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PROF. DR. GÜLSÜN İŞSEVEROĞLU

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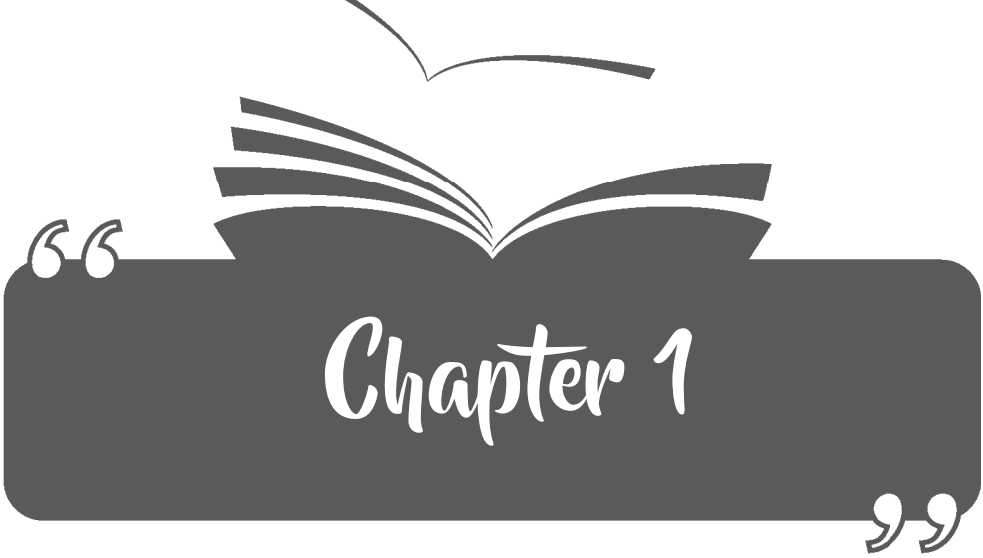
CONTENTS



COMPLIANCE PROBLEMS BETWEEN THE LAWS DETERMINING THE MONETARY ORDER AND THE LAWS DETERMINING THE SOCIAL POLITICAL AND SOCIAL SECURITY ORDER AND THE LAWS DETERMINING THE FISCAL ORDER IN TURKIYE

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INTRODUCTION

Monetary policy can be defined as the policies pursued by voluntarily changing money and credit conditions to achieve economic policy objectives. In other words, monetary policy is an essential tool of economic policy aimed at controlling the money supply and demand according to the general course of the economy and thus ensuring price stability. Monetary policy aimed at controlling the money supply means keeping the amount of money to be put on the market in proportion to economic growth in a way that will not disturb price stability. The monetary policy aimed at controlling the demand for money is based on the principle of withdrawing excess liquidity in the market. The power to change the money and credit conditions covering all these adjustments is left to the central banks. While implementing its voluntary monetary policy, the Central Bank utilizes tools such as money supply, interest rate, open market transactions, rediscount rate, reserve requirement rate, and exchange rate adjustments (Tokatlioglu and Selen, 2021: 13-14).

Between the two World Wars and after the Second World War, there were few areas in social policy development that developed as quickly as social security. This development occurred at the same rate not only in advanced industrial countries but also in economically underdeveloped countries. The fact that the people of poor countries felt the need for social security much more than the people of rich and developed countries supported and accelerated the efforts of the countries in this last category. In varying periods, individuals, like peoples, were sometimes attracted to adventure and sometimes to security. If judged by the desire for social security, it seems that most of humanity has chosen the second goal in our age. Today, the average age of humans is higher than at any time in history, and their need increases along with the years. Perhaps now, the possibilities of making a fortune by adventure are so rare that it now obliges one to rekindle dreams and seek adventure outside economic conditions. In any case, the worker of our age is not content to be sure that they will find food tomorrow, but at the same time, they want to have the opportunity to provide for themselves and their family in the coming days. Though not explicitly stated, this desire has always been present in people's minds. However, this desire, which was once seen among the land aristocracy, emerged as a fact that could only be achieved in the near future for the great majority of workers. The functioning of social security aims to meet the blind injustice of nature and economic life through the implementation of a social and organized justice system (Talas, 1979: 317).

Interestingly, there exists a parallelism between the laws that determine the money order and the laws that determine the social security order.

I. COMPLIANCE PROBLEMS BETWEEN THE LAWS THAT DETERMINE THE MONETARY ORDER AND THE LAWS THAT DETERMINE THE FISCAL ORDER IN TURKIYE

In the years following the Second World War and today, the main reason why inflation is frequently encountered in almost all Western countries is that the state monopolizes the money supply (in the sense of printing banknotes and coins) and has the power to intervene in the money supply indirectly (such as changing interest and rediscount rates and provision rates). L. Von Mises saw this danger as early as 1912 and stated that when the principle that gave the state the power to influence the value of money was accepted, the danger of making mistakes in the use of this power and using it in an exaggerated way would arise. Mises also emphasized that the State should stay away from any initiative that might affect the value of money. Similarly, Hayek, one of the great thinkers of this age, claims that the authority to print money should be taken away from the state. In parallel with this view, M. Friedman proposed to add a provision in the U.S. Federal Constitution which would stipulate that Congress had the authority to increase the money supply "by no less than 3% and no more than 5% per year."

This view, which argues that the main reason for inflation is the direct and indirect interventions of the state in the money supply, is a view adopted by almost all economists. Statistical data from various countries also strongly endorse this view. For example, in the 1780-1914 period, when gold and silver were used as currencies, there was almost no inflation in England, Germany, France, Switzerland, and the USA. Later, in the years when the gold currency system was left partially informally and partially immediately (after World War II), inflation became an integral aspect of economies. In other words, today, there is a serious desire to take constitutional measures that will reduce or even eliminate the intervention of the political power and the Central Bank in the money market (both in terms of money supply and demand) to prevent inflation (Parasiz, 1997: 39, 264).

Most central banks, or groups of more comprehensive institutions that are responsible for a nation's monetary affairs, are tied to a perfunctorily categorized example of "discretionary policymaking." In fact, this discretionary characteristic of policymaking refers to the absence of many specific preemptive limitations. Particularly, this refers to the freedom to deal

with situations that arise according to the interpretation of the situation by policymakers and the views of common political conditions. Beyond its independent and present political significance and the free activity of policymakers, it is often desired to best represent the interests of the nation. The policy should allow a flexible correction to be expressed according to all possible disturbances functioning in the economy. Preliminary limitations on execution undermine the flexibility that is so essential to the proper functioning of complex monetary affairs. A discretionary policy is required to provide detailed opportunities for flexibility that are foreseen and actions in accordance with the policy that are prevented by preliminary limitations on execution. The flexibility inherent in a discretionary policy should thus be expected to ensure a higher achievement of the economic process (Brunner, 1995: 21).

Due to the above-mentioned features and drawbacks, it is of great importance to examine the compliance problems between the rules of monetary creation in Türkiye and the laws regulating monetary relations with the external world in Türkiye and the laws determining the fiscal order.

A. COMPLIANCE PROBLEMS BETWEEN THE RULES OF CREATING MONEY IN TURKIYE AND THE LAWS THAT DETERMINE THE FISCAL ORDER

Monopolistic production of money allows the substitution of cheaply sourced money instead of commodity money. Cheap money substituted with commodity money takes the form of paper money, or demand deposits consisting only of an accounting entry. In almost all countries of the world, paper money (except traveler's checks) is only issued by governments. It is understood that in the 17th, 18th, and 19th centuries, although central banking was subject to some rules, there was also the issuance of paper money, which was not necessarily a coin or precious metal equivalent. Banks with emission authority, which can be called the main function of central banks, were initially and mostly established as private or mixed capital. However, since the emission authority of central banks had a public function, central banks established with private capital have been nationalized over time. Today, only a few countries have central banks established with private capital.

Today, paper money issuance is solely in the hands of central banks, provided that it is subject to specific rules. Apart from this, central banks also have the authority to determine the rediscount rate, to conduct open market transactions, to determine loan ceilings, and to determine provision rates. By using these powers, the central bank can affect the distribution of deposits and loans of commercial banks and loans to different

sectors of the economy. In addition, the Central Bank can grant direct loans to the government. The Central Bank of the Republic of Türkiye was established by the law numbered 1715 passed on June 30, 1930, and started its activities on October 3, 1931. The Central Bank of the Republic of Türkiye was established as a joint stock company with the privilege of issuing banknotes and this privilege was granted time-independently. The purpose of the Central Bank of the Republic of Türkiye is to help the economic development of the country. Its task is to determine the discount rate, regulate the money market and circulation, carry out treasury transactions, and take the necessary measures to ensure the stability of the Turkish currency together with the government. The first Central Bank Law No. 1715 was implemented for nearly 40 years, and during this period, many articles of the law, especially the articles related to the gold equivalent of the Turkish currency, were amended.

On January 26, 1970, with the law numbered 1211, the Central Bank of the Republic of Türkiye was given new duties and powers with a new structure. In this law, the Bank retains the name of the Central Bank of the Republic of Türkiye and the quality of being a joint stock company. However, in this law, it is stated that the bank is bound by the provisions of private law in cases where there is no clarity. According to this law, the privilege of the bank to issue banknotes will continue forever. The duties of the Central Bank of the Republic of Türkiye are defined more clearly in this law and under four headings. These tasks are:

- To conduct monetary and credit policy in accordance with development plans and annual programs,

- To take the necessary measures to protect the internal and external value of the national currency by acting together with the government,

- To regulate the amount and circulation of national money based on this law,

-To undertake the lending of money to banks within the limits specified in this law.

The powers of the bank are expressed in the same law as:

- The issuance of banknotes in the country belongs solely to the Central Bank of the Republic of Türkiye.

-The Bank has the right to determine the rediscount, discount, and interest rates to be applied in credit transactions.

- The bank may determine the interest, commission, and other fees to be collected and given in the lending and deposit acceptance works and the maturity periods in the deposit.

- The bank takes regulatory measures on bank placements in accordance with the objectives of development plans and annual programs. In other words, it regulates the distribution of loan types by sectors and subjects.

- It may take decisions regarding the determination of the amount, interest, and sales conditions of the bonds that may be put up for sale by private sector organizations.

The Bank has the right to issue banknotes in accordance with these duties and powers granted by law, as well as to put money on the market from time to time in new denominations and forms, and to remove the old ones from circulation when necessary. In addition, the bank can determine and announce the rediscount, discount, and interest rates to be applied in its transactions and the conditions of the open market policy to be valid at the entire country level.

The bank also serves as the government's financial and economic advisor. The international financial and economic relations of the state, import, export, exchange, and foreign exchange transactions are carried out by the bank. Apart from these, the rate of general liquid assets (provision and reserve) to be held by banks against their commitments and deposits is determined by the Central Bank. Finally, the Central Bank of the Republic of Türkiye can buy and sell all kinds of gold, as well as import and export gold. In addition, the Central Bank of the Republic of Türkiye can give and receive advances in exchange for gold and carry out various banking transactions (Berberoglu, 1988: 137-138).

The functions of central banks vary significantly from country to country. When considered purely as a financial institution, it can be stated that the functions of these institutions are oriented towards the cash management of the economy. In the fulfillment of these functions, it can be observed that the effectiveness of central banks decreased with the liberalization of financial rules introduced in the early 1980s. As a result of these liberalization trends, the control powers of central banks in monetary macro sizes have entered a process of significant decrease. Meanwhile, the development of new financial instruments related to the payment system and the high degree of integration observed as a result of automation in financial markets have greatly limited the functions of central banks to determine money stocks independently. The limitation of the powers of central banks to independently determine the stock of mon-

ey has raised the need to discuss the effectiveness of traditional monetary policies for total demand. In this context, it is seen that classical policies in the form of changing rediscounts and interbank interest and interest rates in general and affecting total demand are not sufficient. In addition, the quantitative control powers of central banks are losing their importance due to automation and innovation in the financial system. Central banks cannot determine monetary policies based on a certain doctrine and experimentally testable hypotheses within such a theoretical and practical framework, nor can they maintain their practices within the strict limits of a doctrine. Central banks, which operate in the financial sector, which is constantly changing, innovating and in the dynamics much faster than other sectors of the economy, prefer to produce new solutions to the new problems they encounter. These new solutions sometimes fit a solid theoretical style and sometimes tend towards a practical result without any theoretical connection (Ertugrul, 1992: 89).

The extent to which the Central Bank is dependent on the influence of the Government in determining the monetary and credit policy and whether the Central Bank is completely independent of the economic policy of the Government and the influence of the Government is more accurate can be discussed separately. The American FED System (Federal Reserve System) is one of the rare organizations that provides balance and counter control in a way by acting completely independent of the economic policy and influence of the Government.

Due to its different characteristics, it would be useful to examine the independence of the FED system from the Government in the USA in a little more detail and to make a comparison with Türkiye.

In the USA, the independence of the Central Bank (FED) from the Government lies in the availability of its powers and opportunities to implement monetary policy "independently" from the Government. Undoubtedly, in the USA, the FED and the Government (administration) take care to determine and implement economic, fiscal, and monetary policies in harmony. However, if they are not in harmony, it is possible for the FED to effectively conduct a monetary policy independent of the Government and the economic and fiscal policies implemented by the Government. Assuming that the U.S. Administration persists in pursuing inflationary policies by raising public expenditures and expanding the budget deficit, the FED can implement inflation-preventive policies independently and effectively. The FED has the authority to do this, and the conditions of the economy allow it. This is because the United States has a very large private sector and money market outside the public budget. Thus, the FED can completely or even excessively eliminate the inflation-

ary policies pursued by the Government, for example, by resorting to the rediscount rate and open market transactions.

In the case of Türkiye, the situation is completely different. The independence of the Central Bank of the Republic of Türkiye from the Government in terms of governance is a secondary problem; the important thing is whether its authority to implement monetary policy and the relevant economic conditions exist, independently of the Government and the public finance policy it implements. In Türkiye, contrary to the Central Bank Law and the relevant legislation, the Central Bank of the Republic of Türkiye is currently obliged to finance the public sector without showing certain "provisions" and to implement emissions when necessary. Under these conditions, it can be claimed that the volume of money, the increase in the volume of money, and monetary policy in Türkiye are determined as a result of public finance policies. The Central Bank of the Republic of Türkiye will try to reduce the money supply and money supply increases by limiting the rediscount volume of banks or increasing the deposit legal reserve rates while keeping the public sector financing large, but it will only put the burden of reducing the money supply on the private sector and private sector investments. The fact that the expansion of public sector financing reduces private sector investments by raising interest rates and reducing financing funds directed at the private sector is called the "crowding-out effect". Controlling the money supply and preventing inflation through these means - despite the tendency to reduce private sector investments - is very weak. Moreover, it is not possible for the Central Bank of the Republic of Türkiye to carry out open market transactions with efficiency in Türkiye due to the conditions of the economy. In fact, the legislation does not allow the Central Bank of the Republic of Türkiye to buy stocks and bonds and to do open market transactions for the purpose of controlling the money supply. However, these trades, although legally permissible, do not allow effective money credit volume control. Due to the prevalence of cheque payments in the United States, stock bond purchases and sales affect money and credit volume by one coefficient. Also, banks can freely make payments from the reserves of deposits with the FED, and these reserves can be transferred between banks. This brings about the necessity for banks to adjust the loans they open and the volume of deposits accordingly. In Türkiye, none of these conditions exist; therefore, the Central Bank cannot change the amount of money only as much as stock, bonds, and trading. In this case, it cannot be stated that the Central Bank of the Republic of Türkiye has "independent" and "effective" monetary policy opportunities. Apart from the public sector, the private sector money market in Türkiye is actually very limited compared to the USA. In this case, fiscal policies and budget

deficits affect the emission and total money supply in Türkiye to a great extent and eliminate the possibilities of correcting monetary policy without regulating fiscal policies (Hic, 1992: 46-48).

The problem of compliance between the rules of monetary creation and the laws determining the fiscal order in Türkiye results from the fact that the interest income provided to the people who buy Treasury Bonds, which are not an instrument of the Open Market Transactions Policy of the Central Bank of Türkiye, is not taxed at all compared to other sources of income. With the low taxation of the securities income earned by the holders of Treasury Bonds, both resources are unfairly shifted to the public sector and unnecessary resource shortages are created in the economy, which causes GNP to be realized at a low level. Considering that the public sector uses these short-term revenues provided by treasury bonds in an inefficient way, it can be understood how serious the problem is.

B. COMPLIANCE PROBLEMS BETWEEN THE LAWS REGULATING MONETARY RELATIONS WITH THE OUTSIDE WORLD AND THE LAWS DETERMINING THE FISCAL ORDER IN TURKIYE

Regulation of monetary relations with the outer world in Türkiye has been one of the issues sensitively addressed since 24 January 1980. Decree No. 32 on the Protection of the Value of Turkish Currency was issued on August 11, 1989. The decree constitutes an important step towards the liberalization of the foreign exchange regime, which has been ongoing since the beginning of 1980.

The most important changes introduced by Decree No. 32 regarding banks are as follows:

- Residents of Türkiye are allowed to purchase foreign currency from banks, authorized institutions, and private financing institutions without any upper limit.

- It is possible for non-residents of Türkiye (including foreign insurance and investment companies) to buy and sell all of the Turkish stocks registered in the stock exchange through intermediary institutions trading in the stock exchange in Türkiye and to transfer the income from such stocks and the earnings of their sales through banks and private financing institutions under the auspices of the Capital Markets Law. In addition, residents of Türkiye can freely purchase stocks whose prices are determined in foreign stock markets and transfer the purchase cost of such stocks abroad through banks and private financing institutions.

- Receiving cash, non-cash, and equivalent loans from abroad is possible for those residing in Türkiye. The rules governing the extension of foreign currency loans by Turkish banks have been changed towards more liberalization.

- Although it is regulated for exporters to bring export earnings to Türkiye regardless of a certain period from the date of export, they are obliged to deliver the export earnings to the banking system.

- Decree No 32, which aimed at the convertibility of the Turkish lira, loosened many of the other restrictions in the foreign exchange regime. These changes are expected to lead to diversification and the spread of foreign exchange transactions managed by banks. The limit on capital transfers from Türkiye to abroad was removed, but the obligation to inform the authorities to be determined by the Ministry of Treasury and Finance was imposed within 30 days of the capital transfer.

- The blockage on the assets of people living abroad was completely removed (Keyder, 1992: 132-133).

The exchange rate, which is the most prominent expression of Türkiye's monetary relations with the outside world, is the expression of domestic currency in a foreign currency with the simplest explanation. In the occurrence of exchange rates, the exchange rate regimes in force are largely effective. In an environment where there is no state intervention, the exchange rate that eliminates the supply-demand differences in the markets is defined as the "equilibrium rate", and the regime that allows the exchange rates to be formed in this way is known as the free exchange rate regime. In some cases, the public authority intervenes in the exchange rate supply and demand, and this is called the managed float-dirty float.

In the fixed exchange rate regime, exchange rates are kept at a fixed level at a certain parity. All currencies are denominated in gold and traded at this value. In the monetary regime in force between 1944-1971, the US dollar was taken as the international currency (in line with the Bretton Woods Treaty). In addition, a treaty was signed at the end of the Bretton-Woods Conference, and it was decided to establish the International Monetary Fund and the World Bank as a result of this treaty (Onen, 1990: 22). In other words, domestic currencies were expressed in US dollar and according to this parity, governments agreed to replace their own currencies with US Dollar. In the short term, governments tried to ensure that the exchange rates remained in balance within the framework of the parity they declared by intervening in the market with their foreign currency reserves, supporting the supply and demand for the country's currency. However, when there were significant changes in foreign exchange supply

and demand and devaluation or revaluation became inevitable, new parities were announced for exchange rates. In today's practice, governments often turn to foreign exchange buying and selling or enter into credit relations to support exchange rates in the markets with the currencies they provide. These exchange rate support policies directly affect the monetary volume in the country. For example, as a result of foreign exchange purchases, expanding foreign exchange reserves increase the amount of money in the economy. If the administrations do not want the amount of money to expand in the country, they absorb the money released to the market through open market transactions. This is called the sterilization process. Today, many economists are skeptical of sterilization policies. The need for sterilization is perceived as a sign that there is no realistic pricing in exchange rates and/or internal interest rates, and in this respect, it is thought that the need for sterilization will be continuous (Paya, 1994: 88-89).

The most important compliance problem between the laws regulating monetary relations with the outer world and the laws determining the fiscal order in Türkiye is that those who engage in the purchase and sale of foreign currencies are not taxpayers of a "Tobin Tax" type of transaction tax. This type of tax was proposed by Professor James Tobin, who taught at Princeton University in 1972, to ensure the stability of exchange rates (Spahn, 1996: 24). Considering the conditions of Türkiye, this tax as a transaction tax may prevent resources from shifting unevenly to this area since there is no transaction tax that taxes the foreign exchange transactions in question. Again, this tax can be a useful tool for registering the informal economy. However, it should not be noted that if the rate of this tax is kept high, it may cause capital flight from the country. Therefore, the rate of this tax should be kept at 0.1% in transactions related to foreign exchange.

II. COMPLIANCE PROBLEMS BETWEEN THE LAWS DETERMINING THE SOCIAL POLICY AND SOCIAL SECURITY ORDER AND THE LAWS DETERMINING THE FISCAL ORDER IN TURKIYE

Industrialization, which emerged in the 18th century and caused major changes in the production process, and the capitalist economic system are among the main reasons for social policy practices in a narrow sense. Industrialization, which is called the Industrial Revolution because it led to many economic and social changes, is essentially the use of the machine in the production process and the transition to mass production.

With the machine production that started in England for the first time, weaving production based on individual skills until then turned

into a weaving industry. Machine production also brought about a great change in the production relationships. Generally, the elements of labor and capital gathered in the same individual were separated from each other by industrialization. With the labor and capital gathered in separate individuals, a production process based on the division of labor was formed, mass production was started, and great social problems were created with great social changes, especially in labor relations.

This differentiation of labor and capital in industrialized societies inevitably led to a conflict of interest rather than a unity of interest in production and labor relations. In this period, a capitalist economic order based on capital and a liberal state understanding was adopted in Western societies, and political democracy did not even enter the completion process yet. The likelihood of the realization of the social state was still very low. Liberal thought, based on the idea of natural equality and freedom, intensified the conflict of interests in production relations due to the unequal conditions of labor and capital.

The early years of industrialization, which led to the formation of the working class, created an extremely unhealthy working life in every society, including long working hours, very inadequate wages, and working conditions unsuitable for health and safety. In these years, working 16-20 hours, receiving wages that could be termed misery wages, and experiencing the danger of being fired at any time in an environment where there were many job seekers were common working conditions that affected every employee. Along with the adverse conditions in the factories, the cities surrounding the factories also turned into residential centers where unhealthy and unfavorable conditions prevailed (Koray and Topcuoglu, 1995: 7).

Social policy, in a sense, is the name of a new formation that has been in existence since ancient times and is basically symbolized by man, aimed at the protection of the labor force working under the above-mentioned conditions. In order to reach its present meaning and dimensions, centuries had to pass, and the economic, social, political, and cultural structures of societies had to undergo radical changes and transformations. Social policy, in its general form, is a special, separate branch of social relations. It examines the relations and formations between people and classes depending on the economic and social structures of societies. These relations and formations range from the reduction and exploitation of the powerless by the powerful to slavery, to the situations of stratification and classification, the birth of classes, their contradictions, movements, and struggles. All these phenomena create a new law, new rights,

new freedoms, new interest relations, and new policies in society (Talas, 1992: 13).

Social security, which constitutes one of the important problems of social policy, can be defined as "a system that covers these risks of people who are deprived of work or whose income decreases involuntarily and who carry out a professional activity regardless of their nature" or "it is the insurance and guarantee of the current and future life of the people as a whole".

Today, the idea of "social security", which encompasses all members of the society, has developed in Anglo-Saxon countries as a measure in solving social policy problems in the recent past and has widely affected the social policy of other countries. All studies aimed at this purpose and the institutions created aim to ensure social security. In fact, with the "New Deal" plan implemented by President Roosevelt in the United States, it was envisaged to regulate the economic and social imbalances brought by the 1930 economic crisis, to ensure social security, and in the law enacted under the name of "Social Security Act", the wages of industrial workers and aid and insurance relations in cases such as illness and old age were regulated. In England, the British social security system, which was gradually established and managed separately until 1930, gained a broad and comprehensive quality by combining it with the "Beveridge-Plan" prepared under the chairmanship of Sir William Beveridge in 1941.

In this case, "While the state guarantees a minimum income (standard of living) to all individuals, it should also allow individuals to receive an income above this minimum subsistence level thanks to their personal efforts. Poverty can be prevented by the redistribution of national income in the society for the purpose of social security by taking into account the needs of the family. Social security is the securing of income cut by social risks such as unemployment, illness, accident, and old age. Likewise, eliminating the reduced income due to the death of the head of the family and covering extraordinary expenses in cases of birth or marriage are the principles stipulated by the Beveridge-Plan in the accrual of social security.

The Beveridge-Plan not only laid the necessary foundations for social security in England but was also included in the "Universal Declaration of Human Rights" by influencing the developments in the implementation of social policy all over the world in terms of determining the meaning of the concept of "social security" in today's modern social policy.

It is seen that the idea of social security, inspired by this idea, has developed and spread rapidly all over the world. In fact, the Marshall Plan

in Canada, the Van Acker Plan in Belgium, the plans in France, New Zealand, and many other countries can be given as examples of the organizations and plans that nations have formed in accordance with their social structures.

The behavior arising from a certain social thought and based on a general and common idea was created and nurtured by two streams of thought. The first one involves fighting poverty in the name of morality and justice, eliminating compulsory needs, and "Freedom from want" in Beveridge's words. The second stream of thought is the constant effort to ensure the safety of employees.

Since industrial life creates a commitment relationship between employees and employers, it has also exposed the worker to various social and physical risks. This causes a sense of insecurity in the worker, such as not being sure of their job, earnings, and even their future. This needs to be secured in advance by a planned social security organization. Indeed, the worker of our age wants to think about their future along with their family as well as their daily livelihood and to ensure this at a certain level. This desire is a clearly articulated and accepted fact for large masses of workers. Today's social security order established to achieve this purpose aims to reduce the injustice of nature and economic life by implementing an organized justice system that is as humane as it is rational. As a matter of fact, all kinds of measures have been taken to ensure a minimum social security at both national and international levels, especially in Western countries, and systems have been created to foresee measures to meet risks such as unemployment, incapacity, old age, disability, and death (Guven, 1970: 38-40).

The main social parafiscal institutions included within the social security system in Türkiye are the Social Security Institution, the Army Assistance Institution (OYAK) and the Surety Fund (Tugen, 1993: 58).

The most important compliance problem between the laws determining the social policy and social security order and the laws determining the fiscal order in Türkiye is the exemption of social security premiums from tax. No tax is collected from Social Security Premiums at the time of accrual, and then pensions are exempted from tax when the insured retires. Since high inflation has been prevailing in Türkiye for years, tax revenues should be increased. However, in the above practice, no tax is collected from insurance premiums during their accrual and no tax is collected from pensions during the payment of pensions. This poses an important compliance problem between the laws determining social policy and social security order and the laws determining fiscal order.

CONCLUSION

The rules of creating money in a country reflect the country's perspective on economic life. If a country wants its monetary system to function smoothly, it should also seriously prepare the legal infrastructure of the institutions that create money. This is because the monetary system has a unique functioning, and this system should be closed to political interventions. In addition, the personnel structure in the institutions that create money should be formed in a way that covers productivity and merit system, and constitutional and legal foundations should be created for this structure if necessary. In addition, it should not be forgotten that the rules of money creation are an important pillar of public policy.

Solving the compliance problems between the laws that determine the social policy and social security order and the laws that determine the fiscal order is of great importance. This is because the actuarial balance of the Social Security Institution in Türkiye is constantly in deficit, and these deficits have to be covered by the Treasury. In order to reduce this deficit, social security premium losses should be minimized. Another problem in Türkiye is that social security premium deductions are at high levels compared to salaries. The operations of minimizing the loss and leakage of social security premiums together with the efforts to reduce the informal economy should be in parallel with the operations of reducing the ratio of social security premium deductions to salaries to reasonable levels.

