ values\ of\ r.output\ variable$$

$$w_i = Weight\ values\ of\ i.input\ variable$$

Table 2: Reachability Ranking of Institutions Obtained by Data Envelopment Analysis Method

Institution	**Effectiveness Value**	**Ranking**
TİHEK	1	3
CİMER	2	2
Constitutional Court	0,8	4
Ministry of Interior	0,636	5
KDK	3	1

Source: created by the authors

CONCLUSION

Various methods have been developed throughout history to increase individuals' connection with the state. However, particularly during the last quarter-century, when individualization reached its highest level, individuals' expectations of the state increased and they sought different means to convey these expectations. States, in turn, have developed various methods to increase individuals' sense of belonging to the state. This study aims to rank institutions that enable individuals to reach the state and accept individual complaints and applications in Turkey based on their accessibility performance in terms of

online application facilities, using performance indicators on their websites. For this purpose, data envelopment analysis, which allows alternatives to be ranked according to their relative efficiency scores, was used.

The assessment of institutions' accessibility by citizens was conducted through online application facilities. Accessibility criteria were determined by considering the availability and scope of information about online applications, the ease of implementation of the online application process, and the acceptance of applications from different segments of society. Eight criteria were determined within this framework. The ranking results, based on data envelopment analysis, revealed that the institution offering the most favorable accessibility conditions was the Public Supervisory Institution, with the Presidential Communication Center coming in second. The Ministry of Interior's individual application system ranked lowest in online accessibility. The results obtained from this study were obtained without requiring the calculation of criteria's importance weights using any weighting method. For the same purpose, the same assessment can be performed using a multi-criteria decision-making method by increasing the number of criteria and using any subjective or objective weighting method.

SUMMARY

Rapid developments in information and communication technologies have reduced the distance between individuals and the state. In this context, individuals can convey their requests, demands, and complaints to every level of the state, even to the highest levels. There are many examples of platforms created for this purpose that have become models around the world. When considering these digital platforms in the context of Turkey, the first that comes to mind is CİMER (Presidential Communication Center), though many other institutions fulfill this function in various ways. In this context, the study focuses on the online accessibility performance of these platforms. The quantitative method used for this purpose is very envelopment analysis. Indeed, after a literature review, the study introduces the relevant rights-seeking platforms, followed by their application and analysis, and concludes with the results.

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