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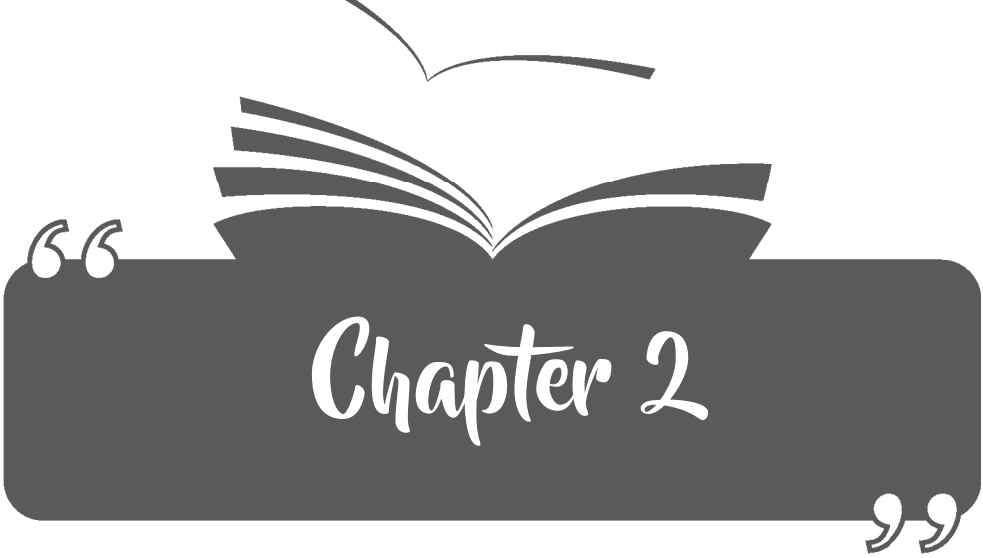

REVISITING THE GROWTH-POLLUTION NEXUS THROUGH CIRCULAR ECONOMY RELATED COMPETITIVENESS AND INNOVATION INDICATORS: A QUANTILE REGRESSION APPROACH FOR PANEL DATA

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1. Introduction

The circular economy is growing in popularity worldwide as the negative impacts of linear production and consumption patterns become increasingly apparent. As a sustainable development paradigm, it encourages closed-loop systems, waste reduction, and resource efficiency. It aims to reduce negative environmental impacts while promoting economic growth. (Herrador and Van, 2024). The circular economy is not a new phenomenon. It has been around for a long time. It involves regenerating and restoring consumption and production patterns so that the value of raw materials and products can be retained and waste can be avoided, thereby spreading inclusive and just social prosperity. Humans in different historical eras have recycled and reused, driven by social, political, technological, cultural, and economic conditions (Swain and Sweet, 2021). The phenomenon of industrialization brought about by the Industrial Revolution initiated both the mass production and consumption process and the pioneer of socio-economic and cultural changes (urbanization, increase in urban population, increases in consumption demand, etc.) triggered mass consumption (Stahel, 2020). Increases in economic activities lead to the rapid depletion of natural resources, and the wastes released from production activities create environmental pollution and negatively impact the ecosystem (Balbay et al., 2021; Chaturvedi et al., 2023). In countries where the industrialization and economic development process continues, in addition to the economic advantages provided by the intensive transfer of labor and resources transition to industrial sector from agricultural sector the pressure on the environment has reached a level that cannot be ignored. The concept of the linear economy with decades of unsustainable mass production and consumption patterns, as well as reckless resource/waste management strategies, has helped produce more food and goods and generate economic growth (Sillanpää and Ncibi, 2019). However, it has also led to the creation and accentuation of various environmental (air pollution, soil erosion and water pollution, climate change, and global warming), social and geopolitical problems (coal and oil sectors, inequalities, and wars) (Lacy et al., 2020; Jakobsen et al., 2021).

Since the Industrial Revolution, the linear economy model, which has operated in the form of "take-make-consume-dispose" in which the goods and services needed are produced using raw materials purchased by the individuals or companies that demand them and then returned to nature as waste when they have been used and their useful life has expired, has begun to be replaced by the circular economy model. This transition is not just a shift in economic models but a beacon of hope for a sustainable future. The circular economy model, based on sustainable production and consumption and recycling processes, offers a promising

alternative to the current linear model (Ormazabal et al., 2018; Boonman et al., 2023; Di et al., 2023; Hondroyiannis et al., 2024). Linear economy is a simple "production-consumption-disposal" structure in which resources are extracted, transformed into products, used, and then incinerated or landfilled. This definition includes a perspective that limits attempt to minimize or utilize production and consumption waste (Biomente et al., 2021: 1; Boonman et al., 2023: 216). On the other hand, circular economy is based on a dynamic, flexible, and more efficient "production-consumption-recycling/recovery" structure, in which resources are recirculated in the same process of a network of processes so that the output of one becomes the input of another, thus preserving the value of products or parts of them (Sillanpää and Ncibi, 2019). A circular economy aims to slow down natural resource depletion, reduce environmental damage caused by extraction and processing, and diminish pollution caused by processing, using, and disposing (Ekins et al., 2019).

It is clear that the ever-increasing use of new raw materials and energy has severe consequences for ecosystems and economies and is unsustainable in the long term. Most of the materials and resources extracted in the current linear "build-use-dispose" economy quickly become waste and emissions, placing a double burden on the planet's living conditions. Keeping materials and resources in use can reduce the extraction of new raw materials and reduce waste and emissions from the disposal of used materials. Therefore, the transition to a closed-loop circular economy may be part of the solution to create a sustainable future (Jakobsen et al., 2021). The first is to decouple economic growth from the extraction and consumption of scarce natural resources such as fossil fuels or hard-to-recycle metals and minerals. The second is to redesign the life cycle of products. This means keeping resources in the whole production system for as long as possible, using essential inputs, minimizing waste and turning waste into wealth (Biomente et al., 2021). Although the concept of a circular economy, first discussed by Pearce and Turner (1990), has been defined differently by different authors and organizations, the EU has provided the most comprehensive and widely accepted definition. According to the EU, the circular economy is "a model of production and consumption that involves sharing, renting, reusing, repairing, restoring, renewing and recycling existing materials and products for as long as possible" (European Parliament, 2024). In this way the life cycle of the products is extended. In practice, this means that waste is minimized. When a product reaches the end of its life, its materials are recycled into the economy. These products can be put to productive use over and over again, generating more value. This is a stark departure from the traditional, linear economic model based on the "take-produce-consume-dispose-model", which is inherent-

ly wasteful. This model relies on large quantities of cheap, readily available materials and energy. Planned obsolescence, where a product is designed to have a limited lifespan to encourage consumers to repurchase it, is also part of this model. As seen, the circular economy is multi-dimensional and complex, with many potential benefits: i) it can make it possible to produce and consume in more innovative and more efficient ways, ii) it protects companies from resource shortages and price fluctuations, iii) it provides opportunities for local employment and social inclusion, iv) it helps optimize waste management, speed up recycling and reduce landfill space, and v) the shorter production process requires less energy, resulting in energy savings and environmental benefits in terms of water, air, soil pollution and climate and biodiversity (European Commission, 2015; Sillanpää and Ncibi, 2019; European Parliament, 2024).

Schumpeter (1934) argued that innovation is the key driver of economic development, and circular economy is an essential tool for reducing environmental impacts while supporting sustainable economic growth. Innovation and technology are at the core of the circular economy transformation process, which depends on the use of technology. In other words, environmental technologies are at the heart of the circular economy (Bucea-Manea-Tonis et al., 2021; Tan and Cha, 2021). Circularity solutions require research and innovation to achieve sustainability (Hondroyiannis et al., 2024). The transformation from the current linear economy to a circular economy requires adopting and diffusing circular economy innovations (Ren and Albrecht, 2023). Circular economy innovations contribute to achieve sustainable development goals and target sustainability's environmental, economic, and social dimensions. For example, reducing energy and material consumption or recycling waste, water, or materials can lead to cost savings, improve a firm's competitiveness, and increase demand for its products (Horbach and Rammer, 2019). Circular economy innovations are a new trend in achieving sustainable development goals. Therefore, they are a key factor in firms' realization of the environmental, economic and social dimensions of sustainability. Due to the advantages of the circular economy, many firms can take a responsible stance in implementing circular economy strategies (Rehman et al., 2022).

Competition encourages firms to compete in many dimensions, including price, marketing, quality, and innovation. The circular economy will also tend to stimulate product and process innovation, as it requires firms to explain ways to optimize their use of inputs, extract more value from resources, and diminish their non-recyclable waste. This typically creates a significant incentive for investment in product design, research, and development supporting materials recycling, repair, and

reuse. By targeting productive efficiency, investing in the circular economy will often lead to more innovation and lower prices (OECD, 2023). According to Wiesmeth (2020), innovation and new technologies are important, particularly for export-oriented countries seeking to maintain or increase their competitive advantage through the development of innovative environmental goods and services. Unsurprisingly, environmental technologies have now become an important economic factor; for example, between 2000 and 2005, three countries, Japan, Germany, and the United States, accounted for about 60% of total innovations in climate change mitigation technologies. A recent study of Dutch firms shows that environmental regulation contributes positively to green, resource-saving innovation and dynamic productivity, while pollution-reducing innovation tends to reduce the productivity of firms (Domadenik et al., 2020).

Recognizing and seeking to take advantage of the spectacular transformation of the circular economy along the environment-technology-growth axis, the EU is almost leading the circular economy process in the world. Moving to a circular economy is increasingly seen as helping to develop "a sustainable, low-carbon, resource-efficient, and competitive economy". On the other hand, the EU produces more than 2.2 billion tonnes of waste each year (European Parliament, 2024). It is also updating its waste management legislation to encourage the transition to the circular economy which is a more sustainable model. The European Green Deal is new growth strategy to make Europe "the world's first climate-neutral continent with net zero greenhouse gas emissions" by 2050. It was declared by the European Commission on 11 December 2019. In addition, the EU has established the Circular Economy Action Plans (2015, 2018, 2020 and 2022) to achieve the goal of a clean and competitive Europe. To achieve the above-mentioned benefits, the EU is funding the circular economy transformation process until 2020 through the European Structural and Investment Funds, the Horizon 2020 Programme and the financial support of the European Investment Bank (European Parliament, 2024).

An enormous amount of literature analyzes the links between economics and pollution under the Environmental Kuznets Curve (EKC) hypothesis. However, the literature contains numerous empirical studies on the positive effects of innovation and competitiveness on economic growth, the theoretical basis of which was established by Schumpeter (1934) and Porter (1985). On the other hand, it might be seen that the number of studies on the circular economy phenomenon, which has been put on the agenda with the questioning of linear production and consumption models leading to global warming, climate change, and increasing environmental degradation, has started to grow in recent years.

Yet the literature review did not identify any studies analyzing the linkage between growth and pollution in the context of innovation and competitiveness, the pillars of a circular economy. This novel research gap provides an exciting opportunity for exploration and discovery. On the other hand, innovation and competitiveness are crucial elements for the transition to a circular economy in Europe. Innovation is needed to realize the systemic changes necessary for this transition. The circular economy is crucial for increasing competitiveness, reducing dependence on scarce resources with volatile prices, and creating new job opportunities and innovative, more efficient production and consumption methods.

Therefore, based on all these, this study purposes to investigate the role of circular economy indicators related to innovation and competitiveness in the growth-pollution nexus in European Union countries. For this purpose, a panel quantile regression analysis was carried out using economic growth, CO2 emissions, patents, investments, and employees in circular economy sectors for the period 2005-2020 for European Union countries. The study is divided into three chapters. The first section consists of the introduction section of the study. The second section provides a detailed literature review on the topic. The third section provides information on the econometric methodology, including the data set and the econometric model employed in the analyses. The next section presents the empirical results and their interpretation. The study concludes with a general assessment and policy recommendations.

2. Literature Review

The relationship between economic growth and environmental pollution has been investigated both theoretically and empirically by researchers for many years. The environmental degradation caused by the increase in fossil resource utilization has brought the use of clean technologies to the agenda. Therefore, the interest of researchers has focused on investigating whether these technologies have the effects of improving environmental quality by reducing emissions and contributing positively to economic growth. This means that in recent years, the pollution-growth nexus has been discussed in the literature in the context of eco-innovation practices based on clean technologies and circular economy rather than the EKC hypothesis.

The literature review for this study was twofold. Firstly, the studies on the relationship between pollution and growth were briefly evaluated, particularly the EKC hypothesis. For example, the empirical results of the studies Al-mulali et al. (2015) and Aye et al. (2017) indicate that the EKC hypothesis is not supported, while the studies of Ang (2007), Pao

and Tsai (2010), Arouri et al. (2012), Shahbaz et al. (2012) and Apergis and Öztürk (2015) provide empirical results that confirm the EKC hypothesis. According to Al-Mulali and Sab (2012), Cai et al. (2018), Gardiner and Hajek (2019), and Onofrei et al. (2022), economic growth and CO_2 emissions are cointegrated in the long run. On the other side, using the FMOLS technique, Azam et al. (2015) examined the effect of CO_2 emissions on economic growth for selected higher CO_2 emissions economies. They concluded that an increase in emissions hurts growth. Sun et al. (2020) estimated the effects of economic growth on CO_2 emissions using the CCEMG and AMG estimators. The results depicted a positive impact of economic growth on CO_2 emissions. While the empirical evidence from studies linking economic growth and pollution is mixed, most studies find a relationship between these variables. Of course, there are differences in the direction of the relationship between countries.

The studies on the circular economy were evaluated in the second part of the literature review. Some of these studies focused the circular economy practices of SMEs and other firms. For example; Bimonte et al. (2021) investigated the determinants of firms' incentives to invest in the circular economy by constructing a Cournot model that decomposes waste costs in the production function. According to the results, R&D investments in the circular economy affect the decisions of innovating firms by affecting the allocation of production and waste costs. The sign of the effect varies depending on the firm's strategy in the product market. When firms that are competitors in the product market cooperate on R&D, it strengthens their incentives to invest in green innovation. Moreover, governments have a significant influence on firm's decisions. Rehman et al. (2022) investigated the role of government incentives in the impact of circular economy and business model innovations on SMEs' economic, environmental, and social performance. Findings from China, Malaysia, and Pakistan suggest a positive effect but also highlight the moderating role of the governments. Chen and Dagestani (2023) used the text analysis method to determine the effects of circular economy practices on the corporate performance of Chinese firms between 2009 and 2019. According to the results, circular economy practices improve the performance of firms according to the resource-based theory, and even innovation and digital transformation strategies can accelerate this positive effect. On the other side, Ren and Albrecht (2023) investigated the role of demand-pull and demand-push policy instruments in shaping circular economy innovations in SMEs operating in the European Union countries. Technology-push policy instruments and legal regulations are essential in adopting circular economy innovations. Legal regulations increase the likelihood of firms innovating to minimize waste or to recycle

and reuse it. In addition to these studies, there exist works (Bianchi et al., 2023; De Pascale et al., 2023) investigating circular economy practices at the sectoral and regional levels. Bianchi et al. (2023) investigated local circular economy practices in the Nordic area and highlighted that circular economy activities and strategies are often developed based on local resources. In the case of the European Union, De Pascale et al. (2023) analyzed sectoral circular economy practices across all sectors and industries. According to the results, food and beverages are the best-performing sectors in terms of circular economy strategies, while capital goods are the worst. The data also show that recycling is the most commonly used circular economy strategy. Several studies in the relevant literature focus on circular economy policies and their effectiveness. According to Domenech and Bahn-Walkowiak (2019), the highly fragmented and complex framework of circular economy policies in the EU member states and the competing goals and objectives weaken the effectiveness of the policies. Herrador and Van's (2024) study on the effectiveness of circular economy policies in ASEAN countries found that Vietnam has a high potential for circularity. The most stable countries were identified as Brunei, Laos, and Myanmar.

Moving towards a circular economy, companies and countries struggle with many challenges, such as high costs, green innovation-induced uncertainties and risks, legal regulations, and adaptation problems, while providing various advantages (growth, employment, resource efficiency, sustainability, etc.). Based on the findings of the survey study to identify opportunities and barriers related to the circular economy for Spanish companies, Ormazabal et al. (2018) concluded that although companies pay attention to legal regulations, they are not very interested in environmental issues because they do not believe that they will increase their profits and competitiveness. They are more likely to focus on the cost savings of the circular economy. Gift et al. (2023) used interpretive structural modeling and MICMAC analysis to determine the obstacles to the circular economy in South African companies. They found that the most significant barrier was the failure to communicate the goals and objectives to the stakeholders properly. On the other side, Papamichael et al. (2023) used a SWOT analysis with hybrid approach to evaluate the process of circular economy transformation from a broader perspective than Ormazabal et al. (2018) and Gift et al. (2023). The SWOT analysis compares the three instruments that measure the circular economy (key performance indicators, quality protocols, and digitalization). According to the results, digitalization has the most significant advantages regarding opportunities and strengths related to the circular economy. It also has the fewest threats and weaknesses for circularity.

Some studies in the literature have measured the circularity performance of the countries by creating a circular economy index and ranking and comparing countries. In these studies, the sample is mainly determined to be the European Union countries, but the results of the studies are mixed. The results of relevant studies measuring circularity performance prove that EU countries do not exhibit a homogenous outlook in the circular economy and that member states have different levels of development. For example, Manea et al. (2021) created a circular economy index based on the Eurostat Framework by reducing 14 variables representing the circular economy to 4 dimensions. The results of the principal components analysis indicate that Austria and Denmark have the highest index values. Similarly, Karman and Polowski (2022) utilized principal component analysis and the catastrophe progression method to determine European Union long-term circular economy performance of the countries. Analysis of a broader dataset than Manea et al. (2021) shows the UK and Sweden to be highly competitive concerning circular economy performance. Yılmaz (2022) measured the circular economy performance of EU-28 countries employing data envelopment analysis for 2016 and 2018 and concluded that countries such as Estonia, Greece, and Bulgaria have low performance. De Oliveira Frascareli et al. (2023) calculated a circularity index for the EU-18 by reducing 52 circular economy indicators to 10 dimensions. Using data envelopment, social network and principal components analyses, they found that high-performing countries are Germany, Austria, Estonia, Latvia, and Sweden, while the lowest-performing country is Luxembourg. On the other hand, Sayın and Utkulu (2023) analyzed Türkiye's circularity performance compared to EU countries. The results of the index, constructed using five basic indicators, indicate that Türkiye lags behind the EU average in terms of circular economy performance but is on an upward trend. Ünlü (2023) examined the relative performance of the EU-27 countries in the circular economy using 19 variables from the Eurostat database. The results of hierarchical clustering analyses show that countries are not clustered according to their level of economic development and that EU countries have three different levels of circular economy development in terms of the circularity.

The circular economy literature also focuses on the impact of circularity on macroeconomic performance of the countries. Horbach and Rammer (2020) examined the effect of circular economy innovations on employment and performance using the Community Innovation Survey data for 2014 and 2016. The empirical findings for German firms imply a positive impact, i.e., increasing circular economy innovations increases employment and performance. Similar to Horbach and Rammer's (2020) findings, the results of the analysis conducted by Hondroyiannis et al.

(2024) using panel data analysis for the period 2010-2019 in the EU-28 countries indicate that the effects of the circular economy on real GDP is positive. In addition to, they found that Technological innovation has a significant impact on circularity as higher R&D expenditures facilitate eco-innovations. Investing in R&D is a cornerstone of a circular economy because R&D is an effective tool that can stimulate innovations by triggering economic growth in the EU countries. Ateş (2021) investigated the relationship between recycling and GDP, using the recycling indicator to represent the circular economy. The Prais-Winston (PCSEs) estimator was employed, utilizing data from 30 selected countries from 2008 to 2017. The results, which are revealed to impact economic growth significantly, show that the effect varies depending on the type of waste. Notably, while plastic waste and the recycling of old car parts are found to have a detrimental effect on growth, the impact of other waste types is positive. Considering a comprehensive approach, Boonman et al. (2023) examine the macroeconomic and environmental effects of an innovation-led transition to a circular economy. They developed a computable general equilibrium model to quantify the circular economy objectives of the European Commission's Strategic Research Agenda for the Circular Economy. They argued that a circular economic policy's success is contingent on complementary policies. These policies are necessary for the expected improvements in macroeconomic and environmental indicators to be achieved. Additionally, complementary policies are instrumental in securing social acceptance of the circular economy transformation process.

Finally, the last group of studies on the circular economy in the literature is the limited number of studies that examine innovation and competitiveness. Bucea-Macea-Toniş (2021) investigated innovation and competitiveness in the circular economy concept for the EU using pairwise comparison, correlation, and clustering analyses. According to the findings, there is a correlation between the eco-innovation index and the employment of R&D personnel. R&D, as a key driver of innovation, is encouraged by innovation and brings creativity to the forefront. The study claimed that investments in R&D and innovative processes that stimulate creativity support eco-innovation, which is crucial for developing and implementing circular economy strategies. Ilıc et al. (2022) concentrated on the relationship between investment and patents in the circular economy context, which has profound implications. Their findings, which show that patents significantly boost investment, are particularly intriguing. Moreover, their clustering analyses of EU countries using innovation- and competitiveness-oriented circular economy indicators revealed six different performance levels, highlighting the implications of heterogeneity in

circular economy performance among EU Member States. The heterogeneity supports the findings of Manea et al. (2021), Karman and Polowski (2022), and Frasceli et al. (2023). Popovic et al. (2022) investigated whether innovation and competitiveness indicators related to the circular economy affect economic growth in EU countries using correlation and regression analyses using data from 2016. The results show a moderate and negative correlation between competitiveness through values added at factor cost and per capita GNI. However, the correlation between gross investment in tangible goods and the number of employees in the circular economy is not statistically significant. Le et al. (2023) investigated the relationships between circular economy practices, production system resilience, ecological innovation, and cleaner production and concluded that cleaner production and ecological innovation play role in mediating the relationships between circular economy practices and production system resilience; that is, there are both indirect and direct moderating effects. Using survey data and the PLS-SEM technique, Rehman et al. (2023) investigated the relationships between triple bottom lines efficiencies, market competitiveness, and circular economy innovations in emerging economies. According to the results, circular economy innovations and market competitiveness positively affect triple bottom lines efficiencies. Moreover, competitiveness moderates the relationships between circular economy innovations and triple bottom lines efficiencies. Vranjanac et al. (2023) modeled the impact of circular economy innovations on circular economy performance in EU countries for 2018-2021. According to the empirical findings, a positive relationship exists between circular economy innovations and circular economy performance. In addition, the study draws attention to the importance of financial support to legal regulations on innovations.

On the other side, Cheng et al. (2019) determined the effects of renewable energy and innovation on CO_2 emissions using panel quantile regression analysis. The empirical evidence for OECD countries from 1996-2015 does not support the EKC hypothesis. Moreover, the effect of innovation on pollution is positive but statistically insignificant. In contrast, Tiwari et al. (2024) analyzed the effects of the circular economy on CO_2 emissions following QARDL and PMG methods. They found adverse effects of the circular economy and climate policy stringency on emissions. As can be seen, no study directly investigating the relationship between innovation and competitiveness-oriented circular economy, economic growth, and pollution was found during the research period. Moreover, studies have yet to be seen to examine these relationships in the European Union case by following the panel quantile regression approach

procedure. These gaps in the relevant literature were the starting point for this study.

3. Data and Methodology

This research investigates the growth-pollution nexus through circular economy-related competitiveness and innovation indicators in the European Union countries following a panel quantile regression approach for the 2005-2020 period. We obtained the variables representing economic growth and environmental pollution from the World Development Indicators in the World Bank database. LNGDP refers to "real gross domestic product per capita calculated as the ratio of real GDP to the average population". LNCO2 represents "CO_2 emissions measured in metric tons per capita". On the other hand, we employed the annual data retrieved from the Eurostat database for circular economy-related competitiveness and innovation indicators (Eurostat, 2024). LNPERSON symbolizes "the number of persons employed in circular economy sectors (the recycling sector, repair and reuse sector and rental and leasing sector)". LNPATENT refers to "the number of patents related to recycling and secondary raw materials". LNINVEST denotes "private investment and gross added value related to circular economy sectors measured in million Euro". This indicator includes "gross investment in tangible goods and value added at factor costs in the recycling sector, repair and reuse sector and rental and leasing sector". The natural logarithmic forms of all variables were used to mitigate heteroscedasticity and acquire the variables' growth rate by their differenced logarithms (Ünlü, 2024).

Table 1: *Descriptive Statistics of the Variables*

	LNGDP	LNCO2	LNPERSON	LNPATENT	LNINVEST
Mean	10.01706	1.930300	2.040216	0.527151	1.390228
Median	10.15113	1.953946	1.884214	0.527862	1.309419
Maximum	11.38793	3.243000	3.858689	1.249108	2.853927
Minimum	8.407378	1.176495	0.410509	-0.402623	0.326234
Std. Dev.	0.671641	0.397849	0.737522	0.261813	0.487044
Skewness	-0.273939	0.497799	0.166331	0.066611	0.340578
Kurtosis	2.380784	3.386763	2.325144	3.365573	2.799164
Jarque-Bera	9.883689	16.49409	8.184789	2.188871	7.291466

To provide preliminary information, descriptive statistics of the variables are given in Table 1. According to Table 1, there exist a total of 347

observations used in the panel data analysis. While the variable with the highest mean value is LNGDP (10.017), the lowest mean value is LNPATENT (0.5271). A similar situation is also valid for maximum and minimum values. Variables LNGDP and LNPATENT have the highest (11.387 and 8.4073) and lowest values (1.2491 and -0.4026) in terms of both maximum and minimum values, respectively. In terms of standard error, the variables with the highest values are LNPERSON (0.7375), LNGDP (0.6716), LNINVEST (0.4870), and LNCO2 (0.3978) and LNPATENT (0.2618), respectively. Skewness and Kurtosis values indicate that all of the variables are not normally distributed (Tabachnick and Fidell, 2013). Therefore, the results obtained from the descriptive statistics above in Table 1, which show that the series is not normally distributed, support the application of panel quantile regression (Koenker, 2004 and Flori et al., 2024).

The basic econometric model used to identify the growth-pollution nexus through competitiveness and innovation indicators related to the circular economy in the European Union countries is given in equation (1) below:

$$LNGDP_{it} = \alpha_0 + \alpha_{1t}\text{LN}CO2_{it} + \alpha_{2t}\text{LNPERSON}_{it} + \alpha_{3t}\text{LNPATENT}_{it} + \alpha_{4t}\text{LNINVEST}_{it} + \varepsilon t \quad (1)$$

In equation (1), i = 1, 2, 3,…,N represents the number of horizontal cross-sections and t= 1, 2, 3,...,T denotes the time dimension. Also α_0 depicts the constant term and ε exemplifies the error term. The α terms in the equation (α_0, α_{1t} and α_{2t}) represent the elasticity coefficients of the independent variables.

In this study, we followed panel quantile regression approach by Koenker (2004) as the econometric methodology. The quantile regression method was first developed by Koenker and Bassett (1978). This method was transformed into a panel form by Koenker (2004) to allow both cross-sectional and time dimension. In 2011, he redefined this model as conditional quantile regression with fixed effects. In the quantile regression model, which is used when the variables are not normally distributed, the variability of the error term is allowed and there is no assumption about the variance structure. While the least squares method minimizes the sum of error squares, quantile regression relies on an objective function minimizing the precise value of the error (Opuko and Aluko, 2021). On the other hand, following traditional regression methodology might cause to under or over estimation of the coefficient. Hence, it may not always be successful in determining a significant relationship as they focus on average effects (Binder and Coad, 2011). It allows the distribution of the effects of independent variables on dependent variables to be in-

terpreted for different quantiles. In other words, different results can be obtained for different quantiles (Koenker, 2004).

The conditional quantile function defined as the response to the j[th] observation for unit i[th] is in equation (2) below (Koenker, 2011):

$$Qy_{it}(\tau|X_{ij}) = \alpha_i + X'_{ij}\beta\ (\tau)_{\text{j=1, 2, 3, …, mi; i=1,2, 3, …, n}} \quad (2)$$

where α_i, y_i, τ and X_i represents unobserved individual fixed effects, dependent variable (economic growth), quantile distributions, a vector of independent variables, respectively. Also, α_i indicate a change of position on the conditional quantile. On the conditional quantiles of the response, it has a pure position shift effect. The effects of covariates, X_{ij} are allowed to depend on the corresponding quantile τ, but this is not the case for α_i. To estimate several quantile models simultaneously, the following model is solved:

$$\min(\alpha,\beta) = \sum_{k=1}^{q}\sum_{j=1}^{n}\sum_{i=1}^{mi}\omega_k\,\rho_{\tau_k}(Y_{ij} - \alpha_i - X'_{ij}\beta\ (\tau_k)) \quad (3)$$

where ρ_{τ_k} is $\rho_{\tau_k}(u) = u(\tau - I(u<0))$ and, for $(u<0)$ and $(u>0)$ are defined $\rho_{\tau_k}(u) = u(\tau-1)$ and $\rho_{\tau_k}(u) = u(\tau)$, respectively.

4. Empirical Findings

The section contains the results of the correlation analysis the empirical findings from panel data analysis. The correlation analysis a useful tool for determining the existence, direction, and strength of the relationship between variables. There exists a high and strong correlation between the variables used in the analysis, as shown in Table 2. For example, private investment and gross added value related to circular economy sectors has a correlation of 0.85 with CO_2 emissions. Similarly, the number of persons employed in circular economy sectors has a correlation of 0.95 with CO_2 emissions. Also, the correlation between private investment and gross added value related to circular economy sectors and the number of persons employed in circular economy sectors is calculated as 0.95. The number of patents related to recycling and secondary raw materials has a correlation of 0.68 with private investment and gross added value related to circular economy sectors.

Table 2: *Correlation Matrix*

	LNGDP	LNCO2	LNINVEST	LNPATENT	LNPERSON
LNGDP	1	0.515	-0.213	0.118	-0.466
LNCO2	0.515	1	-0.859	-0.375	-0.956
LNINVEST	-0.213	-0.859	1	0.688	0.934
LNPATENT	0.118	-0.375	0.688	1	0.517
LNPERSON	-0.466	-0.956	0.934	0.517	1

Figure 1 depicts the estimated results of the panel quantile process. The vertical axis shows the coefficients of the variables and the horizontal axis presents the quantile distributions. It also indicates the confidence intervals of the independent variables in the PQR model (Koenker, 2005). Accordingly, all independent variables (LNCO2, LNPERSON, LNPATENT and LNINVEST) are within the related confidence interval.

Figure 1: *Panel Quantile Process Estimates*

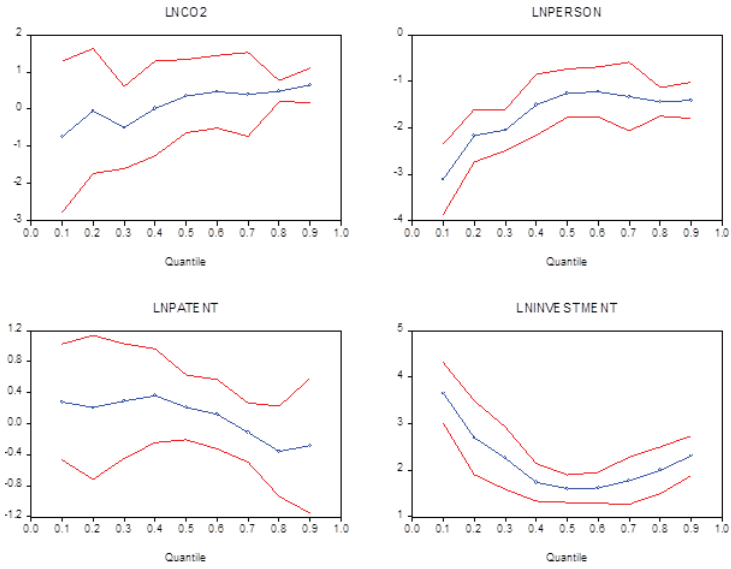

Table 3 depicts the empirical results obtained from panel quantile regression model. The effect of LNCO2 on LNGDP is negative at quantiles q=0.10, q=0.20 and q=0.30, while it is positive at quantiles q=0.40, q=0.50, q=0.60 and q=0.70. However, the coefficients for both are statistically insignificant. For quantiles q=0.80 and q=0.90, the coefficient is positive and statistically significant at the 1% level. Accordingly, in the q=0.80th quantile, a 1% increase in the LNCO2 variable increases the LNGDP variable by 0.48%. Similarly, a 1% increase in LNCO2 at quantile q0.90 increases LNGDP by 0.64%. The effect of LNPERSON variable on the dependent variable is negative and statistically significant in all quantiles. For example; in the q=0.10th quantile, a 1% increase in the LNPERSON variable decreases growth by 3.10%. In the last quantile, this rate is 1.40%. The negative impact of the LNPERSON variable on the LNGDP variable is expected to decrease over time. This is because it takes a long time for the positive impact of innovation and environmental R&D indicators on economic growth to be seen exactly. On the other hand, the effect of LNPATENT variable on the dependent variable is positive at quantiles q=0.10, q=0.20, q=0.30, q=0.40, q=0.50 and q=0.60 but negative at the other quantiles and the coefficients are statistically insignificant. The effect of LNINVEST variable on the dependent variable is positive and statistically significant in all quantiles. For instance, a 1% increase in the LNINVEST variable in quantile q=0.10 increases growth by 2.30%. This positive effect is relatively high in quantiles q=0.20 and q=0.30, while it is relatively low in the remaining quantiles.

Table 3: *Panel Quantile Estimation Results*

	LNCO2	LNPERSON	LNPATENT	LNINVEST	C
q=0.10	-0.740 (1.037)	-3.105* (0.385)	0.280 (0.382)	3.657* (0.332)	11.936* (2.866)
q=0.20	-0.047 (0.857)	-2.167* (0.289)	0.209 (0.473)	2.697* (0.406)	10.354* (2.454)
q=0.30	-0.491 (0.565)	-2.0478* (0.227)	0.291 (0.377)	2.257* (0.342)	11.664* (1.567)
q=0.40	0.021 (0.649)	-1.504* (0.334)	0.360 (0.309)	1.736* (0.206)	10.369* (1.762)
q=0.50	0.354 (0.503)	-1.252* (0.265)	0.210 (0.213)	1.602* (0.151)	9.571* (1.368)
q=0.60	0.470 (0.498)	-1.225* (0.274)	0.121 (0.228)	1.618* (0.169)	9.391* (1.363)
q=0.70	0.399 (0.575)	-1.328* (0.377)	-0.113 (0.194)	1.774* (0.259)	9.732* (1.600)
q=0.80	0.483* (0.145)	-1.440* (0.157)	-0.358 (0.297)	1.997* (0.256)	9.755* (0.472)
q=0.90	0.649* (0.232)	-1.409* (0.198)	-0.284 (0.443)	2.309* (0.219)	9.160* (0.791)

Note: * represents significance at the 1% level.

According to PQR model results, the effect of CO_2 emissions on economic growth is significant and positive only in the last two quantiles, meaning that increases in emissions contribute to growth, albeit to a limited extent. The effect of the number of people employed in circular economy sectors on growth is negative. On the other hand, the findings show that the patent variable does not have a statistically significant impact on economic growth. Investments in sectors related to the circular economy make a significant and positive contribution to growth. These results also show that the investment variable makes the most significant and positive contribution to growth among the competitiveness and innovation-based circular economy variables.

5. Conclusion

Global warming and climate change have caused environmental and economic problems that have challenged linear production and consumption models and put the concept of the circular economy on the agenda. This new circular economy model, which is the focus of both academic and policy attention, is the alternative of the linear economy model. The circular economy model is a holistic process that enables the reuse of products and raw materials. In this model, waste is recovered, energy and all resources are used efficiently, and clean production is carried out so that almost no waste is produced. Clean technologies are highly effective in minimizing environmental degradation by reducing emissions. In addition to the positive effects of the circular economy on the ecosystem, especially through clean technologies, it also has economic benefits for companies and countries. The efficient use of resources leads to productivity gains and cost advantages. Companies engaged in eco-innovation generate high profits. New businesses are created in sectors related to the circular economy, helping to solve the employment problem, and hence, the circular economy contributes positively to growth.

The European Union's primary policy objective is to ensure the transition to a circular economy. This transition aims to minimize the use of resources and the generation of waste. This will enable a low-carbon, resource-efficient, competitive, and sustainable economic structure. For this process to be successful, clean technologies are required. Innovation and competitiveness are the main drivers in producing and using these technologies. This study examines the pollution-growth nexus in the European Union in the context of innovation and competitiveness indicators related to the circular economy. For this purpose, a panel quantile regression analysis was carried out using data from the European Union countries for the period 2005-2020. According to the empirical results of the estimations, the effect of CO2 emissions on GDP is negative at low quantiles and positive at high quantiles. However, the coefficients are not statistically significant except for the last two quantiles (q0.80 and q0.90). The effect of the number of persons employed in circular economy sectors on income is negative and statistically significant. There are two possible explanations for this result. First, the labor force working in these sectors is more educated than others, and thus, they are paid relatively higher wages. This situation, which leads to cost increases, may hurt short- and medium-term income. However, in the long run, efficiency and productivity increases will provide the expected positive impact on growth. The second one is related to the fact that the effects of innovation and competitiveness indicators emerge in the long run due to their nature. In other words, it takes time for these indicators to have the expected impact on

income. The effect of the patent indicator related to the circular economy on income is positive in low quantiles and negative in high quantiles. However, its coefficient is not statistically significant. On the other side, the effect of investments in circular economy sectors on GDP is positive in all quantiles, and the coefficient is statistically significant. While this effect is high in low quantiles, the effect is relatively decreased in high quantiles. The impact of increases in the amount of investment on income gradually decreases. The findings show that LNINVEST has the highest impact on income among the circular economy indicators related to innovation and competitiveness. While the LNPATENT indicator is not statistically significant, the LNPERSON indicator is significant at high quantiles, and its effect on growth is negative. Based on all these, it can be concluded that circular economy indicators related to innovation and competitiveness can be effective in the growth-pollution nexus, especially in the long run. Although the empirical results of this study indicate that circular economy indicators related to innovation and competitiveness might affect growth, there is not enough evidence to claim that they can affect growth by reducing the volume of emissions. However, considering that the use of clean technologies minimizes the volume of emissions, it may be possible to talk about this indirect effect. More precisely, a circular economy based on innovation and competitiveness may positively affect income and growth. On the other hand, the current positive effect is also valid in the context of the growth-pollution nexus.

In line with these empirical findings, the following suggestions can be made for policymakers: First and foremost, in order to take advantage of the vast and valuable growth opportunities offered by the circular economy, it is necessary to emphasize private and public sector cooperation. Especially in circular processes based on innovation and competitiveness, all potential actors must interact and cooperate. On the other hand, well-designed and coordinated policies and legal regulations will contribute to the practical and regular functioning of the process. There is a need for a favorable regulatory framework that promotes innovation, competition, and the adoption and implementation of circular economy practices. This is because both circular economy and innovative processes require a comprehensive, systemic, and holistic policy approach. Especially in economic integrations such as the European Union, Union policies should be compatible with the national policies of the member states. Otherwise, the problem of consistency and clarity in goals and objectives may arise. While implementing country-specific policies, the harmonization with the Union policies should be addressed. Moreover, incentives, especially for increasing R&D investments, and facilities provided to investors are critical for overcoming the barriers to the circular economy.

Incentives, particularly financial support, should be offered to investors to increase investments in the circular economy related to innovation and competitiveness. This study has been carried out for the European Union, taking into account the availability of data. Different data representing the circular economy in relation to innovation and competitiveness can be used for country-or region-specific analysis. The mediating effect of all the circular economy indicators on the nexus between growth and pollution is also a potential area of research.

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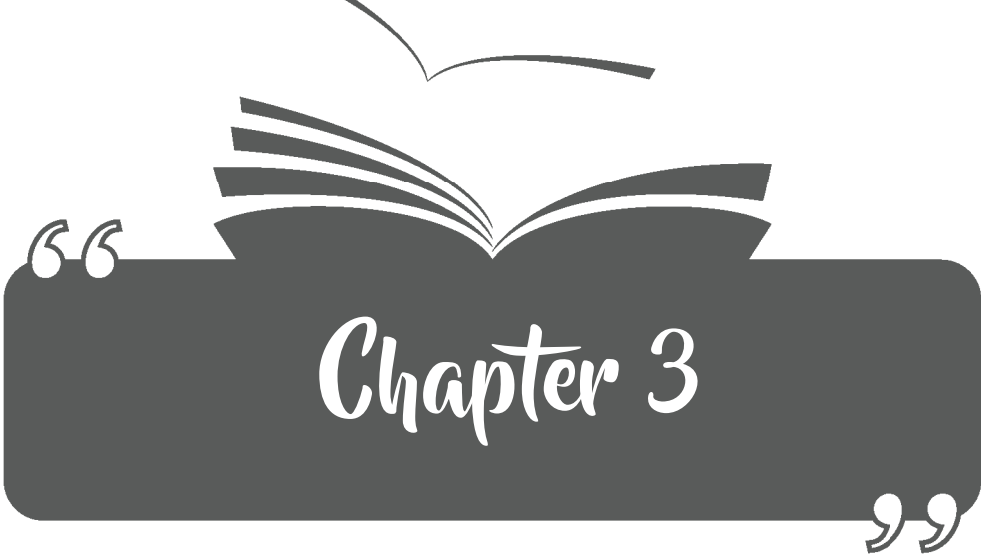

DEFENSE MANAGEMENT AND RENEWABLE ENERGY-GREEN DEFENSE: EVALUATION OF NATO'S TOP 10 COUNTRIES IN 2024

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INTRODUCTION

The basis of defense management is to provide the weapons and systems that the armed forces currently or in the future need and/or will need in order to ensure national security, from both domestic and foreign defense companies. Achieving this, depends on the effective execution of management activities such as Planning, Organising, Staffing, Directing, Coordinating, Reporting and Budgeting within the framework of defence. This forms the basis of Defence Management. Defense management is of critical importance in meeting the needs of armies with the right equipment, in the right place, in the right quantity and at the right time. One of these needs is "energy". "Energy" has significant role in meeting the requirements of a country's armed forces and sustainably continuing their activities by making optimum use of limited resources.

Today, energy costs required for defense expenditures are among the critical elements that must be taken into consideration in defense management. A country that is dependent on foreign sources for both the required weapons and systems and energy is likely to face a defense crisis. Because in today's rapidly changing foreign policy, today's allies can be tomorrow's enemies. It can be said that the sentence that Lord Palmerston said in his speech in the House of Commons on March 1, 1848: "… *We have no eternal allies, and we have no perpetual enemies. Our interests are eternal and perpetual, and those interests it is our duty to follow...*" actually forms the basis of the foreign policy followed by many countries today (Ratcliffe, 2016). Therefore, the fact that a country whose defense industry is insufficient to meet the needs of its own army is also dependent on foreign sources for energy increases the importance of defense management even more. In this study, the energy issue that should be taken into consideration in defense management will be examined within the framework of renewable energy sources, also known as green energy.

CONCEPT OF DEFENSE MANAGEMENT

The concept of "defense" has been accepted for over fifty years as a public property developed by the government of a democratic nation to ensure the safety of the public. (Balathandayutham and Muralidharan, 2021: 30). In other words, although "defense" may at first glance seem like a concept that only evokes military issues, it is a subject that also includes civil authority. Because defense is one of the activities carried out by the government in power of a country. Therefore, the government in power must be equally accountable to the parliament and under the supervision of the parliament in terms of its defence management, as it is in its activities. The national defense policy should be developed in a consultative

manner as much as possible and approved by the parliament. In short, it is important for the civil authority to have effective experience in carrying out defense activities (Le Roux, 2004: 86).

Defence management is significant in terms of striving for the effectiveness and efficiency of defence forces in order to ensure that they best carry out their duties of ensuring public security and defending against exterior threats. Defence management contributes to good governance by ensuring that resources are spent strategically and consistently with national security policy. This means a strong commitment to transparency and accountability at all organizational levels and the existence of an effective oversight system (McConville and Holmes, 2011).

Historically, the concept of "defense management" has only recently developed into a mainstream field of study and practice. The recognition of the concept of "defense management" began over the last 50 years when Western states began to use defense management as a business tool to address the problems of disposition of financial and human resources (HR), to comprehensively solve strategic or operational, or to manage the defense department. One of the ways to achieve excellence in all departments of the defense sector is the management functions implementation (planning, organizing, directing and controlling) of different departments and activities of defense institutions that can improve the performance of the armed forces (Balathandayutham and Muralidharan, 2021: 35).

"Defense management" is actually a field at the intersection of military sciences and management science. In other words, the overlapping subjects of military sciences and management science form the basis of defense management. This overlap prevents a clear definition of defense management (Akman, 2020: 95).

In general terms, defence management outlines the idea that defence organisations must translate defence policies into practice and, in doing so, develop appropriate and sustainable planning mechanisms, support systems and infrastructure. Implementation of these policies requires developing and following sustainable and fully appropriate planning, infrastructure and support system mechanisms (Bucur-Marcu, 2009: 4).

Defense management includes elements such as management of defense industry resources, management of field personnel, and procurement management. One of the most frequently encountered definitions in the literature regarding defense management was made by Begenirbaş (2022). According to Begenirbaş (2022: 11), defense management is a series of cyclical activities that begin with strategic guidance to secure the effective usage resources allocated to defense, continue with the imple-

mentation of management functions and are completed with the procurement of capabilities.

Considering the explanations made regarding management and defense management, it is seen that there is an emphasis on the effective use of available resources. Energy, as well as modern weapons, systems, software and programs, are among the resources allocated to defense in defense management. It is obvious that external dependence on energy, as well as all other resources within the scope of defense management, will disrupt the country's defense. The limited use of fossil fuels and the environmental damage they cause, which continue to maintain their importance in every field today, have led to a shift towards renewable and clean energy in the field of defense.

GREEN TRANSFORMATION IN ENERGY

Despite their environmental damage, fossil fuels continue to maintain their importance today. As a matter of fact, according to the BP Statistical Review of World Energy report published by British Petroleum in 2022, primary energy sources such as gas, oil and coal meet 85% of the world energy demand in 2022 (British Petroleum, 2022: 3). According to another report published by Birtish Petroleum in 2020, the world has coal reserves for 139 years, oil reserves for 54 years and gas reserves for 49 years (https://ourworldindata.org/). According to the 2019 forecast of Boğaziçi University Climate Change and Policy Application Center, the world has 120 years of coal reserves, 60 years of gas reserves and 40 years of oil reserves based on the consumption rate in 2019 (http://climatechange.boun.edu.tr). According to the World Energy Outlook study of the International Energy Agency in 2015, if current consumption continues in 2015, the world will have 110 years of coal, 54 years of gas and 53 years of oil reserves (https://group.met.com/). Different sources have different estimates at different times about how many years of fossil reserves are left in the world. The basis of this difference is the difference in fossil fuel consumption over the years. However, there is a fact that must be accepted, and that is that fossil fuels will run out perhaps a few years early or a few years late, depending on the rate of use. In other words, fossil fuels will eventually run out. This inevitable reality has led countries to use accessible, sustainable and clean energy sources, namely renewable energy - in other words green energy - sources.

Renewable energy source can be described as an energy source that can be available the same way the next day within nature's own cycle. One of the most significant features of renewable energy sources is that the carbon dioxide emission rate is lower than that of fossil fuels. This

means that renewable energy is environmentally friendly. For this reason, renewable energy sources are also called "green energy".

Reducing external dependency on energy due to their local nature, accessibility and acceptability are important advantages of renewable energy sources (Özkaya, 2004).

Considering their definitions and characteristics *wind energy*, *solar energy*, *hydrogen energy*, *geothermal energy*, *hydraulic energy*, *biomass energy* and *wave energy* are included in the frame of renewable energy sources (https://eusolar.ege.edu.tr). Today, many countries have increased their research, investments and incentives for the use of renewable energy sources in recent years due to environmental sensitivities such as global warming and the depletion of fossil energy resource reserves in the medium term. In fact, according to the "Global Outlook of Renewable Energy Finance-2023" report published jointly by the International Renewable Energy Agency (IRENA) and the Climate Policy Initiative on February 22, 2023, global investment in renewable energy technologies reached $1.3 trillion in 2022. This investment level reached its highest level with an increase of 19% compared to the investment level of 2021 and an increase of 70% compared to the investment level of 2019 (IRENA, 2023). Countries' sensitivities regarding the transition to renewable energy are evident in many different areas, including defense management.

WHY SWITCH TO RENEWABLE ENERGY FOR DEFENSE?

Effective use of available resources in defense management is important in establishing a strong military structure that has an important role for ensuring national security. Energy is also one of the important resources that defense management must use effectively. Fossil energy sources continue to maintain their importance as the primary energy source in meeting the energy needs of today's armies. However, the fact that fossil energy sources are limited and environmentally friendly has brought the use of alternative energy sources into the agenda in defense management. There are many reasons behind the increasing importance of renewable energy sources in defense, some of the most prominent of which are mentioned below:

a. Having energy resources is of decisive importance in the economic, security, geostrategic, operational and environmental activities of a country. This strategic importance and decisive role of energy is generally known and accepted by energy consuming countries (U.S. Department of Defense, 2010: 2). Countries that consume large amounts of energy, such as the United States, must meet the increasing energy needs and ensure security of energy supply due to their developing and growing economies

and increasing populations. For example, the United States meets the gap between energy production and consumption through various methods, including the option of hot conflict with countries across its border - especially MENA countries (Sümer, 2017: 12).

b. The imbalance in the distribution of energy resources in the world makes countries that do not have these resources dependent on countries that do. This situation forces energy-dependent countries to act and make decisions in economic, diplomatic and even military matters in line with the wishes of the countries from which they import energy (Deloitte Report LLP, 2009: 9-13). In other words, countries that have energy resources or countries that control countries that have energy resources through various means can use energy as a means of pressure. Russia's use of the energy element as a sanctions tool following the outbreak of the Russia-Ukraine war is a good example of this situation. As a matter of fact, many EU countries import natural gas from Russia today. With the start of the Russia-Ukraine war, EU countries that purchase natural gas from Russia are among the countries that imposed sanctions on Russia. Following Russia's decision to pay for natural gas sales in rubles rather than dollars or euros, Russia cut off the natural gas of Poland and Bulgaria, two countries that did not comply (VOA, 2022). Given that Poland imports 65% of its natural gas and Bulgaria 90% from Russia, both countries need to take Russia's sensitivities into account when making decisions on various issues. The basis for this is their dependence on Russia for energy.

c. When the distribution of primary energy resources in the world is analyzed, it is seen that these resources are under the control of certain countries. The fact that the countries that consume the most energy are far from energy resources requires them to follow long routes, especially by sea, to meet their energy needs. This situation has increased the importance of transit points such as the Panama Canal, Suez Canal, Bosphorus, Strait of Malacca, Strait of Hormuz. Therefore, a disruption at these transit points will lead to an energy crisis in many countries around the world (U.S. Department of Defense, 2010: 2). The March 24, 2021 Ever Given incident is a good example of this situation. As a result of the grounding of the large container ship Ever Given in the Suez Canal, the canal, through which 50 ships pass daily, was closed for 6 days (Yee and Glanz, 2021). While the daily cost of this problem experienced in the transitions to Egypt was $12 to $14 million, its impact on global trade was over $10 billion per day (Aşkın, 2021). Considering that oil and LNG (liquefied natural gas) tankers are among the ships that cannot pass through the canal, any long-term problems or delays that may occur in passing through these passages and straits will cause energy crises in countries

that are dependent on other countries for energy. A possible energy crisis will negatively affect the armed forces of countries and therefore national security.

d. Ensuring and sustaining national security is the sole concern and objective of defense management. Energy and the way it is used directly affects national security. Because national security largely depends on the type and quantity of energy resources and their availability to meet military needs. Therefore, even a small disruption in energy supply to meet defense needs will cause problems in national security (Thomas and Kerner, 2010: 1-3). For this reason, diversifying energy sources is becoming an element that aims to both avoid energy shortages in times of crisis and to avoid making the country dependent on the country/countries that have the required energy resources. Many countries, notably the United Kingdom, the United States and Türkiye, have adopted the practice of neutralizing national security threats across borders. This situation causes the armies of these countries to use armored personnel carriers, tanks, fighter jets, and ships regardless of the distance limitations of the armies in question to increase compared to the past, which in turn leads to an increase in the amount of energy needed in defense management and planning (Deloitte Report LLP, 2009: 9-13). Despite the increasing need for energy in ensuring national security, the limited amount of energy resources has made it necessary to plan the resources needed in defense management by taking into account the energy factor. For this reason, countries have started to turn to different energy sources in order to avoid any problems in energy, which is of critical importance in national security.

e. While national security constitutes one dimension of countries' shift from fossil energy to renewable energy in defense management, environmental sensitivities constitute another dimension. Although they do not seem to be interrelated at first glance, the negative effects of the use of fossil energy resources on the environment are characterized as a security issue. As is known, gases released into the atmosphere as a result of the use of fossil fuels have an increasing effect on global warming. According to military experts, global warming is causing some economic, political and social fluctuations. In the past, wars were fought for control of fossil energy resources; in the future, wars will be fought over water and food resources (Berdikeeva, 2017). Another effect of climate change on defense is to jeopardize the existence of military installations both within national borders and across borders. Research predicts that global warming will cause glaciers to melt and thus sea levels to rise (National Geographic, 2013). For example, the rise in sea level due to the melting of glaciers due to global warming would pose a risk to the existence of 125 military facilities worth billions of dollars in different parts of the world,

including the United States' air base in the Marshall Islands (STM Center for Technological Thinking, 2020). Another defense threat posed by melting glaciers concerns the future of military bases in the polar regions. Indeed, according to the Pentagon's Office of the Observer, glaciers melting with rising temperatures will bring cracks and flash floods on base runways and roads. As a natural consequence, this threatens the long-term viability of American bases and facilities in the Arctic and sub-Arctic regions and puts the United States at a disadvantage in its competition with Russia and China in the region (Knickmeyer, 2022).

f. Today, the increasing and diversifying needs of countries lead to steps to reduce costs in many different items, including defense expenditures. Reducing energy costs by abandoning the usage of fossil fuels in defense and shifting to renewable energy sources is one of the leading methods applied in defense management. In fact, the United States, which has the most fossil-consuming military in the world, spent $15 billion on energy needed for defense in 2010 and $4 billion in 2014 on bases within national borders alone. Efforts to reduce expenditures on fossil fuels in defense were initiated in 2010. Thus, it is aimed to reduce the usage of fossil energy resources by 50% by 2025 (Marston, 2014; Kline, 2014).

Due to the main reasons briefly mentioned above, developed and developing countries have increased their practices and research on the use of renewable energy sources in their armies.

DEVELOPMENTS IN USAGE OF RENEWABLE ENERGY IN DEFENSE

The use of fossil fuels in military and non-military vehicles and platforms for land, air and sea defense increases the size and impact of militaries' carbon footprints. Therefore, the transition to renewable energy in defense provides significant benefits to countries both in terms of making the energy supply needed by the armed forces sustainable and in terms of reducing nonenvironmental impacts. The necessity of a strong military infrastructure in establishing and maintaining national security necessitates the existence of a robust and sustainable energy supply. Indeed, the existence of a sustainable energy supply is also seen behind the United States army being among the strongest armies in the world. Due to the critical importance of the transition to renewable energy in defense, in February 2014 NATO adopted a framework program designed to expand the usage of renewable energy sources in defense (STM Technological Thought Center, 2019: 9). There are also various applications today for making renewable energy sources such as wind energy, solar energy, hydrogen energy, geothermal energy, hydraulic energy, biomass energy and wave energy available in land, air and sea defense (Barry et al., 2022: 15).

Renewable Energy in Navy*:* Ensuring the security of countries' territorial waters and carrying out operational activities in international waters is possible by having a strong navy. Various research and studies are being conducted on the use of renewable fuels instead of fossil fuels in naval elements.

Today, different alternatives for low-carbon ship propulsion have been developed. For example, the United States Navy uses Hybrid-Electric Drive (HED) technology in most of its amphibious ships. The French Navy's multipurpose anti-submarine frigate also uses hybrid electric propulsion technology, which optimizes fuel consumption and reduces exhaust emissions.

AIP (Air-Independent Propulsion) is an emission-free system used in navies. This system with hydrogen fuel cells was developed primarily for use in subsurface vehicles using a combination of an AIP hydrogen fuel cell batteries and systems. ThyssenKrupp Marine Systems' large unmanned vehicle and South Korea's new KSS-III-class submarines are recent examples of air-independent propulsion.

In addition to Hybrid-Electric Propulsion technology, wind energy and solar energy are also among the renewable energy sources used in navies. The wind and solar energy usage is becoming widespread, especially in small and unmanned marine vehicles for more operational purposes. The Saildrone Explorer Unmanned Surface Vessel (USV), developed by California-based company Saildrone, was accepted by the United States Navy in December 2021. The Saildrone Explorer Unmanned Surface Vessel has the ability to use both solar and wind energy thanks to the sensors in its sail (Zaffar, 2022). Similarly, Liquid Robotics, a Boeing subsidiary, has developed an unmanned marine vehicle called the 'Wave Glider.' Wave Glider, which has the ability to use wave and stored solar energy, is used in intelligence, surveillance and reconnaissance missions (www.liquid-robotics.com).

Another alternative energy source, other than fossil fuels, that navies use to meet the energy needs of their subsurface vessels such as submarines is nuclear energy. The United States, Russia, China, the United Kingdom, India and France are among the countries with nuclear-powered submarines (Biber, 2021). For example, Charles de Gaulle is in the French Navy and USS Bainbridge (CGN-25), USS Long Beach (CGN-9), USS Truxtun (CGN-35), USS Virginia (CGN-38) and USS Texas (CGN-39) are among the aircraft carriers with nuclear propulsion in the United States Navy (www.history.navy.mil).

The use of blended or unblended biofuels and synthetic fuels is thought to be another effective method for reducing fossil fuel use in the defense sector. Specifically, naval biofuels include vegetable oils, 1st and 2nd generation biodiesels, biohydrogen, biogas and lignocellulosic-based bio-oil. Although these biofuels have been tried in both the private sectors and military, they cannot be considered as new technology. Because a Fischer-Tropsch biofuel blend was tested on five US Navy ships in the Rim of the Pacific Exercise (RIMPAC) as recently as 2012. However, in addition to limited information on the use of these biofuels by naval elements, the high production cost in comparison with fossil fuels in the short term and medium term poses a significant obstacle to the widespread use of these fuels (Barry et al., 2022: 14).

Renewable Energy in Land Forces: There are also applications and studies on renewable energy in the vehicles used by countries' land forces, both operationally and as support services. For example, for defensive land vehicles, electric motors, whether powered by batteries or hydrogen fuel cells, have superiorities over internal-combustion engines due to their simplicity and reliability, as well as their favorable power-to-size ratio.

Considering the improvements in the civil sector over the last decade, it seems that Hybrid-Electric Drive technology and electric technology are only applicable for light vehicles for now. Therefore, it does not seem possible to apply these technologies to all vehicles used in land operations in the near future. Hybridization is a potential for tracked vehicles, but is more suitable for wheeled vehicles in terms of increasing functionality, range, torque, traction/off-road capability. The United Kingdom's MAN SV Foxhound and Jackal vehicles, which underwent hybrid-electric drive testing in 2020 (www.army.mod.uk), the United States-designed Light Tactical All-Terrain Vehicle (LTATV) HED GMV1.1 (Army Recognition, 2023), and the Griffon, a 6x6 wheeled hybrid-electric armored vehicle developed in the scope of the SCORPION EBMR program launched in 2014 for the French Army (Valpolini, 2022), are prominent examples. It is obvious that the hybrid option will make a significant contribution to reducing the operational costs and fossil fuel consumption of combat service-support logistics vehicles, including unmanned or autonomous models.

A fully electric land system seems more difficult to create because batteries today can be charged very slowly, heavy and offer limited range. But removable, replaceable batteries could solve charging time issues, while continued improvements in lightweight and energy-dense materials could make batteries more competitive in terms of weight.

Unlike vehicles powered by full electric drive and hybrid-electric drive, hydrogen fuel cell vehicles have all the advantages of hybrid-electric vehicles, with the added benefits of fast refuelling and very low fuel consumption when idling. The ZH_2 hydrogen fuel cell electric pickup truck named SURUS, developed by General Motors for the United States Army, is shown as an important example of this field (Seven, 2017).

Biofuels already play an signifacant role in terms of performance in civil road transport, compared to so-called "non-drop-in" fuels, which are obtained through solutions that require adaptation to engine fuel systems or special processing. However, given the unbalanced distribution of available feedstocks and the limited advancement in a few countries, such as the United States and Brazil, despite significant potential in Australia, Canada, China, India and the EU, it seems unlikely that biofuels will become widespread globally. Barriers such as access to raw materials and limited development make biofuels less useful in militaries. This reveals that the use of biofuels is a partial solution for now in the transition to renewable energy in defense (Barry et al., 2022: 14).

Renewable Energy in Air Force: Despite the various challenges, significant developments are taking place in alternative propellants for vehicles used in air defense. For example, Elroy Air is working on a hybrid-electric autonomous vertical takeoff and landing (VTOL) aircraft called the Chaparral for cargo shipments (Vincent, 2022), while LIFT Aircraft is working on an optionally piloted amphibious all-electric version called the Hexa (Patterson, 2022). Small battery-powered unmanned aerial vehicles (UAVs) are already in use by military and civilian actors globally. However, due to current weight considerations, a scalable, battery-powered aircraft for fast jet, bomber or transport operations seems unlikely to be available in the near future, even if it could be balanced with lighter materials.

Hydrogen is currently used for light and small-scale aircraft known as UAVs. Compared to their battery-powered counterparts, hydrogen-powered UAVs are used today especially in intelligence, surveillance and reconnaissance missions due to their low noise and low vibration advantages. Prominent aviation companies such as Airbus and Boeing continue to enhance hydrogen-powered engines for small UAVs such as ScanEagle 3, as well as for new generation single-aisle jets from the mid-2030s (Engineering and Technology, 2021).

On the other hand, synthetic fuel, which has similar physical and chemical properties to hydrocarbons, stands out as a better option compared to biofuel as it can be used without compromising the performance

of internal-combustion engines and does not require the establishment of alternative shipping systems or redesign of the supply chain. Indeed, the tangible benefits of synthetic fuels in aviation can be seen as they can be used on platforms currently used by France, Germany and the United Kingdom without the need for any harmonization process. Germany's plan to establish a new research center for fossil-free fuels, the Royal Air Force's Ikarus C42 microlight test flight being carried out with 100% synthetic fuel, the current status of Rolls Royce's EJ200 fighter engine powering the Eurofighter Typhoon and the MT30 gas turbines in service on naval ships of the US, UK and other armies being compatible with synthetic fuels can be considered as important steps in the transition to renewable energy in the field of defense (Bell, 2021).

Renewable Energy in Military Facilities: In the short term, making military installations self-sufficient in terms of energy through micro energy networks is among the solutions that can be implemented to realize the usage of renewable energy in defense in the short term. It is thought that the surplus energy produced through micro energy networks will also contribute to the country's energy production. In order to implement this application, it is critical to store energy safely and adapt defense supply chain processes to this system and change them to reduce the effects of possible problems (Barry et al., 2022: 14).

Especially in the last decade, some European countries have made efforts to achieve net-zero carbon targets in military facilities and to make their military facilities self-sufficient in energy. In Switzerland, for example, the photovoltaic installation in Othmarsingen already covers the energy needs of the Swiss Army's logistics centre. In 2018, Austria initiated studies to expand the usage of renewable energy sources in military facilities and public buildings by installing photovoltaic panels in buildings and to make these structures self-sufficient in energy (Austrian Federal Ministry of Defence, 2018). In the United Kingdom, the Royal Air Force Base at Leeming became the first net-zero carbon base (Royal Air Force, 2021), while the aim is for all Royal Air Force bases to reach the net-zero carbon target by 2040 (Nicol, 2021). The United States Army announced its first climate strategy in February 2022. Accordingly, the army plans to decrease greenhouse gas pollution by 50% until 2030 and achieve net-zero carbon until 2050 (Kaufman, 2022).

EVALUATION OF NATO'S TOP 10 ARMIES ON TRANSITION TO RENEWABLE ENERGY IN DEFENSE

Although there is no country that has reached the level of meeting all of its army's energy needs from renewable energy today, the world's leading countries in this regard are conducting research and developing various strategies on the transition to renewable energy in order not to encounter any energy problems in the future regarding defense. The vast majority of countries that stand out with their research on the use of renewable energy in defense are NATO members today. Therefore, the study examined the situation of the 10 countries with the strongest armies among NATO members in 2024 regarding the use of renewable energy in defense. In the study, document analysis, one of the qualitative analysis methods, was used. Document analysis is a qualitative research method. It is used to analyze the content of written documents rigorously and systematically (Bowen, 2009).

Since 2006, the United States-based GlobalFirepower (GFP) has published reports on countries' potential to fight in the air, on land and at sea, taking into account more than 60 factors such as manpower, equipment, finance and geography and natural resources for 145 modern military forces. GlobalFirepower (GFP) has listed the top 10 most powerful NATO armies in 2024 as: United States, The UK, Turkey, Italy, France, Germany, Spain, Poland, Canada and Sweden (www.globalfirepower.com). The study examined whether the countries with the 10 strongest armies in NATO in 2024 have any strategies for transitioning to renewable energy in defense. (see Figure 1)

Figure 1: *Renewable Energy Strategies of 10 strongest armies in NATO in 2024*

Source: *Created by author.*

***The United States*:** The United States has published the "Defense Climate Risk Analysis and Climate Adaptation Plan". This plan addresses energy transition and climate change across the Department of Defense, intelligence services, and national security. Another important step taken regarding energy transition and climate change is the "Sustainability Report and Implementation Plan". This plan focuses on diversifying energy production; electrifying the non-tactical vehicle fleet; expanding hybrid technologies for tactical vehicles; exploring tactical and combat vehicle electrification; investigating requirements to support electric vehicle fleets and capabilities, and activities that reduce energy use, as well as improving supply chain security for energy storage and increasing efficiency in facilities (US Department of Defense, 2021). The "Operational Energy Strategy" does not necessarily set a clear target for reducing greenhouse

gases, but it addresses issues related to the efficiency and recovery capacities of the USA (NATO Energy Security Centre of Excellence, 2021).

The United Kingdom: The United Kingdom Ministry of Defence (MoD) has announced the "Defence Climate Change and Sustainability Strategy" on how to achieve the transition to renewable energy in defence and achieve national net-zero targets. Net-zero goals refer to equating the amount of gases such as nitrogen oxide, carbon dioxide and methane released into the atmosphere as a result of human activities and causing the greenhouse effect to the amount of greenhouse gases absorbed by the earth (McKinsey & Company, 2022). In this context, the The United Kingdom Ministry of Defence plans to achieve net-zero until 2050. The "Defence Climate Change and Sustainability Strategy" also includes an active R&D programme, which closely monitors civilian technologies and includes experimental electric aircraft, synthetic aviation fuels and electric propulsion in a range of in-service military vehicles (UK MoD, 2021).

Türkiye: "Türkiye National Energy Plan of Türkiye" announced by the Ministry of Energy and Natural Resources of the Republic of Turkey in 2022. Document, covers Türkiye's current situation in terms of energy and its predictions regarding renewable energy. The Turkish Armed Forces-TAF have also taken various steps to do their part in ensuring Turkey's energy security and transitioning to renewable energy in defense. In this regard, studies were initiated in 2013 to generate electricity by utilizing renewable energy sources. In this context, the current situation was determined by analyzing the energy inputs, waste and carbon dioxide emissions and wastes of military facilities affiliated to the Turkish Armed Forces. As a result of the analysis, it was seen that the use of electricity, which is a cheap and clean energy source, is beneficial for TAF. However, other criteria taken into consideration were not only that electricity is cheap and clean energy, but also that it does not hinder the operational capabilities and possibilities of the Turkish Armed Forces, and that it is compatible with logistics, personnel, operations, intelligence and Communication, Electronic and Information Systems (CEIS) systems. In line with this result, the Turkish Armed Forces determined pilot barracks and initiated sample applications. With the positive results obtained in the pilot barracks, it was decided to spread these practices to all TAF facilities. Within the scope of the TAF's Construction Program in 2015, 2016 and 2017, it was envisaged to start to build up Solar and Wind Power Plants to generate electricity from renewable energy sources, preparing energy survey reports and preparing efficiency-increasing projects (Asker TV, 2015).

Italy: Regarding the use of renewable energy in defence, the Italian Ministry of Defence has developed the "Defense Energy Strategy". This strategy aims to develop energy efficiency, energy independence and an "energy-centric" way of thinking across operations, logistics and infrastructure. In addition to the development of military zones such as "green bases" and "smart bases", determining the appropriate weapon systems and force structure of the future are also among the issues within the scope of the strategy. Similar to the defense strategies developed and put forward by many other countries, the strategy developed by Italy also includes contributing to national, EU and NATO regulations on defense emissions (Italian Defence Staff, 2019).

France: The "Defense Energy Strategy 2020" prepared by the French Ministry of Armed Forces forms the basis of renewable energy use plans in defense. Within the scope of this strategy, it is planned to decrease the dependence on fossil fuels and increase the use of energy sources such as renewable energy sources, hydrogen and biofuels. Accordingly, it is aimed to achieve net-zero carbon emission target, also known as carbon neutrality, by 2050 by using biofuels, especially in aircraft used in air defense. In addition, the inclusion of energy efficiency among the issues to be taken into account in armament programs, hybridization of the drivetrains of vehicles used in land defense, the use of biofuels in air defense and energy optimization in sea defense are among the plans determined by France regarding the usage of renewable energy in defense within the scope of the "Defense Energy Strategy 2020" (French Ministry of Armed Forces, 2020).

Germany**:** The German Ministry of Defence addressed the transition to renewable energy in the defence sector within the scope of the policy document "Increasing Security of Supply by Optimizing Energy and Public Service Supply in Static Area Accommodations" published in 2017. Energy efficiency in operational infrastructure as well as the use of synthetic fuels have been identified as the best way to succeed sustainable mobility without compromising operational abilities or having to make major adjustments to present propulsion systems. The electrification of the non-military vehicle fleet and the implementation of sustainable energy consumption in facilities and construction are also among the topics in the policy document (German Federal Ministry of Defence, 2020).

Spain: The "Program to Combat Climate Change" put forward by the Spanish Ministry of Defense forms the basis of the steps that Spain has taken and will take in the transition to the usage of renewable energy in the field of defense. Within the scope of this programme, Spain has developed and implemented a methodology for estimating greenhouse gas

emissions from military activities since 2012. Although no timeline has been set, the programme aims to reduce defence emissions as close to "carbon zero" as possible in line with government commitments through efficiency, a transition to renewable, alternative and complementary energies, the adaptation of fuels, the improvement of carbon sinks – natural or man-made systems that absorb and store carbon dioxide from the atmosphere – and the promotion of lower emissions in the supply chain (Spanish Ministry of Defence, 2018).

Poland: "The 2020 National Security Strategy of the Republic of Poland" was approved by the President of the Council of Ministers upon the request of the President on May 12, 2020. The strategy document determines national security under four main headings. These include: (1) the security of the state and its citizens, (2) Poland in the international security system, (3) identity and national heritage, (4) social and economic development and environmental protection. In the strategy document, the continuity of energy supply and the protection of critical energy infrastructure are considered among the important elements of the state's resilience. The subheadings of the document's fourth heading, "Social and Economic Development Environment Protection", "Protection of the natural environment" and "Scientific and technological potential" address the use of renewable energy and the contribution of studies in this field to national security. Accordingly, the strategy also covers issues such as intensifying efforts to combat polluted air, developing electromobility and the use of alternative fuels, supporting the development of the energy sector based on the use of zero-emission energy sources, and improving waste management (National Security Breau, 2020; Liz, 2023: 82).

***Canada*:** The "Defense Energy and Environment Strategy 2020-2023" constitutes the strategy determined by the Canadian Armed Forces regarding the use of renewable energy in defense. One of the main objectives of this strategy is to reduce greenhouse gas emissions. Accordingly, it is planned to achieve the net-zero target by 2050 by cutting 40% of the Ministry of Defense infrastructure and commercial light-duty vehicle fleets by 2030. The strategy also includes improving the energy efficiency of bases, procuring clean energy, modernizing the vehicle fleet and increasing the energy independence of remote installations such as the Canadian Forces Warning Station on Ellesmere Island in the Arctic. Ensuring the use of cleaner fuels for military activities and operations that are affordable, meet both military technical requirements and NATO standards that ensure interoperability is another goal of Canada's "Defense Energy and Environment Strategy 2020-2023". The strategy also focuses on designing more efficient unit equipment and kits and providing

more efficient force solutions for operations, including camp infrastructure and utilities (Canadian Armed Forces, 2020).

Sweden: The Swedish Ministry of Defence has launched the "Fossil-Free Armed Forces 2045" project to transition to renewable energy in the defence sector. The project is based on reducing the Swedish armed forces' dependence on fossil fuels and achieving national net-zero targets. Testing the operation of JAS 39 Gripen aircraft engines with a 50/50 biofuel blend is another step taken by Sweden in the use of renewable energy in the field of defense (Swedish Armed Forces, 2020).

Conclusion

Countries' ability to protect themselves against both national and cross-border threats depends on having a strong army on land, air and sea. Having a strong army requires having land, air and sea vehicles equipped with modern weapons and systems, as well as having a sustainable energy source. Meeting all these needs of the armies requires meticulous planning and therefore a strong defense management. Thanks to defense management, the needs of armies can be met with the right materials, in the right place, in the right amount and at the right time. This also applies to energy. Today, most of the energy needs of armies are met by non-renewable, that is, fossil energy sources. However, the unbalanced distribution of these energy resources around the world makes many countries dependent on countries that own and/or control energy resources. This situation is a serious problem that defense decision-makers, especially in countries dependent on foreign energy, must overcome. In addition to reasons such as the limited reserves of non-renewable energy resources, their environmental friendliness and unbalanced distribution, developments in science and technology have brought the use of renewable and clean energy resources to the agenda, especially in the land, air and sea vehicles used in the armies of developed countries, as well as in military structures and facilities.

NATO, the world's leading military alliance, consists of member countries with the world's strongest armies. The research and practices of these countries on the use of renewable energy in their armies are also guiding for many non-member countries. For example some of the developed countries, especially the United States, are making serious investments and research to abandon fossil fuels in their armies and use renewable energy sources. The study examined whether the countries with 10 strong armies of NATO have strategies for transitioning to the use of renewable energy in defense. As a result, it was concluded that the countries with 10 strong armies in NATO in 2024 have different studies and

strategies regarding the use of renewable energy in defense. Considering the strategies and goals that countries have determined to expand the use of renewable energy in their armies, it will not be a utopian approach to see armies that use entirely renewable energy in the not-so-distant future and to encounter concepts such as “green army” and “green defense”.

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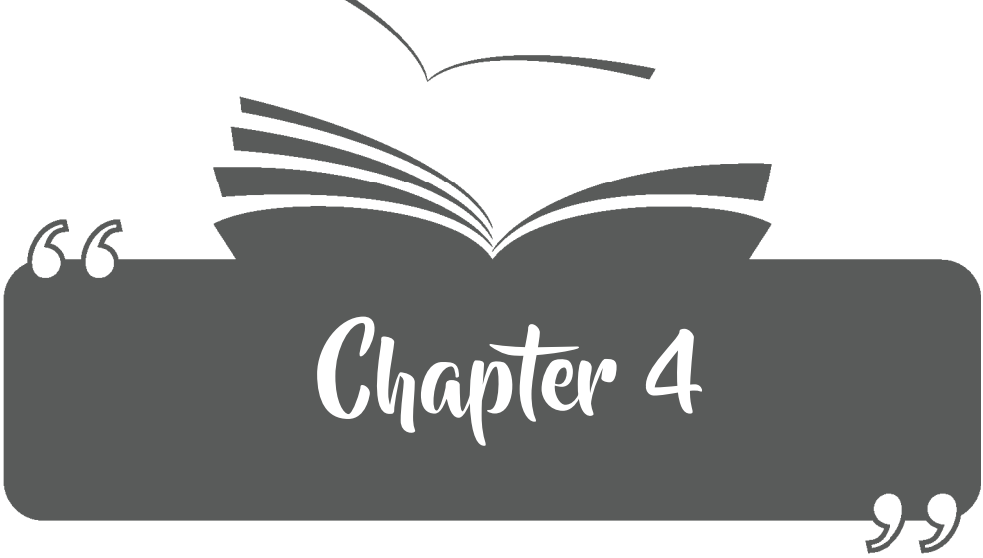

THE INTERACTION BETWEEN THE COMMONALITY OF LAWS DETERMINING THE PRICE FORMATION PROCESS AND THE COMPETITION PROCESS WITH LAWS REGULATING FINANCIAL ORDER

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INTRODUCTION

The concepts of value and price are confused with each other. Price is the monetary amount at which a good is exchanged in the market; in other words, it is the actual market sales value of a good. Assessed value, on the other hand, is the monetary worth determined by an expert. Price is a concrete reality; therefore, it is definite and singular. Assessed value, however, is determined based on valuation principles and methods, making it neither definite nor singular. Value may vary depending on the purpose of valuation, the method used, and the person conducting the valuation (Gozen, 2019: 375).

Competition policy is one of the fundamental policies of economic systems based on a free market economy. The adoption of a market order is not sufficient on its own to ensure the protection of the competition process; therefore, a policy is needed to prevent and oversee anti-competitive and restrictive behaviors of market participants. This is because, in reality, a perfectly competitive market—where many firms are freely entering and exiting, all products are homogeneous, and all actors are perfectly informed—is rarely encountered (Dumlupinar, 2009: 8).

The price formation process and competitive relations are two indispensable pillars of liberal economies.

1. Issues of Alignment Between Laws Regulating the Price Formation Process and Laws Regulating Financial Order in Turkey

A market economy is an economic system model based on competition and profit, in which private property, inheritance, contract-making, entrepreneurship, and freedom of choice are secured, and the state's intervention in the operation of the price mechanism is minimized (Aktan, 1994: 15). Almost all of the fundamental principles of the market economy are incorporated into the constitutions of modern states. The Constitution of the Republic of Turkey also addresses the freedom of contract in Article 48.

The free determination of the price formation process is also a key element of market economies. One of the factors affecting market economies is exchange rates. Exchange rates may be subject to intervention through international agreements to ensure stability in international trade. Under the Bretton Woods Agreement, central banks of countries other than the United States were authorized to intervene in foreign exchange markets to stabilize their currencies based on the dollar (and thus implicitly based on gold) and to maintain the exchange rate within 1% of

parity (Salvatore, 1990: 630). The intervention of states in markets through open market operations is based on the Bretton Woods Agreement.

From a national perspective, the participation of states in domestic and international markets as buyers and sellers is governed by specific laws. One of the legal bases for the state's direct involvement in markets as a buyer and seller is the Public Financial Management and Control Law No. 5018, dated December 24, 2003, and the Public Procurement Law No. 2886, dated September 8, 1983.

The most significant issue of alignment between laws regulating the price formation process and those regulating financial order in Turkey arises from excessive discounts in tenders conducted under the State Procurement Law No. 2886. Such excessive discounts lead to reduced profit margins, market contraction, and decreased investments, which ultimately result in a decline in the state's tax revenues.

2. Issues of Alignment Between Laws Regulating Competitive Relations and Laws Regulating Financial Order in Turkey

During the early stages of the development of liberal capitalism, two key elements were present: the legal structure and the psychological structure. The legal structure was free competition, while the psychological structure was personal interest (Hamitogullari, 1975: 163). However, it is important to remember that competition also has a psychological dimension. In market economies, competition has become institutionalized as a socio-psychological phenomenon, a behavioral pattern, and an established system. In other words, competition is embedded in human nature, customs, and traditions (Kilicbay, 1985: 10).

Initially, a genuine economic race and struggle begin among the founders of numerous small and diverse enterprises, aiming to operate freely and in the most beneficial way for their interests. This struggle can persist for a long time. Eventually, this struggle leads, particularly in the industrial sector, to the dominance of the strongest over the weakest. Thus, among enterprises, those with the best resources, management, and methods emerge victorious in this struggle, expanding their market presence and increasing their production capacities. Weaker enterprises, on the other hand, exit the market. This process alters the structure of enterprises. Those unable to compete with their rivals either merge with or reach agreements with them, leading to the emergence of large enterprises. All censuses conducted in liberal capitalist countries in the second half of the 19th century—such as in France, Germany, England, and the United States—have revealed such a concentration. This marks the first stage. The second stage is shaped directly by the first.

With the onset of concentration in a particular sector of the economy, the structure of liberal capitalism, which was previously based on numerous small enterprises, shifts to being based on a few large enterprises. After this stage, if producers continue to compete with others, their actions may lead to two potential outcomes.

Equipped with advanced mechanical tools and employing a large workforce, these large enterprises will push their production to its maximum capacity. Once all the products from these large enterprises enter the market, it will become evident that the accumulation of goods exceeds demand—more precisely, it surpasses consumers' purchasing power—thus leading to the problem of overproduction.

Each enterprise, in an effort to sell the goods it produces, will set its sights on the customers of its competitors. The best way to attract customers may be to lower prices. Competitor enterprises will respond to these price cuts with the same tactic. As a result of this process of action and reaction, the general level of prices will collapse, and no one can guarantee that this collapse will not fall below cost levels. Selling at a loss may be preferable to not selling at all. The situations mentioned above reveal that maintaining competition does not benefit any producer; on the contrary, only consumers benefit from it. When entrepreneurs become aware of this, their personal interests will deter them from competition. In other words, the two main engines of the operational structure of liberal capitalism—competition and personal interest—come into conflict with each other. In these new structures, individualism becomes at odds with liberalism.

Thus, the concentration of enterprises first emerging in the industrial sector, followed by agreements between enterprises—whether referred to as cartels or trusts, regardless of their appearance—always constitutes a formation that limits or eliminates competition in a segment of the economy.

As can be seen, when formulated, the principles and operational mechanisms of liberal capitalism, which are based on a structure of numerous small and diverse enterprises, no longer align with an economic structure where a small number of large enterprises dominate. In this environment, entrepreneurs find that their pursuit of profit is no longer satisfied, causing the foundational principles to lose their meaning. Proudhon's mid-19th century slogan, "Competition is killing competition," aptly summarizes this situation (Hamitogullari, 1975: 163-165).

Liberalism, which forms the ideological foundation of the market economy system, seeks to make the best possible use of the forces of "com-

petition" that enable people to exert effort in a harmonious order; it does not advocate leaving everything as it is. Liberalism is based on the idea that competition is the best tool for managing individual efforts. Far from denying the necessity of a carefully established legal order for competition to play a beneficial role, it especially insists on it and acknowledges the significant shortcomings of existing and past laws. Likewise, it does not deny that in situations where competition cannot function effectively, other methods may need to be employed for managing economic activity. However, liberalism opposes the replacement of competition with alternative methods that are less efficient and inferior in regulating human activities. Liberalism regards competition as superior to other methods not merely because it is the most efficient of known methods, but primarily because it is the only way to coordinate activities without arbitrary and coercive state intervention. One of the main arguments in favor of competition is that it eliminates the need for "conscious social control" and gives individuals the opportunity to decide whether the prospects offered by a particular profession are sufficient to counterbalance the risks and disadvantages associated with it (Hayek, 1995: 37-38). Competition is one of the most important and fundamental institutions of the market economy. In a market economy, perfect competition does not arise spontaneously, as it is impossible for all the necessary conditions for competition to be present simultaneously in real life (Aktan, 1994: 89). Today, another method used to hinder and complicate competition is to make a given market oligopolistic. It is possible to classify oligopolies based on the degree of competitive difficulty in the market. If entry into the market and the ability to compete with existing firms are highly restricted, it is termed a closed oligopoly; if there are no significant barriers to entering the market and competing with other firms, it is referred to as an open oligopoly (Cologlu, 1982: 13).

Another factor that renders competition dysfunctional and is considered one of the major economic diseases of our time is bribery. As the resources or opportunities subject to bribery grow and if there is competition in the market to obtain these resources or opportunities, bribery tends to increase in both scope and amount. If there is intense competition to acquire economic resources and opportunities, and if competitors have balanced power, then formal control mechanisms (such as public scrutiny, media oversight, and parliamentary control) may become effective, reducing the likelihood of bribery (Aktan, 1992: 28).

Efforts to prevent anti-competitive behaviors also have a historical dimension. Antitrust policies began operating against anti-competitive offenses in two different ways: first, by preventing certain types of commercial practices, such as price-fixing, and second, by targeting

specific market structures, such as monopolies, which are most likely to abuse their power through trade restrictions and other methods.

A review of American antitrust policy includes the following aspects:

-The history of legislative measures, such as the Sherman Act (1890), the Clayton Act (1914), and the Federal Trade Commission Act (1914), along with subsequent amendments.

-Case law regarding market structure and behavior, including definitions of different types of antitrust violations, evolving perspectives on the role of market size and structure in identifying antitrust breaches, and results of major antitrust cases from Standard Oil (1911) to IBM (International Bureau Machines) (1982).

-The new antitrust approach of the 1980s - one that emphasizes the real competition of oligopolists and the government's skeptical ability to use antitrust policies to make the success of large multinational enterprises beneficial.

Antitrust law is like a vast forest grown from just a handful of seeds. The laws that constitute legal frameworks are highly objective, and it is particularly striking how little wording is needed for legal principles to remain surprisingly objective.

Monopolies are often considered unlawful under customary law. However, the laws that established this legal framework were ineffective against the mergers and trusts that began to develop in the 1880s. At that time, populist sentiments guided the enactment of the Sherman Act.

The Sherman Act rendered "monopolizing trade" unlawful and prohibited "any conspiracy in restraint of trade or commerce." However, beyond an aversion to monopolization, there is no clear information regarding which activities are considered lawful or unlawful, nor is there clarity on the definition of evidence concerning legality or illegality. The first and second sections of the Sherman Act are as follows:

1. Any combination in the form of a trust or otherwise, or any conspiracy for the purpose of restraining trade or commerce among multiple states or with foreign nations, is declared unlawful.

2. Any person who shall monopolize or attempt to monopolize, or combine, or conspire with any other person or persons with the intent to monopolize any part of trade or commerce among multiple states or with foreign nations shall be deemed guilty of a felony.

To clarify and elaborate on these vague provisions of the Sherman Act and to reinforce it, the Clayton Act was passed by Congress. This act prohibited tying contracts (where a buyer wishing to purchase product A is forced to buy product B). It significantly impacted price discrimination and unlawful non-public transactions. Since boards of directors often consisted of the same members, the act also prohibited mergers formed by acquiring the common stock of competing companies that operated together. These transactions, as they reduced competition, were deemed unlawful in all cases.

The Clayton Act, as in the Criminal Code, emphasized the importance of prevention before the offense occurred. Despite the common law initially being used against organized labor, the Clayton Act specifically granted antitrust exemptions to labor unions. Sections 2, 3, and 7 of the Clayton Act are partially as follows:

2. It is prohibited to set different prices for buyers purchasing goods of the same grade and quality if such pricing differences have the potential to significantly reduce competition or contribute to the formation of a monopoly in any sector of commerce. Provided that nothing in this will prevent differentials that are the exact equivalent of these differentials just for differences in cost...

3. No individual may lease, sell, or enter into a sales contract that requires the buyer to refrain from using or conducting business with a competitor's products if such a condition is likely to notably weaken competition or encourage monopolization in any area of commerce.

7. A corporation is not permitted to acquire all or part of another corporation if such an acquisition could significantly diminish competition or lead to the creation of a monopoly.

Another regulation, the Federal Trade Commission (FTC), was established in 1914. The primary duties of the FTC were to prohibit "unfair methods of competition" and to act against anti-competitive mergers. In 1938, the FTC was granted one of its most significant functions—the authority to prohibit false and deceptive advertising—by Congress. To strengthen these powers, the FTC was equipped with the authority to inspect, conduct hearings, issue cease-and-desist orders, and rescind orders (Samuelson & Nordhaus, 1989: 617-618).

The state establishes or acquires economic entities for various reasons, including "preventing monopolization." Before World War I, due to the dominance of economic liberalism, state intervention in industrial and commercial sectors remained quite limited. However, it is noted that

the state owned shipyards and arms factories for national security reasons, tobacco and match monopolies for financial purposes, and sometimes railroads and PTT (Postal, Telegraph, and Telephone Service) to facilitate economic and commercial activities. World War I, which compelled the state to intervene in the economy, led to a post-war debate on the role of the state in production. Industrial and commercial public institutions emerged during the interwar period both as a result of developments in legal scholarship and as a response by governments seeking solutions to contemporary economic problems. These institutions engaged in purely industrial and commercial activities, operating in parallel with the private sector under the same conditions. One of the reasons for the emergence of public enterprises was political factors. These political reasons can be categorized as contingent factors, ensuring the independence and security of the state, and political ideologies.

Contingent factors refer to processes in which enterprises held by the private sector came under state control due to prevailing conditions, leading to an expansion of the public sector. For example, at the end of World War I in 1918, France seized the Alsace-Lorraine Railways and Alsace Potash Mines, which had been in enemy hands, and in 1944, it nationalized Renault Factories on the grounds that its owner had collaborated with the enemy. These cases arose from exceptional wartime circumstances. In other words, these were not instances of public enterprise establishment or nationalization for economic reasons but rather situations where private enterprises became public due to the consequences of war.

In some cases, enterprises were nationalized or directly established as state-owned enterprises to ensure the independence and security of the state. Arms and munitions factories worldwide and similar enterprises under Turkey's Machinery and Chemical Industry Corporation are primary examples of such establishments.

Another reason for the establishment of public enterprises is the reaction to capitalism. Trade unions in many countries, particularly the British Labour Party and the Socialist and Communist Parties in France, oppose capitalism and advocate for the expansion of the public sector for this purpose. The Socialist and Communist alliance, which entered the 1978 elections with a new nationalization program, lost the elections but was able to implement a series of nationalizations after winning the elections again in 1982.

Social reasons can also be counted among the reasons for the establishment of public enterprises. Today, it cannot be said that all public enterprises operating in our country and other countries operate sole-

ly for economic purposes. The state, as a requirement of the social state concept and ensuring social justice, is obliged to protect the interests of all classes and has established many public enterprises for this purpose. The nationalization of coal enterprises in France to protect workers' interests, the nationalization of Nitrogen Enterprises to protect consumers, and the establishment of the Wheat Office to protect producers are examples of public enterprises created for social reasons. In Turkey, coal mines continue to exist mainly for social purposes as public enterprises, while institutions such as the Turkish Grain Board (TMO) and the Meat and Dairy Authority (ESK) operate to protect producers. In general, such enterprises, which do not have profitability concerns and assume a social role, operate for the purpose of social benefit. In Turkey, as in the cases of Halkbank and Ziraat Bank, there are institutions operating to provide affordable credit and financing to a specific segment of society, as well as public enterprises established to provide consumers with affordable consumer goods. Today, especially local governments open and operate numerous regulated sales stores for this purpose.

The establishment of public enterprises also has economic and financial reasons. Some of these reasons arise from existing conditions. Rescue operations carried out to protect companies and small rentiers facing difficulties due to changes in the capital structure of companies in which the state participates for various purposes, resulting in the majority shares passing to the public, to sustain companies that partially provide public services, or to prevent international prestige loss, lead to an increase in the number of such public companies and the expansion of public enterprises. Another economic and financial reason is the pursuit of efficiency and the protection of the treasury's interests. The state sometimes engages in business activities directly to generate revenue or to carry out certain activities more efficiently. The operation of the mint to generate revenue and forestry and mining activities for more efficient management can be given as examples. Another reason for the establishment of public enterprises is to create models and exemplary enterprises. The need to undertake or improve certain essential productions for the country compels the state to become a producer and entrepreneur. In Turkey, due to insufficient capital accumulation and development efforts, the state has established many enterprises. More realistically, most public enterprises in Turkey were established as a result of the state's aim to lead the industrial sector and create models. As examples of such model enterprises, State Production Farms and the Milk Industry Institution (SEK) can be cited. Another reason for the state's establishment of public enterprises is intervention in economic life. In this way, the state also contributes to production. Especially in France and England, the doctrinal movements

that led to nationalizations after the World Wars were based on economic reasons. One such reason is the formation of monopolies in certain sectors. The state, which occasionally establishes monopolies itself, may resort to nationalization to break monopolies that disadvantage consumers and cause price increases due to lack of competition, or it may directly engage in production and business activities. Another reason for state intervention in economic life through the establishment of public enterprises is the inadequacy of private enterprise. For this purpose, the state invests in areas that do not align with the capitalist investment mindset and are considered risky for capital. Another aim of state investment based on the inadequacy of private enterprise is to establish dominant enterprises with a trust-like nature to ensure coordination in the industry, thereby directing industry in accordance with public interest. In many countries, coal mining and iron and steel production are kept under state control for this purpose. Another objective of state investment due to private enterprise insufficiency is to rationalize and improve the efficiency of an entire sector or its sub-sectors through business and production activities. A river regulation project carried out by the state, which would impact sectors such as energy, agriculture, transportation, and tourism, can be given as an example.

Another reason for the establishment of public enterprises by the state is the recognition of public enterprises as a management tool in economic operations. The state may often engage in business activities to implement its economic policies. In particular, it may participate in private sector companies as an incentive policy. However, at the same time, it may withdraw from such participation as a result of economic policy. Regulated sales stores aimed at reducing the prices of consumer goods used by the public could also be considered within this category (Atasoy, 1993: 15-16, 27-29).

The functioning of competition in the labor market presents another dimension of the issue. The labor market refers to the arenas where the labor force, representing the labor supply in a country, meets labor demand. Individuals who offer their labor in the labor market participate in economic activities to earn an income and receive wages in return (Zaim, 1992: 10-11). In the labor market, the labor owner and the capital owner come face to face, engaging with each other as individuals with equal rights; the only difference between them is that one is the seller and the other is the buyer. In this respect, they are equal before the law. For this relationship to remain sustainable, the labor owner must only offer their labor power for a limited period. If they were to sell it entirely and permanently, they would have effectively sold themselves, ceasing to be a free person and turning from a labor owner into a commodity. A labor owner must always regard their labor power as their own property, their

commodity, which can only be realized by offering it to the buyer for a temporary and specified period. Only in this way does the labor owner retain ownership rights over their labor power (Marx, 1993: 183).

The concept of wages, which represents the income obtained from labor activity, has various dimensions from a competition perspective. From a social policy standpoint, the wage concept is divided into wages based on productivity and wages based on need. Productivity-based wages are an economic concept, referring to compensation based on the value and difficulty of the work performed. In contrast, need-based wages are a social concept, considering wages not as compensation for a production factor but as an income source that ensures the survival of human beings, who are at the center of society and life. However, since businesses are profit-oriented organizations, they do not readily accept the concept of need-based wages. This is because the need-based wage must be sufficient to meet the minimum necessary needs of the worker and their family. This varies depending on factors such as marital status and the number of dependents. Therefore, as employers do not voluntarily adopt this approach, efforts were made to implement this view within specific systems. This was attempted in two ways: by providing family allowances based on the number of dependents, in addition to normal wages, and by determining minimum wages. Family allowances can either be mandated by law or regulated through collective agreements. There are three possibilities for implementing minimum wages:

1- The state can establish a nationwide minimum wage through legislation.

2- Minimum wage commissions, established by law, can set minimum wages for specific regions or industries.

3- Employers and labor unions can negotiate and formalize minimum wage agreements through collective bargaining.

In Turkey, the second system has been implemented, albeit with variations in its application. In 1936, a provision on minimum wages was included in the Labor Law, but it was not enforced. Between 1951 and 1967, minimum wages were determined through local commissions, but their implementation was limited to cases deemed necessary by the Ministry of Labor, preventing a nationwide minimum wage system. The Labor Law numbered 1475 regulated the determination of minimum wages under Article 33, granting authority to a central wage commission in Ankara with final and binding decisions, thereby abolishing local commissions. Since 1974, minimum wages have been set nationwide. The commission, comprising government, labor, and employer representatives,

convenes at least once every two years to determine the minimum wages for all workers, seafarers, and journalists employed under labor contracts. However, due to rapid inflation in recent years, minimum wages have been revised before the two-year period ends to prevent declining living standards due to rising prices.

In a labor market, the entire workforce is not in competition with one another. The competing workforce is divided into specific groups, and competition conditions can only be effective within each group. This theory, introduced by John Cairnes, is called non-competing groups. The groups differentiated by workers' qualifications constitute the main competitive groups in a labor market. These groups can be classified as follows (Zaim, 1992: 171-172, 205): "1- Skilled workers, 2- Unskilled workers, 3- Semi-skilled workers, 4- Technicians, engineers, consultants, 5- Managers and civil servants, 6- Self-employed professionals, 7- Employers." Employers form the opposing front to the first six groups. However, in the long term, competition between groups may occur due to labor market mobility, the fluidity of economic organization, and social mobility. Even in the short term, under perfect competition conditions, competition can only exist within these groups. When it is stated that competition conditions in the labor market are not perfect, it means that even within these groups, competition conditions are not entirely met (Zaim, 1992: 42-46). The aforementioned characteristics were observed in England during the economic depression years following the Napoleonic Wars. During these years, a movement emerged to improve working conditions, and as a result of reports prepared by Parliamentary Committees, a new trade unions act was enacted in 1824, allowing unions to be established as legal organizations. When this new law eliminated the criminal prosecution of workers for organizing, employees began forming unions and initiating labor disputes and strikes, particularly to improve wages and working conditions. These developments led to a legislative amendment in 1828, which introduced restrictions on the trade union movement (Ekin, 1989: 77-78). A long time after the process mentioned above, the right to collective bargaining by trade unions became a right recognized in the legal systems of many countries and, in some cases, incorporated into national constitutions as an inseparable part of trade union rights among social rights. The International Labour Organization's Convention No. 98, adopted in 1949, establishes principles for the implementation of organization and collective bargaining, setting forth the principles of collective bargaining activities by national and international organizations to protect the economic and social interests of both workers and employers. Article 51 of the Constitution concerns the right to form unions, Article 52 concerns trade union activities, Article 53 concerns the right to collec-

tive agreements, Article 54 concerns the right to strike and lockout, and Article 55 concerns the right to fair wages. The trade union movement in Turkey, which had previously been fragmented, underwent a restructuring towards unification with the enactment of laws in 1983. The Trade Unions Law, which came into force on May 2, 1983, mandated a uniform and sectoral-level organization for unions. The Collective Agreement, Strike, and Lockout Law No. 2822 essentially required collective bargaining agreements to be made at the workplace level. Article 3 of the law states, "A collective bargaining agreement may cover one or more workplaces within the same industry," thereby enforcing workplace-level collective bargaining while unions were required to be established at the national and industry level (Koray, 1992: 138-139, 176, 200). European and British collective agreements, when covering an entire industry or multiple industries, generally only set minimum wage levels. However, in tight labor markets where there are workforce shortages, individual employers may pay wages higher than the established minimum level (Ekin, 1989: 112). Collective bargaining agreements sometimes enforce working conditions applicable even to those who are not direct parties to the agreement (Koray, 1992: 137). In the United States, many agreements impose a maximum wage cap and, in some cases, a minimum wage floor for wage-price adjustments. In 1978, wage cap clauses were included in the variable wages of 1.5 million workers. The railway workers' agreement also contained this clause, covering a total of 469,000 workers. Additionally, wage cap policies were introduced in the machinery, aviation, and food industries, affecting approximately 269,000 workers with a minimum wage floor, while 192,000 workers were subjected to both a wage cap and a wage floor. Some agreements also set wage caps for wage reductions in cases of price declines (Zaim, 1997: 392). This phenomenon is demonstrated in Hicks' Collective Bargaining Model, which suggests that beyond the agreed collective bargaining point (to the right of this point), the likelihood of both parties enduring a prolonged strike increases if they insist on a preferred bargaining wage (Lordoglu and Toruner, 1995: 148). Before resorting to strikes or lockouts in collective labor disputes, three peaceful resolution methods are considered. The first is conciliation, which involves an external party or a designated board attempting to mediate between the disputing parties before a strike or lockout decision is made. A conciliator, either an individual or a conciliation board, undertakes the process, striving to bring the opposing views closer together. Since conciliation is not binding, if it fails, parties still have the option to proceed with a strike or lockout. The second peaceful resolution method is mediation, which plays a more active role than conciliation. If the mediator fails to broker an agreement, they prepare a report outlining their recommendations. Although the parties are not obliged to accept the me-

diator's suggestions, the mediator's decisions carry weight in influencing public opinion. This influence stems from the mediator's ability to publicly disclose their views and decisions. Another dispute resolution method is arbitration. Arbitration is a distinct practice from both mediation and conciliation. Arbitration is either a legal practice or a practice agreed upon by the parties themselves and plays the role of decision-making rather than conciliator in the resolution of labor disputes. In arbitration, arbitrators examine the arguments of both sides and issue a binding decision based on their assessment. The process of dispute settlement by arbitration boards is often resorted to in situations and circumstances where strikes and lockouts are prohibited. Even in countries that recognize the right to strike, strikes may be banned in certain labor groups, industries, or circumstances. In such cases, unresolved collective negotiations may be settled through compulsory arbitration. It is obligatory to submit the dispute to the arbitration boards, composed of government representatives as well as the worker and employer representatives, and to abide by the decisions of the arbitration boards.

Apart from compulsory arbitration, in voluntary arbitration, which is established by the parties' own will, the parties may decide to refer the dispute to an arbitrator if they wish so. However, once the parties agree to arbitration, they are then obliged to comply with the arbitrator's decision (Koray, 1992: 153-155). In Turkey, the period of the High Arbitration Board remained in effect from 12 September 1980 to November 1983, during which collective agreements and wages were entirely regulated by this board (Zaim, 1992: 348).

Another element that activates the types of competition mentioned above is information. In recent years, economists have increasingly emphasized the role of information in the economy. Information is undoubtedly a valuable commodity, and as those with a certain level of education are aware, the markets for information and expertise are highly developed. Conceptually, talent markets are akin to several other valuable service markets. However, information and expertise markets have particular issues. One of these issues is that information is often a public good, making it prone to underproduction by the private sector. This is because once information is known by anyone, its price decreases, as in other goods in the market. Even when information is not a public good, talent markets tend to experience market failure. A participant frequently generates private information through methods that alter the nature of their own transactions, thereby gaining a rent advantage over others (Lipsey et al., 1990: 429).

There are also economic events that undermine the aforementioned benefits of information. Many economists highlight the fact that prices contain valuable information for consumers. It is easy to recall that Elm City sells a gallon of gasoline for $1.10, and based on this, one can easily compare Elm City's prices with those of Exxon or Arco. The main theme to be addressed in the next section is that inflation erodes information. During periods of rapid inflation, price tags are frequently changed. As a result, when consumers go shopping, they struggle to compare prices since last week's prices have changed. Consequently, they may mistakenly pay more for goods than necessary. The disruptive effect of rapid price changes on value assessment can be illustrated with a comparable example. Every year, telephone numbers increase slightly, a phenomenon known as "telephone number inflation." If telephone number inflation is rapid, one can imagine the extent of the problems it may cause and the difficulty of finding the correct number to call home every day. As an additional assumption, if numbers change daily, one could predict the impact on operator and directory assistance services (Samuelson and Nordhaus, 1989: 317). One reason why information has become so crucial in ensuring a competitive order is the emergence of the information society in the last quarter of the modern era. The industrial society, which completed its institutionalization over more than a century, entered the final quarter of the twentieth century with the capacity to lead technological innovations and assimilate them in terms of material, personnel, and institutional infrastructure. The ability of institutional infrastructure to generate knowledge that can pioneer innovations and transmit it through communication channels has led to the cumulative accumulation of information. Thus, the bipolar world of the industrial society has entered a transformation process toward a globalizing world through the dissemination and shareability of information. The countries that were the "industrial giants" of the past are now progressing toward becoming information societies. The goods produced in the information sector, which is the sector where information is generated, include computers, communication and electronic devices, office and workplace equipment, measurement and control instruments, publishing, all forms of printed media, electronic communication, advertising, education, communication development research, librarianship, insurance, consultancy, and research and development (R&D) firms. Given that an increasing portion of the workforce is employed in information-based enterprises, the necessity of adding the "information sector" to the traditional tripartite sectoral classification of agriculture, industry, and services has emerged. As early as 1977, it was found that approximately half of the U.S. national income was derived from this sector. Consequently, the new social structure, referred to as the "knowledge economy" by Fritz Machlup, the

"technocratic era" by Brzezinski, "post-capitalism" by Rolf Dahrendorf, "post-modern" by Amitai Etzioni, "post-industrial" by Daniel Bell, and "Post-Business Society" by Peter F. Drucker, has emerged with information technology at its core. This new societal structure has been aptly termed the "information society" by M. U. Porat and the Japanese scholar Masuda (Erkan, 1995: 182). In the information society, flexibility, competition, efficiency, and innovation have gained prominence within the industrial sector. The presence of a cluster composed of interconnected and supporting industries leads to synergistic interactions among economic units, enabling competition and cooperation to coexist. The involvement of multiple enterprises in the industrial sphere enhances competition, efficiency, and innovation while also revealing the dynamic advantage of the new restructuring associated with the information society through information technologies. Furthermore, Porter's analyses highlight the industrial structure formed by interconnected and supporting industries, along with the competitive structure, as key elements in determining competitive advantages. With the information society, the increasing prominence of innovative strategies and methods has further emphasized the significance of the industrial environment and competitive structure in which firms operate. Thanks to information technologies, on the one hand, increasingly flexible production methods are gaining importance, while on the other hand, processes such as solidarity with supporting industries, diversification and differentiation, and an intensifying competition race based on quality and efficiency are coming into play. Within the industrial organization transformed by the information society, factors such as the integration status of the industry, its horizontal and vertical integration, and the competitive structure within the sector will be significant. In the information society, the race for self-assertion among individuals is expected to take the form of a competitive race that ensures the continuity of knowledge production. However, by nature, human beings require a warm environment where they are not in constant competition and can find emotional satisfaction. This warm environment is the family institution. In the information society, the fundamental motive driving individuals and entrepreneurs toward knowledge production will be a sense of achievement aimed at self-assertion and self-actualization. This achievement race will take the form of competition for success, manifesting not only at the local level but also on a global scale. The industrial society has four fundamental decision-making mechanisms: the market mechanism, the election (democracy) mechanism, the bureaucracy (hierarchy), and the collective bargaining system. Among these mechanisms, the dynamic decision-making mechanism is the market mechanism, as it is based on the competitive process. The characteristic of competition, which is centered on innovation and creativity, has been the main element deter-

mining the dynamism of the market system. For instance, the collapse of centrally managed Eastern Bloc systems stemmed from their lack of an internal dynamic that was both competitive and innovative. Similarly, in the information society, competition will remain the source of innovation. However, even if this competitive race shifts from material domains to knowledge production, leading to an expansion of the "non-market" domain and a contraction of the market domain, the competition and innovation race that sustains the dynamism of the information society will persist, ensuring the system's developmental momentum. The phenomena of the information society and globalization have necessitated the inclusion of competitive development as a core element in explaining the process of economic growth. When determining the competitiveness and capabilities of nations, Porter considers factor conditions, demand conditions, related and supporting industries, and firm structure, strategy, and competition. The supporting and related industries that provide high-quality intermediate goods and inputs to firms constitute the potential strengths behind competitive firms. Additionally, a firm's defined objectives, the strategies it implements in production, sales, marketing, and management, and the presence of a competitive market structure among firms are prerequisites for the firm's success in the international arena.

In summary, the factors crucial for a country's development include:

-The quantitative and qualitative advancement of factor conditions,

-The enhancement of demand quality, pushing firms toward innovation,

-The ability of related and supporting industries to obtain higher-quality and cost-effective intermediate inputs within a competitive structure,

-The orientation of firm structures toward dynamic and innovative strategies, and finally,

-The existence and quality of a competitive environment and process in the economy

. These interrelated factors, influencing each other reciprocally, are the primary determinants of internationally competitive firms and national development. In contrast to the model mentioned above, Cho (1992) proposed a model for developing countries in which workers, politicians and technocrats, entrepreneurs, and professional managers play significant

roles in competitive economic development. Porter, on the other hand, asserts that competition occurs not between nations but between innovative firms and that national advantages stem from the advantages gained by firms. In this regard, he examines countries with competitive advantages and their competitive firms. Delays in the cultural sphere can be addressed through a renewal in thinking (quantum leap), while fostering scientific thought, as well as instilling motivations for competition and success in society, can pave the way for technological advancement.

When evaluating the competitive process of the information society from Turkey's perspective, the following observations arise. The competitive process that ensures the effectiveness of the market system in Turkey, along with the spirit of competition, competitive logic, and application, is far from sufficient. The lack of widespread acceptance of competition, which is the central axis of a market economy, and the insufficient prevalence of independent human individuality, along with the absence of an innovative and constructive personality as an extension of these deficiencies, constitute significant obstacles to becoming an information society. Therefore, alongside appropriate education and cultural policies to foster an innovative and competitive market economy, it is imperative to swiftly implement an effective competition policy (Erkan, 1997: 139-140, 142-143, 157, 167, 174-176, 191-193, 224-225).

Despite all the features and shortcomings of competition mentioned above, almost every country has laws aimed at preserving competition. In Turkey, the "Law on the Protection of Competition" came into force on December 7, 1994, under Law No. 4054. Article 4 of this law defines Agreements, Concerted Practices, and Decisions Restricting Competition as follows:

"Agreements between undertakings, concerted practices, and decisions of associations of undertakings that directly or indirectly aim to prevent, distort, or restrict competition in a specific market for goods or services, or that have or may have such an effect, are illegal and prohibited.

These situations particularly include:

a) Determining the purchase or sale price of goods or services, including cost, profit, and all kinds of purchase or sale conditions,

b) Sharing markets for goods or services, as well as distributing or controlling all kinds of market resources or elements,

c) Controlling the quantity of supply or demand for goods or services or determining them outside the market,

d) Hindering, restricting, or making it difficult for competitors to operate, or removing market players through boycotts or other behaviors, or preventing new entrants from accessing the market,

e) Except for exclusive dealerships, applying different conditions to equal parties for equal rights, obligations, and performances,

f) Requiring the purchase of another good or service alongside a good or service contrary to the nature of the agreement or commercial customs or imposing conditions on the resale of a good or service requested by intermediary undertakings.

If the existence of an agreement cannot be proven, similarities between price changes, supply and demand balance, or operational regions of undertakings in markets where competition is restricted, distorted, or limited shall constitute a presumption that undertakings are engaged in concerted practices.

Each party can avoid liability by proving that it did not participate in the concerted practice, provided that the claim is based on economic and rational facts."

Exemption from Agreements, Concerted Practices, and Decisions Restricting Competition is outlined in Article 5 of the same law as follows:

"The Board may decide, upon the request of the relevant parties, to exempt agreements between undertakings, concerted practices, and decisions of associations of undertakings from the provisions of Article 4 if all the following conditions are met:

a) Ensuring new developments and improvements in the production or distribution of goods or the provision of services, or promoting economic or technical progress,

b) Allowing consumers to benefit from these developments,

c) Not eliminating competition in a significant part of the relevant market,

d) Not restricting competition more than necessary to achieve the objectives in subparagraphs (a) and (b).

Exemption decisions are granted for a maximum of five years. The granting of an exemption may be subject to the fulfillment of certain conditions and/or obligations. If the conditions for exemption continue to

exist at the end of the exemption period, the exemption decision may be renewed upon the application of the relevant parties.

The Board may issue communiqués granting exemption to certain types of agreements on certain subjects as a group and specifying the conditions thereof, provided that the conditions set forth in the first paragraph are met." The Board referred to in this article is the Competition Board.

Article 6 of the law defines Abuse of Dominant Position as follows:

"The abuse, by one or more undertakings, of a dominant position in a market for goods or services in the whole or a part of the country, either alone or in agreement with others, is illegal and prohibited.

Forms of abuse particularly include:

a) Directly or indirectly preventing another undertaking from entering a commercial activity or engaging in practices that aim to make it difficult for competitors to operate in the market,

b) Applying different conditions to equal buyers for equal rights, obligations, and performances, thereby engaging in direct or indirect discrimination,

c) Imposing restrictions on resale conditions, such as tying the purchase of one good or service to the purchase of another good or service, requiring intermediary buyers to display another good or service along with the requested one, or prohibiting the resale of a purchased good below a certain price.

d) Using financial, technological, or commercial advantages derived from dominance in a particular market to disrupt competition conditions in another market for goods or services,

e) Restricting production, marketing, or technical development to the detriment of consumers." The dominant position referred to in this article means the power of one or more undertakings to determine economic parameters such as price, supply, production, and distribution quantities independently of competitors and customers in a particular market.

Furthermore, Article 7 of the same law defines prohibited activities in the event of mergers or acquisitions as follows:

"The merger of one or more undertakings or the acquisition of another undertaking's assets, partnership shares, or instruments granting managerial rights (excluding inheritance acquisitions) in a manner that creates or strengthens a dominant position, thereby significantly reducing competition in a market for goods or services in the whole or a part of the country, is illegal and prohibited.

The Board shall announce, through communiqués, which types of mergers and acquisitions require notification and approval to gain legal validity."

When the Concept of Competition is examined in terms of the worker's non-compete obligation, an additional dimension is added to the concept of competition. The provisions regarding the worker's non-compete obligation are set forth in Articles 445-447 of the Code of Obligations:

"A worker who has legal capacity may undertake in writing to refrain from competing with the employer in any manner after the termination of the contract, particularly by opening a competing business on their own account, working for another competing business, or engaging in any other type of interest relationship with a competing business.

The non-compete agreement is valid only if the employment relationship provides the worker with the opportunity to acquire knowledge about the customer base, production secrets, or the employer's work and if the use of this knowledge is likely to cause significant harm to the employer.

The non-compete obligation may not include unreasonable restrictions regarding location, duration, and type of work that would unfairly endanger the worker's economic future, and its duration may not exceed two years except under special circumstances and conditions.

The judge may limit an excessive non-compete obligation in terms of scope or duration by freely assessing all circumstances and conditions, as well as considering the counter-performance that the employer may have undertaken in a manner that is fair.

A worker who violates the non-compete obligation is liable for all damages incurred by the employer as a result.

If the violation of the prohibition is subject to a penalty clause and there is no contrary provision in the contract, the worker may be released from their obligation related to the non-compete agreement by paying

the stipulated amount; however, the worker must also compensate for any damages exceeding this amount.

The employer, apart from demanding the payment of the penalty clause and additional damages, may also request the cessation of the violation of the non-compete obligation if it is explicitly reserved in writing in the contract, and if the importance of the employer's violated or threatened interests and the worker's conduct justify this request.

The non-compete obligation terminates if it is determined that the employer no longer has a legitimate interest in maintaining the restriction.

If the contract is terminated by the employer without just cause or by the worker for a reason attributable to the employer, the non-compete obligation ceases."

Additionally, Article 55 of the Turkish Commercial Code defines "acts and commercial practices contrary to the principle of good faith" as an element of Unfair Competition as follows:

"The following situations are among the primary cases of unfair competition:

a) Advertisements and sales methods contrary to the principle of good faith and other unlawful practices, in particular:

1. Disparaging others or their goods, work products, prices, activities, or commercial transactions with false, misleading, or unnecessarily offensive statements,

2. Making false or misleading statements about oneself, their commercial enterprise, business signs, goods, work products, activities, prices, stock, sales campaign structure, or business relationships, or advancing a third party in competition through similar means,

3. Pretending to possess qualifications, diplomas, or awards that one has not received, thereby creating the impression of having exceptional ability, or using false professional titles and symbols conducive to such an impression,

4. Taking measures that lead to confusion with another's goods, work products, activities, or business operations,

5. Comparing oneself, one's goods, business products, activities, prices with others, goods, business products, or prices in a way that is untrue, misleading, unnecessarily disparaging, or unnecessarily taking

advantage of the reputation of the competitor, or putting the third party ahead in similar ways,

6. Repeatedly offering selected goods, work products, or activities for sale below their supply cost, highlighting these offers in advertisements, and misleading customers about one's or competitors' capabilities; provided that, if the sales price is lower than the supply cost applied to similar-volume purchases of the same type of goods, work products, or activities, the existence of deception is presumed; the defendant may rebut this presumption by proving the actual supply price,

7. Misleading the customer about the real value of an offer through additional services,

8. Restricting the customer's freedom of decision, particularly through aggressive sales methods,

9. Concealing the characteristics, quantity, intended use, benefits, or dangers of goods, work products, or activities, thereby misleading the customer,

10. Failing to clearly state the business title in public advertisements related to installment sales contracts or similar legal transactions, or failing to specify the cash or total sales price or the additional cost resulting from installment sales in Turkish Lira and annual rates,

11. Failing to clearly state the business title in public advertisements related to consumer loans or failing to provide clear declarations regarding the net amount, total costs, and effective annual interest rates of the loans,

12. Within the scope of business operations, offering or entering into installment sales or consumer credit contracts while using contract templates that contain incomplete or incorrect information regarding the subject matter, price, payment conditions, contract duration, the customer's right of withdrawal or termination, or their right to early repayment of outstanding debt.

b) Inducing breach or termination of contract, in particular:

1. Directing customers to act in violation of their existing contracts with others in order to personally enter into contracts with them,

2. Seeking to gain advantages for oneself or others by offering or providing undue benefits to third parties' employees, agents, or other

auxiliaries that could lead them to act contrary to their obligations in the performance of their duties,

3. Encouraging employees, agents, or other auxiliaries to disclose or obtain their employers' or clients' production and business secrets,

4. Inducing a buyer who has entered into an installment sale, cash sale, or consumer credit agreement to withdraw from the contract, or persuading a buyer who has entered into a cash sale agreement to terminate the contract in order to conclude such a contract with oneself.

c) Unauthorized use of others' work products, in particular:

1. Unauthorized use of entrusted work products such as offers, accounts, or plans,

2. Benefiting from a third party's work products such as offers, accounts, or plans, despite knowing that they were provided or entrusted without authorization,

3. Acquiring and utilizing market-ready work products of others through technical reproduction methods without making a proper contribution of oneself.

d) Unlawful disclosure of production and business secrets, in particular: A person acts contrary to good faith if they secretly and without permission obtain or learn through unlawful means information about a producer's business secrets and exploit or disclose such information to others.

e) Non-compliance with business conditions, in particular: A person acts contrary to good faith if they fail to comply with business conditions imposed by law or contract, or with conditions customary within a particular profession or industry.

f) Use of unfair contract terms, in particular: A person acts contrary to good faith if they employ pre-written general contract terms that, in a misleading manner, impose significant disadvantages on the other party by:

1. Deviating substantially from statutory regulations applicable either directly or through interpretation, or

2. Establishing a distribution of rights and obligations that significantly contradicts the nature of the contract."

One of the compliance issues arising from the application of laws regulating competition relations and financial order in Turkey is the unfair economic competition caused by certain taxpayers taxed under the simplified procedure. Some of these taxpayers operate multiple businesses in the same or complementary fields under the names of different family members, who are officially registered as taxpayers. The removal of the head-of-family declaration in recent regulations has further exacerbated this issue, creating an economic unfair competition between those taxed under the simplified procedure and those taxed under the standard method. In effect, this means that taxpayers under the standard taxation system bear a heavier tax burden compared to those under the simplified system.

CONCLUSION

In a free market economy, interfering in the price formation process is seen as contrary to the spirit of the liberal economic order. However, in cases where oligopolistic market structures emerge, it becomes necessary to intervene, particularly in profit margins. Controlling excessive profit margins helps reduce the influence of monopolistic and oligopolistic structures and promotes competition in the market. Such interventions also facilitate the entry of new firms into the market and encourage efficiency and productivity.

The dismantling of monopolistic and oligopolistic structures, along with the establishment of efficiency and productivity, will ensure the prevalence of economies of scale. Economies of scale contribute to lowering unit costs and reducing prices. While firm managers will still achieve similar profit levels, they will be operating in a competitive market structure, which will enhance fair income distribution and contribute to solving inflation issues. It is crucial for both firms and economic policymakers to swiftly move away from imperfect competition conditions to maintain balance in GDP growth.

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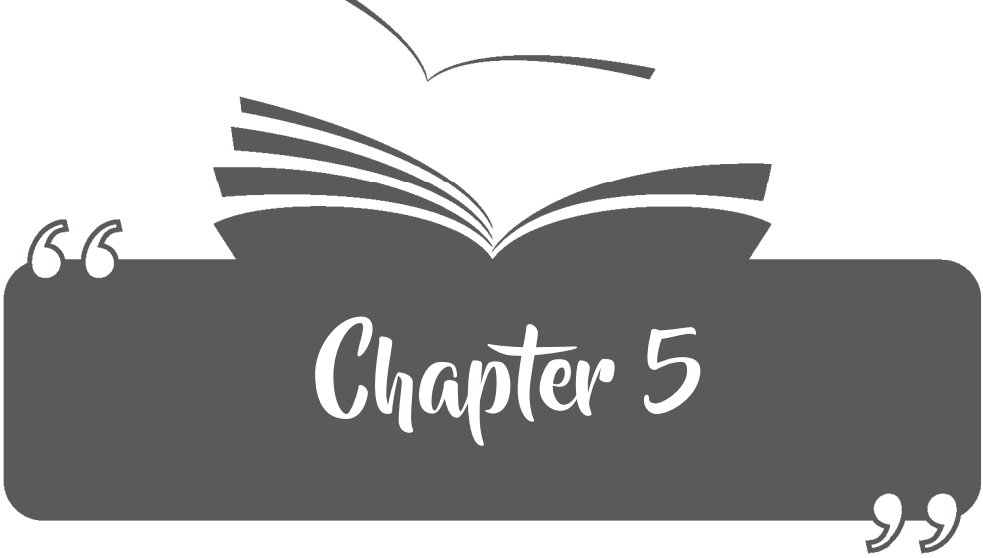

DYNAMIC VOLATILITY AND RISK IN BITCOIN MARKETS: AN ASSESSMENT WITH GARCH MODELS

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1. Introduction

Since its introduction by Nakamoto (2008), Bitcoin has become the leading and most notable cryptocurrency, attracting considerable interest from investors, financial institutions, and policymakers. Operating on a decentralized digital ledger known as blockchain, Bitcoin offers a unique value proposition of security, transparency, and independence from traditional banking systems. This foundational technology, while revolutionary, also contributes to the cryptocurrency's inherent price volatility due to its novel and decentralized nature. Bitcoin's price movements have been characterized by substantial and often extreme fluctuations, attracting traders and investors seeking high returns while simultaneously exposing them to considerable risk. Indeed, the volatility of Bitcoin has been observed to be almost ten times higher than that of major exchange rates, raising concerns about its viability as a stable currency and necessitating careful consideration of its role as an investment asset (Baur & Dimpfl, 2021). This inherent volatility presents a critical study area, demanding a thorough exploration of its dynamic characteristics and the methodologies employed for risk assessment within this evolving market.

This study thoroughly investigates the dynamic volatility inherent in Bitcoin markets and examines the various risk assessment methodologies to understand and manage the risks associated with this cryptocurrency. Dynamic volatility refers to the time-varying nature of Bitcoin's price fluctuations, acknowledging that the degree of volatility is not constant but evolves over time. Understanding Bitcoin's volatility and the associated risks is paramount for a diverse range of stakeholders. For investors, this knowledge is crucial for making informed investment decisions, effectively managing portfolio risk, and potentially achieving desired returns while mitigating potential losses. Portfolio managers also depend on insights into Bitcoin's volatility and risk to formulate effective asset allocation strategies, and optimize overall portfolio performance involving this digital asset (Wang et al., 2022). Moreover, financial regulators are increasingly concerned with understanding Bitcoin's volatility and risk to assess potential systemic risks, develop appropriate regulatory frameworks, and ensure market stability in the face of growing cryptocurrency adoption (Hacibedel & Perez-Saiz, 2023). The increasing interest in Bitcoin as both a speculative asset and a potential store of value further underscores the need for robust and dynamic risk assessment tools and models (Zwak-Cantoriu & Anghel, 2024). The unpredictable price movements of Bitcoin have far-reaching implications, influencing not only individual investment strategies but also potentially affecting the stability of the broader financial market, thereby necessitating a comprehensive understanding of its volatility and associated risks (Zinoviev, 2024).

Volatility modeling is a cornerstone of financial econometrics, given that asset return volatility is time-varying and exhibits clustering (periods of high volatility tend to be followed by high volatility, and vice versa). Accurate volatility estimates are crucial because they feed into risk management tools, derivative pricing, and portfolio allocation. In the context of cryptocurrencies, volatility modeling takes on added importance due to the extreme price fluctuations observed in these markets. Bitcoin, for example, is known for its high volatility and speculative nature, with large price swings that exceed those of most traditional assets. Such behavior has been attributed to the asset's novelty, limited regulation, and sensitivity to market sentiment. As a result, understanding and forecasting volatility in cryptocurrencies is vital for investors and policymakers. Recent studies underscore that examining Bitcoin's volatility is crucial for its inclusion in financial markets and portfolio management (Cheah & Fry, 2015). Moreover, empirical evidence shows that the Bitcoin market exhibits long memory and persistent volatility stylized facts that justify using advanced volatility models in analysis (Bariviera, 2017; Zhang et al., 2018). Volatility forecasts also directly support risk management: they improve financial risk measures and help organizations mitigate the risk of financial failure (Gultekin et al., 2022). In short, the ability to model and predict volatility accurately is fundamental for informed financial decision-making, especially in high-volatility arenas like cryptocurrency markets.

The study of volatility modeling began with Engle's (1982) ARCH model, enabling the conditional variance of returns to change over time based on past errors. Bollerslev (1986) introduced the Generalized ARCH (GARCH) model, treating conditional variance as an autoregressive moving average (ARMA) process. However, GARCH models assume volatility reacts symmetrically to positive and negative shocks, which limits their effectiveness, especially given the leverage effects in financial markets where negative returns often increase future volatility more than equivalent positive returns. To address this, Nelson (1991) proposed the Exponential GARCH (EGARCH) model, which models the logarithm of variance and includes asymmetry terms to account for the differing impacts of negative and positive shocks. This innovation allows EGARCH models to capture the leverage effect seen in stock and crypto markets, where bad news tends to increase volatility more than good news.

Glosten et al. (1993) developed an alternative model to capture asymmetry, now known as GJR-GARCH. The GJR-GARCH model modifies the standard GARCH by adding a term that is activated when the previous error is negative. A dummy variable distinguishes between "good news" and "bad news." When returns decline (bad news), an additional

coefficient is applied to the squared innovation, typically resulting in higher volatility than would occur with positive returns. Both EGARCH and GJR-GARCH have become standard extensions of GARCH, commonly used to investigate leverage effects in volatility. These foundational models established the toolkit for volatility forecasting that is still widely applied across asset classes.

Building on this theoretical background, this study addresses the volatility dynamics in cryptocurrency markets. We conduct a detailed empirical investigation focusing specifically on Bitcoin, the most prominent and widely studied cryptocurrency, utilizing a unified methodological framework. By systematically comparing the empirical performance of established GARCH-family volatility models—including GARCH, EGARCH, and GJR-GARCH—this research aims to provide insights into the volatility behavior unique to Bitcoin's market dynamics.

The remainder of the paper is organized as follows: Section 2 describes the data and outlines the econometric methodology, specifying the models and estimation procedures applied. Section 3 presents empirical results, discussing volatility estimates and forecasts, and provides detailed Value-at-Risk (VaR) estimations. Lastly, Section 4 concludes by summarizing the findings, highlighting key implications for risk management practices, and suggesting directions for future research.

2. Methodology

2.1 Data Collection

Accurate and reliable data is essential for modeling financial time series, particularly in analyzing stock market dependencies and volatility. This study collects historical price data for Bitcoin (BTC-USD) using the yfinance package, which is a Python interface for Yahoo Finance that enables easy retrieval of financial market data (Aroussi, 2025). The dataset spans from September 18, 2014, to March 3, 2025, ensuring a robust sample that captures various market cycles, economic conditions, and volatility regimes.

Figure 1 presents a comprehensive visualization of the BTC closing prices and key statistical properties derived from the dataset. The top-left panel displays the historical price movement of Bitcoin, revealing significant long-term trends and volatility. The accompanying Q-statistic and ADF test results indicate that Bitcoin prices exhibit non-stationarity, as evidenced by the high Q-statistic value and an ADF p-value above 0.05, suggesting a failure to reject the null hypothesis of a unit root. Additionally, the Hurst exponent—estimated at 0.55—points to a moderate deg-

ree of long-range dependence, implying that while the price series has some persistence, it remains closer to a random walk than to strong trending behavior. Over the observed period, major events such as the late 2017 bull run, the subsequent correction in 2018, the pandemic-induced volatility in early 2020, and the surge in institutional adoption in 2021 significantly influenced Bitcoin's price dynamics.

The top-right panel provides a quantile-quantile (QQ) plot, which compares the distribution of Bitcoin prices to a normal distribution. The pronounced deviations from the red reference line at both tails indicate heavier tails than would be expected under normality, suggesting a higher probability of extreme price movements (Zhang et al., 2018; Chen et al., 2024). The computed skewness and kurtosis values support this observation: positive skewness reflects a tendency for larger upward movements, while the kurtosis value confirms fat-tailed behavior. This finding underscores the importance of risk management strategies that account for non-normal distributions and extreme events. Notably, if the QQ plot is based on raw prices, further analysis on returns offers a more conventional approach to investigating distributional properties.

The bottom-left panel presents the autocorrelation function (ACF) of Bitcoin prices, demonstrating strong persistence, as seen in the slow decay of autocorrelation values over increasing lags. This pattern suggests that past prices have a lasting influence on future prices, reinforcing the notion of long-term memory in Bitcoin price dynamics. The Hurst exponent value of approximately 0.55 further supports this finding, indicating a mild level of persistence and trend-following behavior.

Finally, the bottom-right panel shows the partial autocorrelation function (PACF), highlighting significant autocorrelation at the first lag while subsequent lags remain relatively insignificant. This suggests that short-term dependencies exist in Bitcoin prices but diminish rapidly beyond the immediate past value.

Overall, the results in Figure 1 indicate that Bitcoin prices are non-stationary, exhibit long-term dependencies, and deviate from a normal distribution. These findings underscore the importance of employing advanced econometric models that can account for such statistical properties in further analyses.

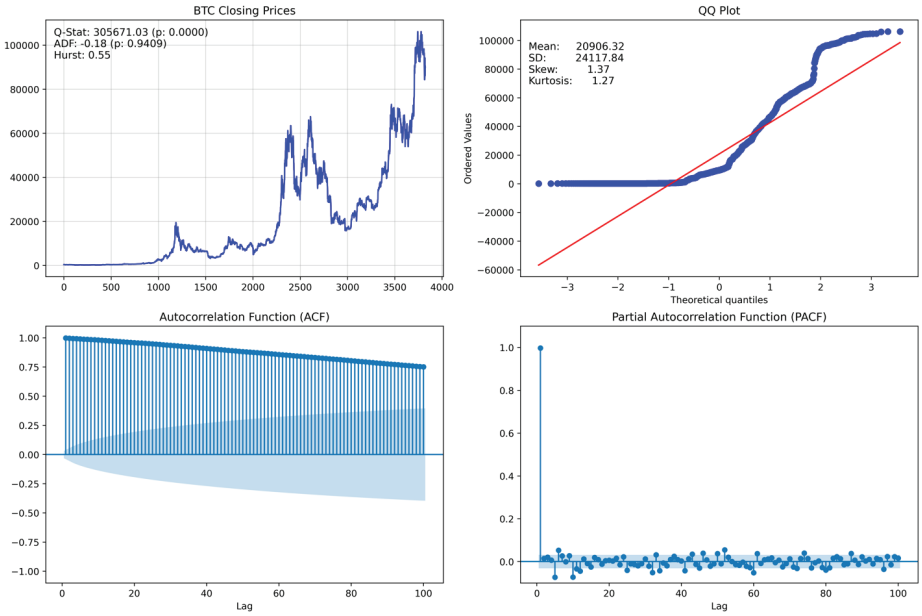

Figure 1. Statistical and time series analysis of BTC closing prices

2.2 Data Cleaning and Preprocessing

To ensure a robust dataset for analysis, several preprocessing steps are applied. First, missing values within the dataset are handled by removing any incomplete data points. This step is necessary to prevent inconsistencies in subsequent calculations.

Following this, unnecessary columns that do not contribute to the core analysis are removed, leaving only the relevant financial metrics. This simplifies the dataset and reduces computational complexity. After cleaning, the logarithmic return is computed to measure Bitcoin's price changes over time. The logarithmic return is defined as:

$$r_t = 100 \times (\ln p_t - \ln p_{t-1}) \tag{1}$$

where r_t represents the logarithmic return at time t, and p_t and p_{t-1} are the closing prices of Bitcoin at time t and, $t-1$ respectively. The logarithmic return provides a symmetric measure of returns and is often preferred in financial analysis due to its time-additive properties. Finally, missing data points that may arise during the computation of returns, particularly for the first observation where differencing is applied, are eliminated to ensure a complete dataset for analysis.

Figure 2 illustrates the logarithmic returns of Bitcoin, offering a transformed view of the price series that emphasizes return distributions and dependencies. In contrast to raw prices, log returns typically exhibit more stationary behavior, which supports more reliable statistical modeling. The top-left panel of Figure 2 shows how Bitcoin's log returns fluctuate around a relatively constant mean, lacking any obvious trend. This visual indication of stationarity is reinforced by the Augmented Dickey-Fuller (ADF) test, whose test statistic is significantly lower than the critical threshold—leading to the rejection of the null hypothesis of a unit root. Furthermore, an analysis of the Hurst exponent for the log returns yields a value near 0, suggesting strongly anti-persistent behavior. In other words, positive and negative deviations from the mean are more likely to be followed by reversals rather than continued movement in the same direction.

The top-right panel displays a QQ plot of the log returns, which visually compares the empirical distribution to a normal distribution. Deviations from the reference line indicate heavy tails, suggesting that extreme price changes occur more frequently than under normality. The observed negative skewness implies that large downward movements are more prevalent than large upward movements, while a kurtosis value significantly exceeding 3 confirms the leptokurtic nature of Bitcoin returns. This indicates that the probability of extreme events is much higher than would be predicted by a normal distribution.

The bottom-left panel, which shows the ACF of log returns, demonstrates that unlike raw price levels, log returns exhibit minimal autocorrelation. The rapid decay of ACF values indicates weak dependency across time, which is a common characteristic of financial return series. The PACF plot (bottom-right) reinforces this finding, with limited significant partial autocorrelations beyond the first few lags.

Comparing Figures 1 and 2, we observe a fundamental shift in statistical properties when transitioning from price levels to log returns. While Bitcoin prices in Figure 1 exhibit strong persistence and non-stationarity, the log return series in Figure 2 is stationary with weak dependencies. This transformation is crucial for time series modeling, as many econometric models assume stationarity when analyzing financial data.

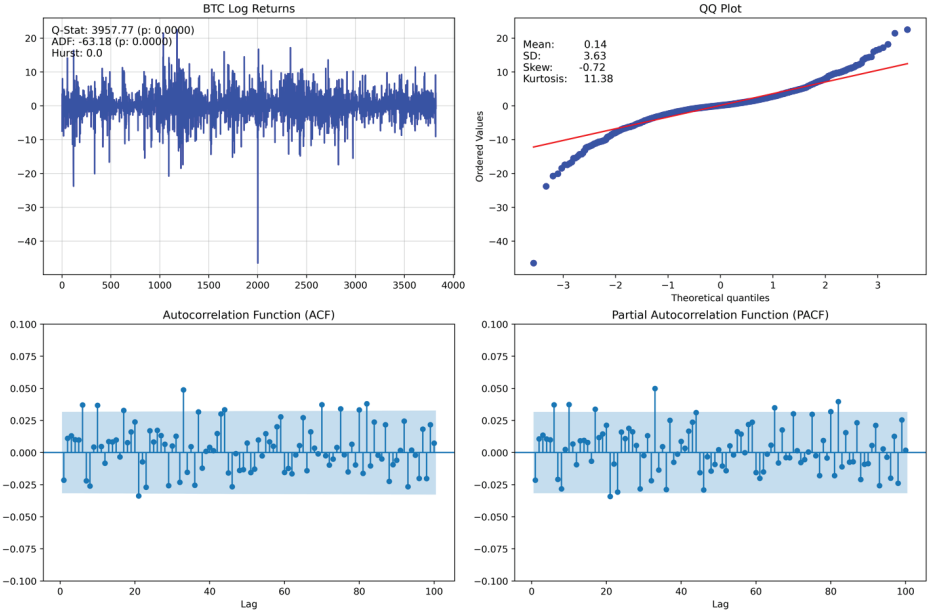

Figure 2. Statistical and time series analysis of BTC returns

2.3 Methodology

2.3.1 Model Specification

We employ three distinct volatility models to capture the dynamics of Bitcoin returns: the GARCH, the EGARCH, and the GJR-GARCH models. The GARCH model is a natural extension of the ARCH model (Engle, 1982), as developed by Bollerslev (1986), and is defined as:

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2, \tag{2}$$

where $\omega > 0$, $\alpha \geq 0$ and $\beta \geq 0$ are parameters to be estimated. This specification effectively captures volatility clustering by allowing the current variance to depend on past squared innovations and past variances.

However, empirical evidence suggests that financial return series often exhibit asymmetry in their volatility response to shocks. The EGARCH model, proposed by Nelson (1991), addresses the asymmetry in volatility response. Unlike the standard GARCH model, EGARCH models the logarithm of the variance, which removes the non-negativity constraint on

the parameters and naturally incorporates asymmetry. Its general specification is given by:

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \alpha \left(\frac{|\epsilon_{t-1}|}{\sigma_{t-1}} - E\left[\frac{|\epsilon_{t-1}|}{\sigma_{t-1}}\right] \right) + \gamma \frac{\epsilon_{t-1}}{\sigma_{t-1}}, \quad (3)$$

where the parameter γ captures the leverage effect. A significant γ indicates that negative shocks have a different (often larger) impact on volatility compared to positive shocks.

To further incorporate asymmetry, the GJR-GARCH model, introduced by Glosten et al. (1993), extends the GARCH framework by including an indicator function for negative shocks:

$$\ln(\sigma_t^2) = \omega + \alpha \epsilon_{t-1}^2 + \gamma \epsilon_{t-1}^2 I(\epsilon_{t-1} < 0) + \beta \sigma_{t-1}^2, \quad (4)$$

where $I(\cdot)$ is an indicator function that takes the value 1 when its argument is true and 0 otherwise. Here, γ quantifies the additional effect of negative returns on volatility. This formulation allows the model to capture the leverage effect observed in financial markets.

2.3.2 Estimation and Evaluation

All three models are estimated using maximum likelihood estimation (MLE), which seeks the parameter values that maximize the likelihood of the observed data. MLE is a widely accepted method in time series econometrics, especially when the error distribution is correctly specified. By assuming that the innovations follow a Student's t distribution in all models, our estimation procedure becomes more robust to the presence of fat tails in Bitcoin returns.

Once estimated, the models produce conditional volatility forecasts that are evaluated using model selection criteria such as the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), and log-likelihood. Lower BIC and AIC values indicate a more parsimonious model with better out-of-sample forecasting performance (Akaike, 1974; Schwarz, 1978).

Bitcoin returns, characterized by high volatility and frequent extreme observations, necessitate a modeling approach that can accommodate heavy tails and asymmetry. Estimating the standard GARCH model with a

Student's t distribution better fits the data by capturing the probability of extreme returns more accurately.

The EGARCH model's logarithmic specification further enhances our ability to capture asymmetric volatility responses, while the GJR-GARCH model explicitly accounts for the additional impact of negative shocks. Together, these models provide a comprehensive framework for understanding and forecasting the dynamic volatility of Bitcoin returns, thereby offering valuable insights into market risk.

3. Results

In this section, we present the findings from our volatility modeling exercise. We compare three competing models—GARCH, EGARCH, and GJR-GARCH—using a set of standard evaluation metrics. All model estimations and forecasts were conducted using the arch package in Python (Sheppard, 2024), which provides robust implementations of univariate GARCH-type models with various extensions. The performance of each model is assessed using the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC), and the log-likelihood. These criteria balance model complexity and goodness-of-fit, where lower values generally indicate a more parsimonious and better-performing model.

Table 1. Evaluation metrics for the three models.

Model	BIC	AIC	Log-Likelihood
GARCH	19113.3078	19082.0638	-9536.0319
EGARCH	19064.9383	19027.4456	-9507.7228
GJR-GARCH	19118.4473	19080.9545	-9534.4773

Based on the BIC, which is particularly stringent in penalizing model complexity, the EGARCH model emerges as the preferred specification. This finding suggests that the EGARCH model provides a better trade-off between model fit and parsimony for capturing the dynamic volatility of Bitcoin returns. The enhanced performance of the EGARCH model likely stems from its capacity to accommodate asymmetries in volatility responses—a crucial feature given the heavy-tailed and skewed nature of Bitcoin market returns.

Figure 3 illustrates the estimated conditional volatilities from the GARCH, EGARCH, and GJR-GARCH models, plotted alongside the actual Bitcoin returns (shown in gray). In this visualization, the gray area represents the daily returns, while the colored lines depict the model-based volatility estimates over time. All three models capture the general pattern of volatility clustering, but noticeable differences exist in their responses to market extremes. Consistent with the statistical metrics presented in Table 1, the EGARCH model (red line) appears more reactive during periods of heightened turbulence, reflecting its ability to account for asymmetric effects. This observation reinforces the conclusion that the EGARCH model provides a superior fit for Bitcoin's distinctive volatility characteristics.

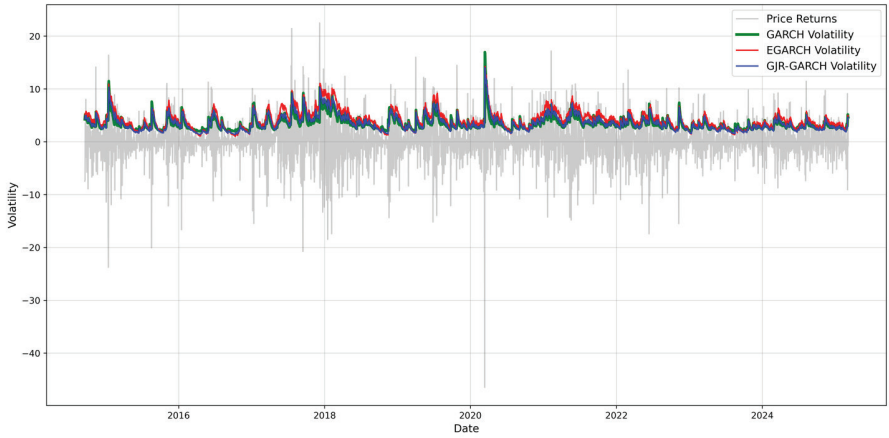

Figure 3. Comparative volatility estimates from GARCH, EGARCH, and GJR-GARCH models

Table 2 presents the key parameter estimates from the EGARCH (1,1) model applied to Bitcoin returns. The choice of the EGARCH (1,1) specification is motivated by its ability to capture both the persistence and asymmetry in volatility while maintaining a parsimonious structure. Prior research has shown that the EGARCH (1,1) model effectively models financial return volatility, particularly for assets exhibiting clustering effects and leverage asymmetry, such as Bitcoin (Naimy et al., 2021), (Martinet & McAleer, 2015), and (Fakhfekh & Jeribi, 2020).

The mean equation coefficient μ is estimated at 0.1235 with a statistically significant p-value of less than 0.05, indicating a positive average return. In the volatility model, the parameter ω is positive and statistically

significant, reflecting a baseline level of volatility. The magnitude effect, represented by α, is 0.2502, confirming that absolute shocks significantly increase volatility. The asymmetry parameter γ is positive (0.0272) and significant, suggesting that negative shocks tend to increase volatility more than positive ones, albeit to a small degree. The persistence parameter β is close to one (0.9880), indicating that volatility shocks have long-lasting effects. Finally, the degree of freedom parameter ν suggests that returns follow a heavy-tailed Student-t distribution, consistent with financial time series exhibiting extreme values.

Table 2. Estimated Parameters for the EGARCH Model

Parameter	Estimate	Std. Error	t-Statistic	p-Value
μ	0.1235	0.0303	4.078	0.0000
ω	0.0854	0.0219	3.894	0.0000
α	0.2502	0.0302	8.275	0.0000
γ	0.0272	0.0133	2.048	0.0406
β	0.9880	0.0051	192.115	0.0000
ν	2.7201	0.1350	20.153	0.0000

Overall, the EGARCH(1,1) model effectively captures the time-varying nature of volatility and asymmetry in financial returns, as indicated by Table 2. The results confirm that volatility persists over time, with asymmetric responses to positive and negative shocks, making EGARCH a suitable model for capturing these dynamics in financial markets.

Figure 4 presents a comparative visualization of two primary volatility forecasting methodologies applied to Bitcoin price data: Model-based Simulation (left panels) and Bootstrap Scenario analysis (right panels). The figure effectively demonstrates the distributional differences between these approaches across a 5-day forecast horizon. In the upper panels, we observe multiple simulation paths represented by red (model-based) and blue (bootstrap) lines, with the black line indicating the mean forecast. These trajectory plots illustrate how the conditional volatility evolves over

the forecast horizon. The model-based simulation produces a wider dispersion of potential volatility paths than the bootstrap method, suggesting it captures more extreme scenarios. This difference is particularly important for risk management in cryptocurrency markets, where tail risks are significant concerns.

The lower panels display boxplot distributions of the variance forecasts at each time step, revealing the changing uncertainty structure as the forecast horizon extends. The increasing width of the boxplots across time points indicates growing forecast uncertainty at longer horizons, which aligns with theoretical expectations. Both methods appear to generate similar patterns of outliers (represented by circles above the boxplots), but with potentially different frequencies and magnitudes.

The visualization effectively demonstrates how these two simulation approaches can yield different risk assessments for the same EGARCH model. This comparison is particularly valuable for financial institutions and investors seeking to implement robust risk management frameworks for cryptocurrency investments, where traditional assumptions about market behavior may not hold.

From a methodological perspective, the simulation-based approach likely incorporates more model parameter uncertainty, while the bootstrap method relies more on the empirical distribution of historical innovations. This distinction explains the different characteristics of the forecast distributions and highlights the importance of method selection when forecasting volatile assets like Bitcoin.

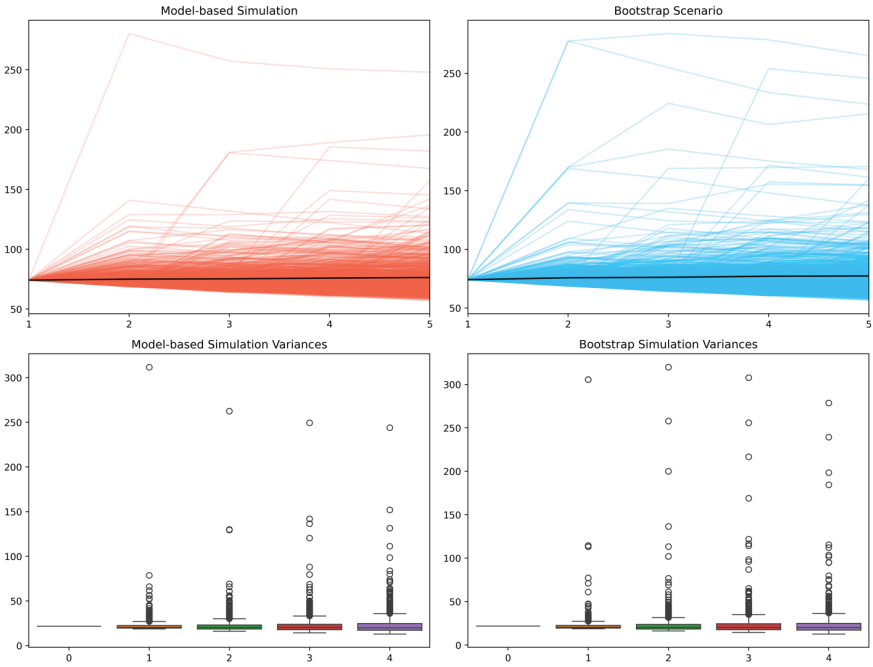

Figure 4. Comparative Analysis of Model-based and Bootstrap Simulation Methods for Bitcoin Volatility Forecasting

Figure 5 comprehensively visualizes Bitcoin's volatility patterns, combining historical data with forward-looking forecasts generated through two distinct methodological approaches. The figure effectively demonstrates the transition from observed historical volatility (red line) to projected future volatility using both simulation-based (green line) and bootstrap-based (blue line) EGARCH forecasting techniques. The historical volatility pattern (July 2024 to March 2025) reveals Bitcoin's characteristic volatility clustering—periods of heightened volatility followed by relative calm. Several notable volatility spikes appear around August 2024 and November 2024, reaching peaks of approximately 5.8% and 5.0% respectively.

We observe a particularly fascinating phenomenon at the forecast boundary. Both forecasting methods predict an immediate upward trajectory in volatility, suggesting that the model has identified signals in recent data indicating increasing market uncertainty. However, the magnitude of this projected increase varies significantly between the two methods. The simulation-based forecast anticipates a more dramatic volatility rise, peaking at approximately 6.7% before moderating slightly towards the end of the forecast horizon. In contrast, the bootstrap-based forecast sug-

gests a more conservative volatility increase, reaching about 5.5% at its maximum. This considerable divergence between the two methods underscores how different statistical approaches to uncertainty can result in significantly different risk assessments.

The simulation method likely incorporates more parameter uncertainty and can generate more extreme scenarios. In contrast, the bootstrap method relies on resampling historical residuals, potentially constraining the range of possible outcomes to patterns observed in the historical data. This methodological distinction has important implications for risk management in cryptocurrency markets, where proper volatility forecasting is crucial for derivative pricing, portfolio optimization, and value-at-risk calculations.

The convergence and divergence patterns between the two forecast methods also provide valuable information about forecast uncertainty across different time horizons. The initial close agreement followed by increasing separation suggests greater model uncertainty as the forecast horizon extends, a common characteristic in financial time series forecasting. This visualization would be particularly valuable for financial practitioners and researchers who want to understand the limitations and strengths of different forecasting approaches in the highly volatile cryptocurrency markets.

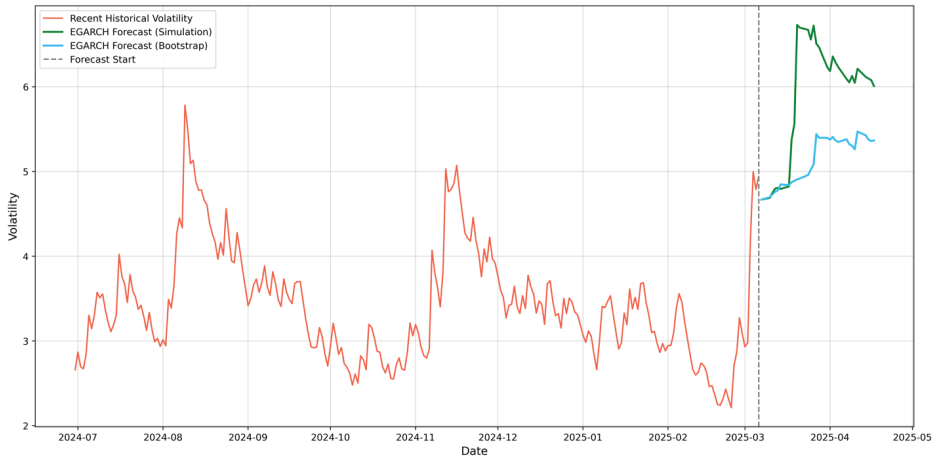

Figure 5. Comparative Volatility Forecast of Bitcoin Using EGARCH Model with Simulation and Bootstrap Methods

Figure 6 provides a clear look at the Value-at-Risk (VaR) analysis for Bitcoin returns, which uses a straightforward parametric approach based on an EGARCH model with Student's t-distribution. It vividly shows how Bitcoin's risk profile evolved from January 2024 to February 2025. This visualization shows the predicted risk levels and the actual instances where returns exceeded expectations. The blue line marks the 1% VaR threshold, representing the maximum expected loss you could face, with 99% confidence, over just one day. Throughout this period, this threshold shows considerable fluctuations, ranging from about 5% to spikes over 15%, especially during periods of high volatility, which were particularly striking in April and August 2024.

The orange line represents the less conservative 5% VaR threshold, fluctuating between approximately 3% and 8% throughout the observation period. The synchronized movement of both VaR measures reflects the underlying volatility clustering that defines cryptocurrency markets, where periods of high volatility tend to persist.

What makes this visualization particularly valuable is the overlay of actual daily returns (black dots) against these risk thresholds. Returns that exceed the 5% VaR threshold but remain below the 1% threshold are marked with magenta squares. In comparison, returns exceeding even the more conservative 1% VaR are highlighted with red markers (though these appear to be absent in this visualization). Most returns fall within the expected boundaries (black dots), which suggests reasonable model calibration.

From a risk management perspective, this analysis demonstrates the effectiveness of the EGARCH model in capturing the fat-tailed nature of Bitcoin returns. Several exceedances at the 5% level align with theoretical expectations. Moreover, the dynamic adjustment of the VaR thresholds in response to changing market conditions highlights the importance of conditional heteroskedasticity models for cryptocurrency risk assessment.

This type of VaR analysis offers essential insights for institutional investors, risk managers, and regulatory bodies engaged in cryptocurrency markets. It facilitates more precise risk quantification, capital allocation decisions, and stress-testing scenarios in the context of highly volatile digital assets.

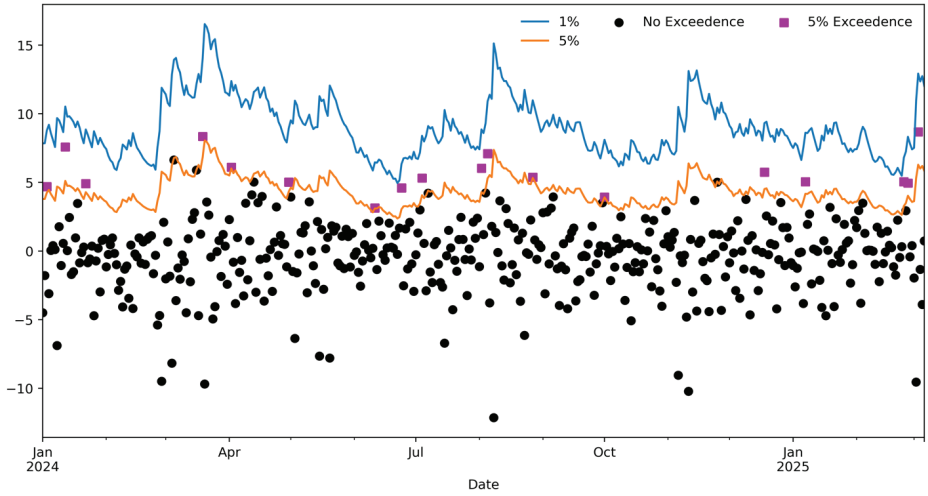

Figure 6. Value-at-Risk Analysis for Bitcoin Returns with EGARCH Model

Figure 7 presents a sophisticated dual-axis visualization that simultaneously tracks Bitcoin's price evolution and its corresponding 5% Value-at-Risk (VaR) metric from January 2024 through March 2025. This approach provides a comprehensive view of the relationship between price movements and risk metrics over time. The red line represents Bitcoin's closing price (left axis), demonstrating significant volatility throughout the observation period. Beginning around $45,000 in January 2024, Bitcoin experiences several distinct phases: a substantial rally to approximately $70,000 by March 2024, followed by several months of consolidation between $60,000-$70,000, before embarking on another significant uptrend starting in October 2024 that takes prices above $100,000 by early 2025.

Concurrently, the light blue line displays the 5% daily VaR (right axis), calculated using a parametric EGARCH model. This measure represents the maximum expected one-day loss at a 95% confidence level. In several instances, the VaR exhibits pronounced countercyclical behavior relative to price, with risk measures often increasing sharply during periods of rapid price appreciation.

The significant VaR spikes visible in March 2024, August 2024, and February 2025 are particularly noteworthy, each corresponding to substantial price volatility or directional movement periods. The highest VaR readings, exceeding 8% in March 2024, suggest that investors should have been prepared for potential daily losses of more than 8% of their Bitcoin holdings with a 5% probability during this period.

The visualization reveals an important characteristic of cryptocurrency markets: risk often intensifies during both bullish and bearish price movements. For instance, the March 2024 VaR spike coincides with a powerful upward price surge, while the August 2024 risk elevation corresponds with a period of price oscillation and uncertainty. This pattern underscores that rapid price appreciation doesn't necessarily represent reduced risk in cryptocurrency markets—in fact, it frequently signals the opposite.

From a financial risk management perspective, this figure demonstrates why dynamic risk models are essential for cryptocurrency investors. Static risk assessments would fail to capture the rapidly changing risk environment evident throughout this time series. The visualization provides crucial insights for portfolio managers, highlighting periods where risk mitigation strategies or reduced position sizing might be prudent despite potentially bullish price action.

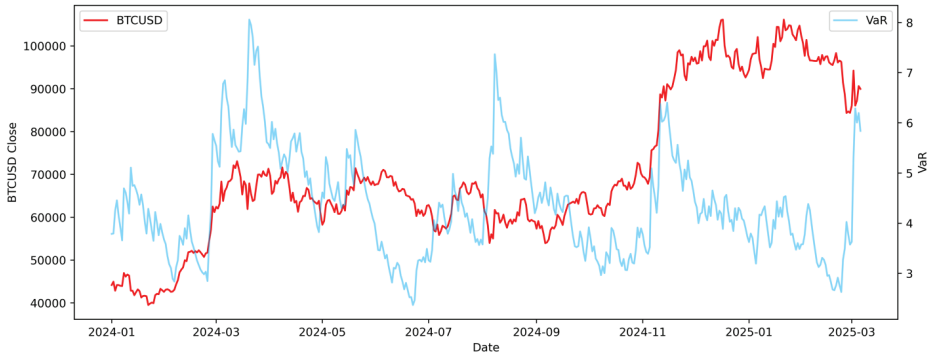

Figure 7. Bitcoin Price Movement and Value-at-Risk Dynamics

4. Conclusion

This study comprehensively analyzes Bitcoin's dynamic volatility and associated risk assessment methodologies. By employing advanced GARCH-family models—including GARCH, EGARCH, and GJR-GARCH—we capture the unique volatility characteristics of Bitcoin markets, emphasizing the necessity of asymmetry-aware models for accurate forecasting. Our findings indicate that the EGARCH model offers high performance. It effectively accounts for the leverage effect observed in cryptocurrency markets, where negative shocks result in disproportionately higher volatility increases compared to positive shocks.

The empirical results confirm the presence of significant volatility clustering, heavy tails, and long-memory properties in Bitcoin returns, reinforcing the need for robust risk management strategies in crypto-based investments. The application of Value-at-Risk (VaR) estimation further highlights the potential for extreme price movements, underscoring the importance of dynamic risk assessment frameworks. Moreover, the comparative analysis of volatility forecasting approaches demonstrates how different methodologies can yield varying risk estimations, emphasizing the necessity of method selection in financial decision-making.

Overall, our research contributes to the growing literature on cryptocurrency volatility by providing a detailed empirical evaluation of Bitcoin's risk dynamics. The findings have crucial implications for investors, portfolio managers, and policymakers, offering valuable insights into effective risk mitigation strategies in the highly unpredictable crypto market. Future research can expand on these insights by incorporating additional cryptocurrencies, exploring machine learning-based volatility models, and integrating macroeconomic factors to enhance predictive accuracy.

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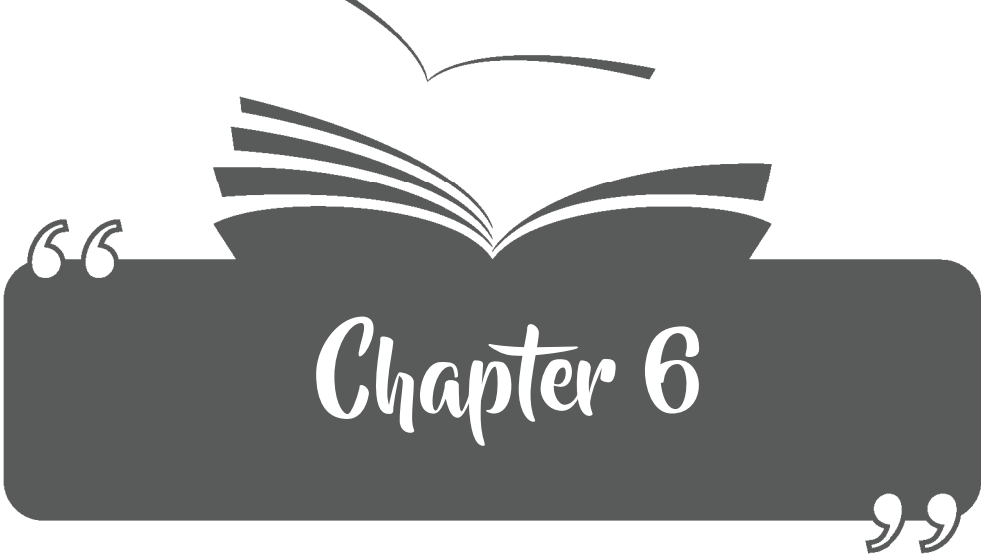

THE IMPACTS OF CLIMATE CHANGE ON WORK: A GLOBAL OVERVIEW

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1. Introduction

Considered as a multi-dimensional problem, climate change is a global threat that is expected to deeply affect the socio-economic structures of societies. It is predicted that this problem, the effects of which are already being gradually seen, will affect the entire world much more severely in the near future. Although this is a large-scale problem that involves all countries, it should be underlined that not all countries will be equally affected by this problem. Food and Agriculture Organization (FAO) data indicate that the countries that cause the least global warming are the countries that will pay more for global warming. Rising sea levels and increasing ocean water temperatures, prolonged droughts and the effects of these droughts on fresh water resources and agricultural production indicate that it will be difficult to feed countries in the near future. In addition to damaging crop and animal production, extreme natural events will also destroy infrastructure. These developments will increase migration and put food security at risk. All these events will have a greater impact on developing countries. Developing countries are countries with a large rural population and a high share of agriculture in the economy. Therefore, the agricultural sector, whose production structure is largely dependent on natural conditions and climate, is the sector that will be most affected by climate change. According to FAO data, 3 billion people live in rural areas and agriculture is the main source of livelihood for 2.5 billion of them. These 3 billion people also constitute 80 per cent of the world's poor. In short, climate change is primarily a threat to the world's poor (FAO, 2018) . United Nations Framework Convention on Climate Change (UNFCCC) reveals that, developing countries are more vulnerable to the negative impacts of climate change because they have far fewer resources - socially, technically and financially – in adapting climate change. Adapting to climate change means reducing the negative effects that will occur with climate change, so it is necessary to implement many regulations and practices in order to adapt to climate change (UNFCC, 2007). It is clear that climate change, which is known to significantly affect global production, natural resources, geography and biodiversity all over the world, will also have significant effects on workforce and jobs. Decreased air quality, floods, fires and increases in disease-carrying pests will negatively impact the workforce and lead to job losses (WEF, 2023a). According to the International Labor Organization, rising temperatures cause significant decreases in workers' physical activities, abilities and capacities. Temperature rises reduce labor productivity notably (ILO, 2019).

The aim of this study is to examine the effects of climate change on work in detail. In this context, in the first section of the study we attempt to examine the effects of climate change on labor productivity and the

health of employees. In the second section we try to address the effects of the relevant problem on workplaces and migration. We target to to examine green jobs that emerge as a result of climate change in the third section. In the conclusion section, the findings of the study are briefly summarized and policy recommendations on the subject are included.

2. Impacts on labour productivity and workers health

Climate change is a problem that has significant negative impacts on countries' growth potential and productivity. According to a study analysing the impact of climate change on economic growth in 126 low- and middle-income countries in the period between 1960-2017 compared to its historical average, climate change reduces the growth in real income per capita in the relevant countries by 0.74-1.52 percent. As to the related study, increasing temperatures in the mentioned period also have a negative impact on agricultural output and agricultural productivity (Bandt et al.,2021). The impact of climate change on labor productivity largely emerges through heat stress. The reduction of labor productivity due to heat stress is an important problem both for developed and developing countries. A study covering 23 developed countries between 2000 and 2021 shows that, heat increase is a factor that reduces labor productivity. This effect is much higher in low-productivity firms and small firms, and high humidity and low wind speeds increase the decrease in labor productivity. In addition, in countries with milder climates (higher average temperatures), the productivity decrease mentioned is less. At this point, it is assumed that there is an adaptation. However, adaptation is also limited, and productivity losses increase significantly as temperatures increase too much (Costa et al, 2024). According to the ILO, labor productivity decreases at temperatures above 24-26 degrees, for example, a worker working at 33-34 degrees loses 50% of his capacity. Exposure to extreme heat can lead to many health problems, such as heat stroke, which can even be fatal. 1.5 degree increase in global temperature at the end of the 21st century will cause a 2.2% decrease in total working hours in 2030, with the optimistic estimates. If we also take into account the fact that agriculture and construction are sectors operating under the sun, there will be a loss of 3.8% in total working hours in 2030, which is equivalent to the loss of 136 million full-time jobs. While economic losses due to heat stress in workplaces were 280 billion dollars in 1995, this figure is expected to rise to 2,400 billion dollars in 2030. It is also underlined that the effects of heat stress will be felt more in low- and middle-income countries (ILO, 2019). It is thought that the related productivity loss will vary by region in the European continent. The workers who will be most affected by heat stress will be those in the agricultural and construction sectors. While it is stated that labor productivity in outdoor work will decrease significantly, up

to 15% by the end of the century, in Southern Europe (Bulgaria, Greece, Italy, Macedonia, Portugal, Spain and Turkey), a lower decrease (up to 4% by the end of the century) is predicted for Northern Europe (Denmark, Estonia, Finland, Norway and Sweden) (Gosling et al, 2018). DasGupta et al.(2021) reports that, there will be a decline in labor supply and productivity in many parts of the world, especially in tropical regions, in the near future due to climate change. South Asia, Southeast Asia and parts of sub-Saharan Africa are at greater risk under future warming scenarios. According to a study examining the effects of climate change on labor productivity and the economy in China, heat-related labor productivity will decline by 2100. Economic losses will vary across regions, sectors, and types of labor force. Low-income regions in southwest China are expected to suffer the highest economic losses. Economic losses in these regions will be 3.4–7.1 times greater than in high-income regions. In addition, wages for workers in heat-sensitive occupations have been shown to increase. For example, wages in Guangxi are expected to increase by 8.3%. Conversely, wages in occupations with low heat sensitivity are expected to decline (Zhao et al., 2024).

Heat stress causes many mental and physical illnesses, puts human life at risk, and reduces the productivity of the workforce by causing illness. Amoadu et al. (2023) report that high temperatures cause heat-related illnesses, dehydration, kidney disease and mental illness, and emphasize that pregnant women, children and migrants are more vulnerable to heat stress. Another study highlight that farmers engaged in agricultural production are more vulnerable to heat stress due to the nature of their work. Heat-related diseases and kidney disorders are prominent illnesses due to heat stress, while various preventive measures (protective clothing, drinking water, changing working hours, taking breaks, etc.) are of great importance in coping with the related stress (Moussa et al., 2022). Higher temperatures are increasing the risk of heat-related illnesses, mental health problems and respiratory problems, according to a recent comprehensive report detailing the health impacts of climate change. People living in low-income areas and older individuals are more vulnerable to these impacts due to more adverse housing conditions and higher health risks. Sunstroke, cardiovascular diseases, anxiety, respiratory diseases that occur with increasing temperature and air pollution are the main health problems caused by rising temperatures (UK, 2023). Temperature increase is not the only health threat that climate change will create. Climate change will endanger workers' health in many different ways. UV radiation (which will especially affect agricultural, construction, port and electricity workers), extreme weather events (which will more intensely affect medical and emergency personnel, agricultural, fishing,

construction sector and firefighters), air pollution (all outdoor workers, transportation workers and firefighters will be more intensely affected), vector-borne diseases (which are riskier for outdoor workers, especially farmers, construction workers and firefighters), agricultural chemicals (which are riskier for farmers, forestry workers, chemical industry and pesticide sales workers) are the other elements that will increase in density and endanger workers' health. All these factors will cause an increase in diseases such as sunstroke, various cancer types (skin, lung, kidney etc), cardiovascular diseases, kidney diseases, eye diseases, weakening of the immune system, respiratory diseases, malaria, fever and diseases transmitted by harmful insects and flies, endocrine diseases and reproductive diseases (ILO, 2024). The adverse health impacts of climate change are projected to be more severe on outdoor workers. Especially low-income individuals living in tropical and sub-tropical developing countries, predominantly agricultural labourers and small-scale farmers, are expected to be more adversely affected by climate change. Migrants without access to health services are also expected to be significantly affected by this risk. It is known that women work in many jobs with heat exposure in developing countries. Therefore, women, especially pregnant women, are the groups that will be adversely affected (UNDP, 2016).

3. Impacts on workplaces and migration

The emergence of degradation in workplaces is the other possible consequences of climate change. Workplaces differ significantly in terms of sectors. For example, in the agricultural sector, the workplace is mainly fields, in the industrial sector it is mainly factories, and in the tourism sector it is mainly hotels, which can be classified as both indoor and outdoor areas. Although workplaces differ from sector to sector, all sectors are expected to be affected in different ways by climate change, which is a global problem.

In the agricultural sector, climate change may cause differentiation and relocation of the areas where crops are grown, in which case the amount of inputs (such as fertilisers, pesticides) used in agricultural production may also change significantly. In some production types, water use will differ and agricultural yields may change. Fisheries may decrease significantly with the changing habitat and may even disappear. Forestry may decline due to drought and fires, and weak root structure may lead to the spread of storms. Work in the infrastructure and construction sector may be difficult due to extreme weather events. Working areas in the tourism sector may also be significantly affected by temperature changes. Certain tourism areas may suffer extreme damage due to weather events, for example, some areas may become too hot to visit, or there may be no snow

at all in areas allocated for winter tourism. All these facts may lead to significant reductions in the number of visitors & tourists and may cause significant decreases in tourism revenues (CCOHS, 2023). The events experienced in Greece and Italy (in July 2023) confirm the devastating socio-economic effects of climate change on the tourism sector. In Greece, where 15% of the country's income comes from tourism revenues, 2,000 tourists were quickly evacuated from the uncontrolled fire on the island of Rhodes. The area was closed to visitors when temperatures reached 45 degrees in the Acropolis. The heat wave in Rome caused tourists to leave the city early, and hospitals in the city saw an extreme increase in emergency cases (WEF, 2023b).

Throughout history, people have tended to leave areas that are difficult to live in, and considering that climate change will make life difficult in some areas, it is predicted that it will also trigger migration to a significant extent. Migration is an increasingly accelerating phenomenon in today's world. The main driving forces of migration are natural disasters and conflicts, and as global reports reveal, it tends to increase significantly every year. According to global data, while the number of individuals migrating due to natural disasters and conflicts in 2022 was 71.1 million, this figure increased to 75.9 million in 2023. Storms, hurricanes, floods and earthquakes are the leading causes of migration other than conflicts. When examined regionally, it was determined that the continent with the highest migration in 2023 was Sub-Saharan Africa. Conflicts and natural disasters are the main causes of migration from the region. The region where migration due to disasters is most intense is East Asia and the Pacific countries. The Americas region is a country where migration due to storms is intense. Europe and Central Asia are also among the regions where migration due to natural disasters is very intense in 2023. The earthquake in Türkiye (February 2023 twin earthquakes) is a major disaster that has significantly escalated migration in the region (IDMC, 2024).

According to FAO, climate change is one of the important causes of rural migration, food insecurity and rural poverty. Climate change carries out its escalating effect on migration through both sudden events (such as sudden storms, floods) and slow events (rise in sea level, desertification, salinization). The high climate-related risks in the agricultural sector, combined with other socio-economic factors, make agriculture vulnerable, cause the loss of livelihoods and accelerate migration. The loss experienced by the agricultural sector due to climate-related disasters in developing countries is 26%. It has been determined that 26.5 million people migrated due to natural disasters and climate change between 2008 and 2015, and this number is expected to exceed 400 million by 2050. It is predicted that the rise in sea levels, one of the slow-moving consequences of climate

change, will cause permanent migration of people living in coastal areas in particular, and these areas will become uninhabitable. Climate change will significantly reduce agricultural assets and agricultural production, and may significantly erode livelihoods in rural areas. Another prediction is that the accelerated migration of young men from rural areas due to climate change will lead to the increasing feminization of agriculture in rural areas and the aging of the rural population (FAO, 2017).

It is underlined in the literature that the effects of climate change on migration will be much more intense in developing geographies and that the poorest people in these regions will be the most negatively affected by the situation. A study reveals that, climate change in Sub-Saharan Africa, South Asia and Latin America, which constitute 55% of the total population of developing countries, will force tens of millions of people to migrate from their countries to other places by 2050. According to the relevant study, approximately 2.8% of the population in these three regions (over 143 million) will be forced to migrate due to the slowly developing effects of climate change. Differences in sea levels and storms will make it difficult for the relevant population to access water and significantly reduce agricultural product productivity, paving the way for their migration. Those living in regions with high dependence on climate conditions and the poorest will be much more negatively affected by the crisis. Since these effects will be much more striking in climate-sensitive sectors, the need for infrastructure and social support in these sectors will be much greater. According to the report, if there is no decrease in greenhouse gas emissions and the necessary measures are not taken, climate-driven migration will increase and accelerate in 2050 (Rigaud et al., 2018).

4. Impacts on new job generation, green jobs

Countries trying to cope with the negative effects of climate change are transforming their labor markets and trying to move from brown jobs to green jobs. In these countries, brown jobs that are not environmentally sensitive and based on traditional production methods are decreasing, while green jobs that are environmentally sensitive and based on sustainability are increasing, meaning a significant transformation is taking place. Transition to a low-carbon economy paves the way for new employment opportunities. In this case, the distribution and qualifications of employees based on occupations will also have to change significantly. An econometric study has attempted to examine the transformations that climate change will create in the labor market and the elements that play a role in the transformation. According to the relevant study, education is the most important determinant in the transition to green jobs. Graduating from scientific fields is an advantage for young individuals, especially

when entering the labor market. Women have less opportunity to enter green sectors when entering the labor market. Those working in sectors that pollute the environment more are more likely to be displaced than other workers (Causa, O. et al., 2024).

Green jobs are decent jobs that contribute to protecting and repairing the environment, these jobs can be in sectors such as manufacturing and construction, as well as new sectors such as renewable energy and energy efficiency. When examined qualitatively, green jobs are jobs that increase energy and raw material efficiency, limit greenhouse gas emissions, minimize waste and pollution, facilitate adaptation to the effects of climate change, and protect and repair the ecosystem (ILO, 2023).

Green jobs are more common in developed countries, they are very effective in preventing economic crises as well as eliminating environmental problems. China, the United States, European Union countries, the Republic of Korea and Japan are countries that have made major investments to make their economies greener (ILO, 2025). Recent data from the World Economic Forum (2024) reveals that China has the highest number of green jobs in the world. There are more than 7 million green jobs in China and 46 per cent of the global green job total belongs to China. The sector with the largest share is the solar energy sector. Wind power and hydropower also have a significant share. The second region in the world where green jobs are concentrated is the European Union, where there are 1.81 million green jobs (WEF, 2024). Solar energy related jobs are quite intense in the region. It is expected that 4 million jobs will be created in the sector by 2050 (WEF, 2023c). Brazil is the third region where green jobs are concentrated. Biofuels, solar energy and hydropower are highly developed in the country. Brazil is home to 1.57 million green jobs. The United States of America is also a geography where green jobs are quite intense. The country hosts 1.06 million green jobs, mostly related to biofuels, onshore wind and solar PV (WEF, 2024). It is expected that 14% of all jobs in the country will be green jobs by 2030 (WEF, 2023c). With 1.02 million green jobs in 2023, India is another region where green jobs are intense. Hydropower is the country's primary sector in this area, while solar PV is another important sector (WEF, 2024).

According to the ILO, efforts to reduce carbon in the energy sector will create 24 million jobs and destroy 6 million jobs, i.e. the net gain will be 18 million new jobs. Moreover, it is stated that the gains will not be equal in all regions worldwide, and net job losses will be high in some regions. While the regions with high net occupational gains are projected to be the Americas, Asia and the Pacific and European countries, it is suggested that if there is no change in economic functioning and policies by 2030,

net occupational losses will be high in Middle East and Africa (Montt et al.,2018).

5. Conclusion

Climate change is expected to have a significant impact on work, employees and working styles throughout the world. While climate change is expected to affect work places, working styles and employees in many sectors, the sectors most affected are thought to be agriculture, construction, tourism and healthcare. As detailed in previous sections, temperature increases, severe weather events, air pollution and other negative factors that occur with climate change will both reduce the productivity of employees and increase the risk of contracting many diseases. Although it is expected that outdoor workers (especially those working in the agricultural sector, construction sector, and tourism sector) will be affected more by these negativities, these negativities will also strain individuals working in indoor areas, reduce their productivity, and endanger their health. Therefore, in the near future, in addition to low productivity, many diseases, from cancer to heart diseases, from endocrine to reproductive diseases, will be more of a problem for workers especially in developing countries. It is obvious that the related productivity and health losses will create additional cost that will strain national economies.

The impacts of climate change on workforce and jobs will vary region to region. It is suggested that coastal areas and rural areas will be more impacted by climate change. Agriculture, tourism, energy and transportation sectors are seen as the primary sectors that will be most affected by climate change. Climate change will make it impossible to do work in specific areas, and may change working places, hours and production methods. Migration is also expected to increase with climate change, meaning that significant displacement of the workforce is possible in the near future. As mentioned in previous sections, FAO estimates that the migrant population will exceed 400 million by 2050. The phenomenon of migration will affect those living in developing countries and the poor segment of society much more severely. To sum up, the negative impacts of climate change on workers will be much more negative for workers living in developing world, especially for the poorest. Since governments in developing countries are inadequate in implementing policies to cope with climate change and measures to mitigate the effects of climate change are also cost elements, it is clear that workers in the relevant countries will be more vulnerable to climate change.

Climate change will weaken some sectors and strengthen others, thus destroying some jobs and creating new ones. In this context, while fossil

fuel-dependent industries are expected to be limited, the renewable energy sector is expected to develop significantly. Montt et al. (2018) shows that the net gain in terms of jobs will be greater for many parts of the world. On the other hand, it emphasizes that there are regions such as Africa and the Middle East that will face net losses if the current economic functioning continues and the necessary steps are not taken. Today, many countries, especially China, are focusing on the transformation to green jobs and accelerating policy implementations in this direction. Although green jobs are more popular in developed geographies today, developing countries need to adapt to the green transformation quickly. As this study reveals, climate change will have its most negative effects mainly on jobs and employees in developing countries. Governments in the relevant countries have an important responsibility to ensure that the countries that cause the least climate change do not pay the highest prices.

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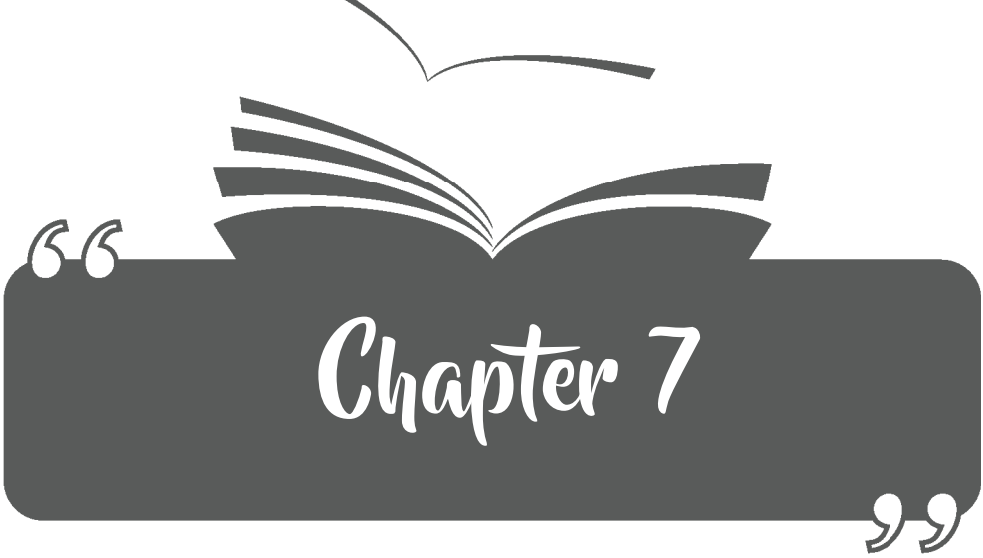

EFFECTS OF AUTONOMOUS SHIPS ON MARITIME TRADE

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1. Introduction

Maritime trade, which is spread over a very wide area, consists of stakeholders such as ship operators, port operators, shipyards, agencies, brokers, classification societies, financial institutions, maritime education institutions, insurance, tourism and fisheries (Demirel, 2024). Maritime trade refers to the international or regional transportation of goods and/or passengers by sea. A large part of global trade and transportation is carried out by sea and this sector plays a critical role in economic growth, development, logistics and supply chains. Therefore, maritime trade is the backbone of the global economy and plays an indispensable role in international trade and logistics processes.

The maritime trade sector, which has been continuously developing, has started to increase its impact since the 19th century and has entered a new process called Industry 4.0 today by undergoing changes. First, Industry 1.0, in which water and steam were used, then Industry 2.0, in which electricity was used, Industry 3.0, in which electronics and information technologies were used as a result of the developments that occurred, and finally Industry 4.0, in which cyber systems were effective, emerged (Acarer, 2023). With Industry 4.0, production based entirely on automation has started (Yılmaz & Önaçan, 2019).

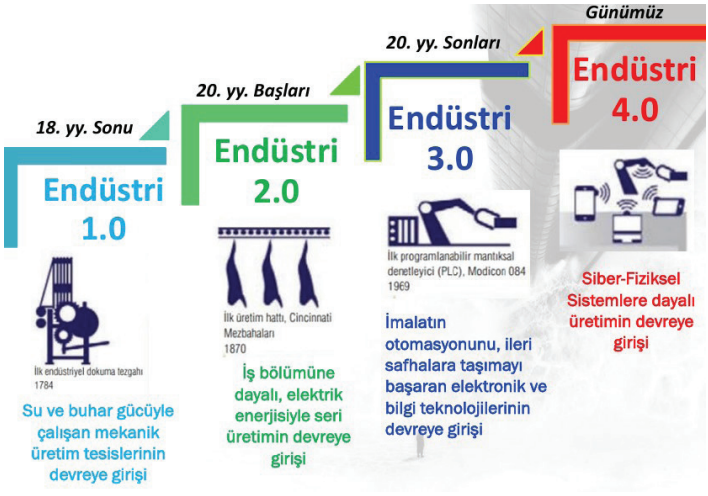

Figure 1: Processes of the Industrial Revolution (KMO, 2024).

Maritime transportation, which has increased its efficiency by taking advantage of the developments in technology (Nalbant, 2021), has started

to turn towards autonomous ships as a result of reasons such as economic, safety, environmental pollution, elimination of human errors and security (Doğru & Yorulmaz, 2021; Yılmaz, 2023).

Autonomous ships increase navigational safety and reduce costs by minimizing/eliminating human errors by controlling navigation, speed and maneuvering using software and sensors (Yılmaz, 2023). In addition to these, considering their environmental impacts, it is evaluated that they will become more important in the future (Yalman, Tıkız & Bamyacı, 2023)

As a result of the economic and technological developments, the structure of the fleets, the type and size of the ships have changed, and the use of automation systems in ships and ports has started to increase (Demirel, 2024)

Today, unmanned maritime vehicles (UUVs) are effectively used in areas such as "mapping, hydrography, maintenance of oil platforms, scientific research, mineral exploration, laying and maintenance of pipelines and underwater cables, maintenance and repair of ships and ports, wreck surveys(Gözüyeşil, 2021). The increasing use of autonomous ships in maritime requires a number of technical or legal regulations.

In order to carry out international maritime trade effectively, many legal regulations and international agreements have been made taking into account the human factor (Feyzioğlu, & Yorulmaz, 2023)

Autonomous ships, which have emerged with the development of technology and can navigate without human intervention through artificial intelligence and advanced sensors, have the potential to revolutionize the maritime industry. The impact of autonomous ships on maritime trade is of great importance in terms of operational efficiency as well as legal and economic aspects. To this end, treaties need to be reviewed and reorganized in order to bring unmanned ships into compliance with the legislation.

In this study, the effects of autonomous ships on maritime transportation in terms of economic, efficiency and safety and security, their advantages/disadvantages, and what needs to be done in order to ensure the transformation effectively are tried to be determined.

2. Autonomous Ship Concept

In the 21st century, with the digitalization that started to develop, technologies such as websites, internet, cloud, smart objects, artificial in-

telligence, virtual reality and internet of things have emerged (İnanlı & Yorulmaz, 2021).

Autonomous ships;

a. Sensors consist of artificial intelligence and automated systems and can adapt to

environmental conditions by analyzing real-time data (Yalman, Tıkız & Bamyacı, 2023)

b. Self-manage navigation, management and maintenance by analyzing information and data on sea state, traffic and port with their sensors, internet and other facilities (Yılmaz, 2023),

c. Ships that navigate by remote control or full autonomy (Gözüyeşil, 2021)

A fully autonomous ship can make decisions and produce solutions by thinking about the problems it may encounter from the port of departure to the port of arrival without the need for human intervention (Özkaya, 2023). When artificial intelligence completes its development, it will be able to have human behaviors such as feeling, decision-making, problem solving and learning (Kara, 2020). Today, the development of fully autonomous ships continues

Different ratings have been made for autonomous ships in terms of human element and control mechanisms. By IMO

Grade-1: "Seafarers are on board to operate and control the ship's systems and functions. Some operations may be automated and unsupervised, but there are seafarers on board ready to take control."

Grade-2: "The ship is controlled and operated from another location. Seafarers are present on board to take control and operate the ship's systems and functions

Grade-3: "The ship is controlled and operated from another location. There are no seafarers on board.

Grade-4: "The ship's operating system makes decisions and determines its actions on its own" (IMO, 2018a) (Ciğer, 2023).

Unmanned ships, according to the human element in their operation and control mechanisms

a. Always Manned Bridge/Autonomy Assisted (AAB): "The bridge is always manned and the crew can intervene immediately in ongoing operations and processes

b. Limited Unmanned Bridge (PUB): "The ship can operate without a crew on the bridge for limited periods of time, for example on high seas and in good weather. The crew is on board and can step in if there are any problems

c. Limited Manned Ship (LMS): "The ship operates without a bridge crew for long periods of time. A boarding party enters the ship or an escort boat accompanies the ship during port berthing, channel crossings, etc.

d. Continuous Unmanned Ship (CUS): "The ship is designed to operate unmanned, except in special and emergency situations. This means that there is no one on board authorized to take control of the bridge. Otherwise the ship is classified as PUB. It is possible to have maintenance crew or passengers on board" (Gözüyeşil, 2021).

IMO for the development of autonomous ships;

a. Provisional guidance on the navigational experience of MASS type ships (IMO, 2022)

b. For MASS ships; SOLAS (safety and maritime security), COLREG (collision at sea), LOADLINE (loading and stability), STCW (seafarers training), SAR (search and rescue) and TONNAGE 69 (measurement of tonnage) (Ekinci, Öztütüncü & Ertogan, 2024).

As a result of the developments in artificial intelligence, autonomous ships have started to be used in the commercial field. The use of autonomous ships and remotely controlled ships in maritime is increasing day by day (Britannica, Artificial-Intelligence, 2025). In this context, for autonomous ships;

- The MUNIN project, supported by the European Union, aims to build an unmanned expedition (Cordis, 2024),

- AAWA project by Rolls Royce and FinFerries to determine the technical specifications of the next generation of ships (Rolls-Royce, 2024)

- The Birkeland project by Yara Shipping and Kongsberg, which aims to build an autonomous and fully electric container ship (Denizcilikdergisi, 2024),

- Det Norske Veritas-DNV's Revolt project, which aims to produce an unmanned and battery-powered short-haul container ship (Denizhaber, 2024) stands out.

Unmanned ships are considered to be beneficial in many ways, as they can perform high-risk missions and do more work with less energy expenditure (Özkaya, 2023)

Artificial intelligence enables machines to perform human tasks by analyzing the data obtained with its capabilities such as learning/self-improvement, troubleshooting and decisionmaking (Ece, 2024).

Autonomous ships

a. It is equipped with sensors that monitor the ship and its functions, its environment and meteorological conditions in the area of movement

b. There are predefined options for solving the problems encountered (Gözüyeşil, 2021).

Aiming to prevent maritime accidents, IMO sets minimum standards for ships. Within the scope of the Convention on the Safety of Life at Sea (SOLAS-74), communication devices must be equipped on board (Acarer, 2023).

Ships are equipped with radars, cameras, AIS, GPS and many other sensors related to navigation systems, which allow monitoring of environmental conditions, traffic conditions and navigation routes (Yalman, Tıkız & Bamyacı, 2023).

Technologies such as the Internet of Things, big data, satellites, energy storage and blockchain constitute the stakeholders of artificial intelligence. The Internet of Things (IoT), where physical objects are connected to each other and to systems, senses the environment and analyzes data using sensors, software and other technologies to enable devices and systems to communicate with each other and transfer data (Wikipediaof ThingsInternet , 2024).

Machine learning is a technology that can make identifications and predictions with algorithms and modeling. This technology is used in many industries with the ability to learn from large data sets and predict future events (Datamarket, 2024).

The fact that the machines are in communication among themselves allows both the machines to work in coordination and to alert the relevant units in order to detect and eliminate the malfunctions that may occur in

the machines. As a result of the developments in Artificial Intelligence, M2M (Machine-to-Machine) communication has taken on a completely different structure and has become one of the important stakeholders in the use of the ship "remotely controlled" without a human on board (Acarer, 2023).

Artificial Intelligence can be used effectively in many areas such as container tracking in ships and ports, port operations, cargo management, optimization of ship fuel usage, reduction of emissions and ship maintenance. By combining data from various sources such as GPS, weather, ship traffic and real-time weather data, it will be able to redefine the routes of ships or calculate the most appropriate route in order to minimize fuel usage and reduce environmental damage. In addition, insurance premiums can be calculated by determining risk factors using accident statistics from previous years (Ece, 2024).

The control mechanisms of autonomous ships can regulate their routes, speeds and movements. By integrating the mechanical and electronic components of the ship, control mechanisms enable autonomous ships to navigate safely and efficiently (Deniztasimacilik, 2024).

The autonomous ship can solve all the problems it encounters on its own and automatically follow its planned route. In this case, the ship is not controlled by the coastal control center and there are no personnel on the bridge. Artificial intelligence calculates the risks, makes decisions and takes the necessary actions. Autonomous ships, also called smart ships, have become safer with their automatic berthing systems, collision avoidance systems and smart technologies (Gözüyeşil, 2021).

Components of Autonomous Ship Management:

- Navigation and Machinery Equipment: The use of systems such as radar, electronic charting ("ECDIS"), sounder, flare and communication devices ("AIS", "Navtex", etc.) has become widespread.

- M2M (Machine to Machine) Communication: Plays an important role in communication between ships.

- IoT (Internet of Things): Allows ships to sense their surroundings with various sensors and collect data.

- Artificial Intelligence (AI): Empowers decision-making processes of autonomous ships.

- Management and Remote Control Equipment and Software: Provides control of autonomous ships.

- Communication Systems: Facilitates data transfer between ships and land.

These components play an important role in the functioning of autonomous ships (Acarer, 2023).

In addition to being unmanned, autonomous ships also include features such as coordination of sensor networks, integrated underwater navigation and mapping, detection and tracking at sea with infrared sensors, sensor-assisted guidance and course adjustment. In addition, adaptive and cooperative control capabilities such as intelligent mission management and collision avoidance in complex sea conditions increase the safety of autonomous ships (Kara, 2020).

Autonomous ships, which can react appropriately by analyzing the situations they encounter, can quickly adapt to environmental factors and ensure navigational safety. However, in Artificial Intelligence applications, data quality is very important for decisions to be accurate and flawless, and controlling data quality to ensure that data is clean, consistent and error-free is vital for navigational safety (Ece, 2024)

Since autonomous ships rely entirely on software and computer systems, they can be more vulnerable to cyber-attacks. In order to ensure cyber security, which encompasses many aspects such as information security, operational security and computer security, there is a need to protect the confidentiality, integrity and accessibility of information (Abudu & Bridgelall, 2024).

For autonomous ships, there are serious cyber risks such as piracy, enemy attacks, diversion from their routes through methods such as GPS and AIS, and interference with ship management systems. For this purpose, measures such as identification and assessment of cyber risks, development of protection and defense mechanisms, identification of threats and implementation of response methods, backup/repair of systems are needed (Gürler, 2023). Cyber-attacks cause disruption of maritime trade, death/injury/ kidnapping, theft of sensitive data, smuggling and economic losses. This is of vital economic importance for maritime trade. If a ship sailing in narrow waters with heavy traffic, such as the Istanbul and Dardanelles Straits or the Suez Canal, is disabled by a cyber-attack, it will affect not only that ship but all ships in the region and world trade will be adversely affected.

Watchkeeping, which is the most important issue in ensuring safety of navigation, can be carried out on autonomous ships with audio technical systems, radars, cameras, sensors and other technological systems. In order to ensure the safety of navigation effectively, a system that can be used instead of human senses is needed (Gözüyeşil, 2021).

An effective lookout reduces maritime accidents to a great extent. In narrow waters such as the Bosporus and Dardanelles Straits and in seas with heavy ship traffic such as the Aegean Sea, lookout is very important. In addition, it is important for ships to navigate safely, especially at night, when traffic is heavy, noise levels are high and coastal lights are close. For this purpose, in order to provide an effective lookout on autonomous ships, the ships should be equipped with systems and equipment capable of detecting and evaluating small parts on the sea surface and detecting sound and visible signals under night conditions.

When the maritime accidents that have occurred are analyzed, it is seen that the accidents are mostly caused by human errors. Autonomous ships will reduce the number of accidents and the impact of accidents ("human injury, environmental damage, material loss, etc."). Smart ships may reduce grounding and collision accidents, but may lead to an increase in accidents such as taking on water and sinking. This situation shows that problems such as determining cyber security and insurance risks, transferring the responsibility of captains, etc.

are threats that need to be resolved (Yorulmaz & Karabulut, 2021)

Autonomous Ships in Terms of Maritime Safety:

-Cyber security threats,

-Equipment/device malfunction,

-Inaccurate/incomplete information,

-Difficulty recognizing the accident,

-to port security

are considered as potential risk factors (Yılmaz & Önaçan, 2019).

In order to intervene in possible malfunctions that may occur as soon as possible;

- A sufficient number of Emergency Repair Personnel may be assigned to each ship,

- Each company create a life cycle for their own ships and assign Emergency Repair Personnel to the centers they will establish on the most widely used / most critical routes, or to the centers to be established in coordination with more than one company, or to the centers that can be established by the regional states.

It is evaluated that the malfunctions that may occur on autonomous ships can be intervened in the shortest time possible.

The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) supports sustainable environmental projects to reduce maritime carbon gas emissions. In this context, it is planned to reduce carbon emissions from ships by "40% by 2030 and 80% by 2050" (IMO, 2020b).

Within the scope of the 2023 IMO Greenhouse Gas Strategy, in order to combat climate change in shipping;

-Measures to improve the energy efficiency of ships,

-Bastewater management, combating biological pollution and protecting marine mammals,

-Studies are being carried out on plastic package transportation and disappearing containers to combat marine litter.

Smart ships equipped with electric propulsion systems and batteries can significantly reduce operating costs and can be used in the maritime sector to achieve the zero gas emission target (Yorulmaz & Karabulut, 2021). Within the scope of the process of decarbonization of maritime transportation, environmental sustainability in maritime transportation can be achieved by using ships operating with low-carbon fuel options (Demirel, 2024).

With Industry 4.0, the need for manpower has decreased and production processes have accelerated. As a result, production costs have decreased, time has been saved and error rates have been minimized. As a result of this transformation, some professions will disappear, some professions will be transformed and some new professions may emerge (Yorulmaz & Derici, 2023).

With the developing technology, the number of crew on ships has started to decrease as seafarers have been replaced by artificial intelligence-supported decision systems. The ratio of personnel expenses to total operating expenses varies between 40-50%, and as a result of the increase in the qualifications of seafarers, wages are increasing and there are

difficulties in recruiting personnel (Acarer, 2023). However, since there will be no need for living spaces for personnel on autonomous ships, these areas can be used to carry containers, increasing the ship's cargo carrying capacity (Akhan, 2024).

It is uncertain whether an accident will occur as a result of human error at the coastal control center. As the risk of accidents decreases, insurance premiums are expected to decrease. However, how cyber risks will affect insurance premiums may change depending on the development of technology (Nalbant, 2021).

There are many problems in insuring autonomous ships, such as seaworthiness, liability, cyber risks, artificial intelligence and lack of legal regulations. For crewless ships, legal regulations such as the concept of seafarer and seaworthiness need to be updated. Autonomous ships raise many liability issues related to artificial intelligence and machines. It is necessary to determine the responsibilities and make an international regulation for insurances (Gürler, 2023). Seaworthiness refers to the ship's ability to escape from marine hazards and other possible risks. It affects many areas such as "shipbuilding contracts", "maritime insurance law", "transportation of goods by sea", "marine pollution" and "ship charter contracts" (Nalbant, 2021).

Operational characteristics of maritime transport include seaworthiness, safe navigation, maintenance, communication, risk assessment, environmental protection, safe cargo delivery and insurance coverage. The Maritime Safety Committee (MSC) has established the framework for defining autonomous ships, levels of independence and work plans. It was also decided to revisit the regulations of SOLAS, COLREGS, MARPOL and other international conventions regarding autonomous ships, such as maritime safety, environmental protection and prevention of other illegal activities at sea (Kara, 2020)

How autonomous ships will affect international conventions is still a matter of debate. Existing conventions are mostly human-based. For this reason, they have shortcomings in terms of autonomous ships and regulations are needed for technological developments. In addition, issues such as where the coastal control centers will be located, how they will function, which state will be in control, their legal status, responsibilities and cyber security are also discussed (Feyzioğlu & Yorulmaz, 2023). The question of "who uses it?" is important in determining the liability status for autonomous ships. Along with the developing technology, the law needs to develop new rules in the face of this situation (Nalbant, 2021).

In order to assess the status of unmanned ships, issues such as "ship definition", "seaworthiness conditions", "personnel requirements" and "navigation rules" should be evaluated first. There are conventions and regulations in many areas such as maritime safety, security, environmental issues and maritime crimes (Bolat & Koşaner, 2021).

Whether or not autonomous vessels qualify as ships is important for determining their legal regime. According to the definition of ship set forth in MARPOL, COLREG and Article 931 of the Turkish Commercial Code No. 6102, autonomous marine vessels are legally recognized as ships regardless of whether there is a crew on board (Yorulmaz & Derici, 2023).

Within the scope of Article 931 of the Turkish Commercial Code, a ship is defined as : "Every vehicle, which is not very small, which is capable of swimming and whose purpose for which it is allocated requires it to move in water, shall be considered as a ship in terms of this law, even if it is not possible to move spontaneously." This definition also provides an important legal framework for adapting to new technologies such as autonomous ships

The high level of autonomy of autonomous ships raises new legal issues and deviations from traditional navigation rules. Moreover, as the role of the crew diminishes, there is a need for regulatory changes and adaptation of safety standards. As artificial intelligence in autonomous ships influences decision-making processes, existing liability law fails to adapt to this new situation. Maritime safety elements such as data transfer, security and watchkeeping are becoming more important for safety of navigation (Gözüyeşil, 2021)

Article 94 of UNCLOS imposes an obligation on flag states to equip ships under their flag with appropriately qualified personnel. (Yorulmaz & Derici, 2023). Pursuant to Article 14 of the Rotterdam Rules; the carrier is obliged to equip the ship with a crew and to maintain this situation throughout the voyage (Ciğer, 2023).

Article 10 of STCW 1978 states that it is necessary to check that seafarers are equipped with the documents required by the convention. However, how port state authorities can inspect autonomous ships is one of the problems to be solved (Feyzioğlu & Yorulmaz, 2023).

The International Maritime Organization (IMO), some maritime administrations and classification societies are working to establish a legal and technical infrastructure for autonomous ships. In particular, while the validity of the provisions of STCW (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers) is

being questioned, many international conventions such as SOLAS, COLREGs and MARPOL are being considered for updating (Gürler, 2023)

Remote control of autonomous ships requires operators to be familiar with global and regional laws and operational procedures, and to be trained accordingly. The required training and qualification certificates for remote control center employees should also be determined. There is uncertainty about exemptions or additional requirements for special situations such as strait crossings, port operations, etc. In addition, studies should be carried out on issues such as flag state inspections, procedures of inspections and training requirements for inspectors (Feyzioğlu & Yorulmaz, 2023). The Regulation on Seafarers and Pilots regulates issues such as the qualifications, training, health status and watchkeeping rules of seafarers. Regarding autonomous ships, it is necessary to define remote control operators. This regulation also covers administrative sanctions for seafarers and maritime training institutions (Ekinci, Öztütüncü & Ertogan, 2024).

Although COLREGs Rule 5 provides for visual and hearing surveillance, there is no certainty as to whether this task is to be performed with the naked eye or with vehicles. Unmanned systems have the capability to perform the lookout without fatigue and distraction, and to track multiple objects simultaneously. Therefore, it requires a reorganization of the lookout rules in existing contracts (Bolat & Koşaner, 2021). In addition, in the event that the coastal control center manages more than one ship, responsibilities should be determined and the captain and crew should be defined. Whether the ships in this situation will be classified as ships with limited maneuvering power may have important legal consequences (Yılmaz, 2023).

Legal and insurance regulations regarding autonomous ships also need to be made. These regulations will provide great benefits in terms of process, cost and speed, and may contribute to the widespread use of autonomous ships. In addition, it is expected that insurance clauses or independent insurance policies specific to cyber risks and artificial intelligence will be issued and legal regulations will be made in this field (Gürler, 2023).

Autonomous ships need to be more clearly defined in legal terms. Although existing ship definitions are sufficient for autonomous ships, more specific definitions such as “smart ship”, “remotely controlled ship” and “autonomous ship” should be defined in maritime law. In addition, there will be a need for training systems for ship personnel in accordance with the emerging system. It is important for educational institutions to realize

the transformation of infrastructure and staff to train seafarers who are compatible with autonomous ship technology and who can use information systems (Yorulmaz & Derici, 2023).

Regulations on autonomous ships should be made urgently and standards for autonomous ships should be set on a universal scale

3. Advantages and Disadvantages of Autonomous Ships

With 5G technology, it allows remote information on cargo status, ship structure and machinery parts and increases fuel efficiency. While crewless ships reduce piracy risks, the risk of hacking may arise. The absence of people on board may limit the decision-making capacity of the machines and cause new risks (Kara, 2020).

By continuously monitoring environmental conditions, autonomous ships will be able to make instant decisions and respond quickly and effectively to potential risks (Yalman & Tıkız & Bamyacı, 2023)

Considering that most maritime accidents are caused by human errors, unmanned or autonomous ships managed by sensors and remote control will increase navigational safety by minimizing human errors compared to manned ships (Wang, Xu, Feng, He, Yang, Li, Yang, 2024). While smart ships reduce human-caused accidents, they may cause new accidents and create new business opportunities, but may cause employment problems (Yorulmaz & Derici, 2023).

The strengths of autonomous ships are energy efficiency, reduced operating costs, safe and efficient operation, reduced man-made accidents and environmental friendliness, while collisions, groundings and cyber-attacks are their weaknesses (Yılmaz & Önaçan, 2019).

Advantages:

a. Safety: By eliminating human errors, it reduces maritime accidents and increases navigational safety (Ece, 2024).

b. Environmental Sustainability: It reduces environmental damage by reducing fuel consumption and minimizing carbon emissions (Yorulmaz & Karabulut, 2021).

c. Cost: It reduces operating costs by saving on items such as personnel and fuel costs (Ece, 2018).

d. Efficiency: The thinking and decision-making speed of artificial intelligence saves time and increases operational efficiency (Yorulmaz & Derici, 2023).

Disadvantages:

a. Safety: Failures in artificial intelligence or the inability to transfer data effectively and cyber-attacks may cause unexpected problems and threaten the safety of ships (Ece, 2018).

b. Unemployment: The unemployment rate may increase as a result of the decrease in the number of personnel in ships and maritime trade sectors (Yorulmaz & Karabulut, 2021).

c. Artificial Intelligence: The absence of humans on board may lead to erroneous decisions in the face of first-time/unexpected situations (Gözüyeşil, 2021).

d. Legal Deficiencies: Since the legal status of autonomous ships is not regulated, it may increase the level of risk for possible incidents/accidents that may arise and increased costs (Kara, 2020).

While autonomous ships offer great advantages such as increasing safety, reducing environmental impacts and lowering costs in maritime transportation, they face disadvantages such as technological risks, labor loss and legal uncertainties. In the future, it is important to develop safety measures and legal regulations for these systems to realize their full potential.

4. Conclusion and Evaluation

With the integration of autonomous ship technology into shipping, it is assessed that efficiency in maritime transportation, maritime safety and ship security will increase, new business areas will emerge, environmental impacts, maritime accidents and costs will significantly decrease, but cyber risks will emerge and unemployment will increase

In order to ensure the effective use of autonomous ships, there is a need for legal arrangements. The responsibilities of stakeholders should be clarified by making improvements and arrangements at the international level in the existing legal regulations regarding the use of autonomous ships. In this process, the new responsibilities of ship owners, software developers, manufacturers, insurance companies, shipyards and traffic systems operators need to be managed through effective regulation. In order to successfully complete this transformation process, all stakeholders should act in coordination and international cooperation should be strengthened.

In order to ensure safety effectively, autonomous ships will to be

- Equipping the navigation systems with highly sensitive systems/ equipment that can provide effective surveillance and ensure complete safety of navigation and prevent accidents,

- Equipping the system/hardware to ensure uninterrupted data flow,

- Taking measures to intervene in possible failures that may occur as soon as possible, will be required.

Considering that autonomous ships will be managed by artificial intelligence, artificial intelligence should be organized in such a way that it can make decisions against situations/events that may arise for the first time at sea by using its experiences like a human

For wider adoption of autonomous ship technology, it is important to establish a comprehensive industry-wide roadmap. The future of maritime transportation depends on effective management of digital transformation and timely updates to legal frameworks.

In order to ensure the effective use of autonomous ships, there is a need for future studies to examine legal regulations and to conduct detailed studies on data related to navigational safety, ship security and cyber security.

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