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E-mail: info@european-science.org
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CONTENT

ECONOMIC SCIENCES

JURIDICAL SCIENCES

MEDICAL SCIENCES

PEDAGOGICAL SCIENCES

PHILOLOGICAL SCIENCES

PHYSICS AND MATHEMATICS

SOCIAL SCIENCES

TECHNICAL SCIENCES

ECONOMIC SCIENCES

THE ROLE OF FISCAL POLICY IN ECONOMIC REGULATION

Aliyev R.,
PhD in Economics, Associate professor, UNEC
ORCID: 0000-0002-0651-4913
Baku, Azerbaijan
Hasanzade R.
Undergraduate Student, Boston University, USA
ORCID: 0009-0001-9914-6194

ABSTRACT

This article analyzes the current state of the economy of the Republic of Azerbaijan and its fiscal policy. Alongside comparative analysis, the study utilizes a historical research methodology and conducts investigations. Additionally, specific analyses related to Azerbaijan in the Economic Freedom Index are included.

Keywords: economic regulation, growth, rule of law, fiscal policy, development.

Introduction

Under the conditions of a market economy, the primary task facing the Republic of Azerbaijan is to establish a truly democratic legal state based on diverse and equal rights for ownership and entrepreneurship, aligned with the progressive trends in the development of global states. Ensuring this balance in a globalized world is indeed a highly complex economic challenge.

In the modern economic environment, the goal is to create an efficient economy in the country by advancing production and its structure, based on high technology and techniques, in a manner that can meet the social and cultural needs of the population while improving the material interests of the citizens. Naturally, the role of the state in ensuring the normal functioning of the economic system is invaluable. The interaction between the state and the economy is one of the fundamental issues. Based on global experience, the state's influence on the economy is implemented in three main directions:

– Implementing an intervention policy corresponding to the adverse effects on the economy;

– Attempting to subordinate the economy to state control;

– Hindering economic development, thus causing deformations.

Considering the above points, it can be stated that state intervention in the economy can lead to either negative or positive trends in the economic development of any country. In the modern context, states predominantly favor the third approach.

It is more appropriate to determine the role of the state in a market economy by distinguishing three possible types of state activities. These functions primarily include increasing efficiency, ensuring equity, and stimulating macroeconomic stability and growth. Increasing efficiency refers to addressing negative manifestations arising from the natural development of the market economy, such as environmental pollution, monopolization, and similar issues. As Adam Smith stated, the advantages of the market mechanism are realized only when perfect competition is established. The existence of such a condition ensures that all goods and services are exchanged in the market at their true value, preventing any buyer or seller from influencing market prices or the market as a whole.

Since monopoly—a process contrary to competition—has a profoundly negative impact on economic efficiency, combating it holds significant importance in modern state economic policy. The antitrust legislation first adopted in the United States was later implemented in unique forms across various countries. In the Republic of Azerbaijan, there is antitrust legislation as well as laws on competition, and to ensure the implementation of these laws, a special institution—the State Antimonopoly Policy and Support for Entrepreneurship Committee—operates. The main duty of this state body is to strengthen perfect competition and ensure the operation of the "invisible hand" in the economy. Such a mechanism, in turn, ensures the efficient use of resources and brings the economy closer to its production possibilities frontier. By ensuring that all economic sectors operate within the framework of perfect competition, the state creates conditions for markets to produce all the goods needed by society using the highest technologies and minimal resources.

However, fulfilling this task is complicated by the fact that the main characteristics of the market economy do not align with the criteria of perfect competition. The primary factors causing this mismatch include imperfect competition (e.g., monopolies), externalities (e.g., environmental pollution), and the need to ensure public welfare (e.g., national defense), all of which lead to the wastage of society's material wealth in various ways. In such a situation, only the power of the state can ensure the simultaneous and optimal resolution of all problems.

It should be noted that the foremost factor reducing market efficiency is imperfect competition or monopoly. While in a perfect competition environment no firm can significantly influence market prices, monopolistic conditions dictate the opposite. For example, if a telephone company or a labor union can influence telephone service or labor markets, respectively, it indicates the existence of a monopoly, regardless of whether it is accompanied by positive or negative outcomes. In cases where monopolization is inevitable and cannot be eliminated, the state strives to neutralize its

negative effects through direct intervention. Throughout the 20th century, most states pursued strict intervention policies to mitigate the consequences of imperfect competition. This primarily manifested in the regulation of prices and control over the income of monopolies.

Another issue that attracts significant attention from the state in a market economy is externalities. As technology and innovation advance, the scale of negative externalities the state has to address expands. Due to overall development, the volume of harmful products such as energy, chemicals, and other hazardous materials continuously increases, which makes combating these problems more challenging, including addressing the growing threat of environmental pollution. Solving such global problems requires not just the efforts of individual states but the combined efforts of all countries worldwide.

From this perspective, state regulation focuses significantly on addressing the negative externalities of production, such as water and air pollution, destructive use of natural resources, toxic waste, dangerous drugs, radioactive materials, and so on. All similar state efforts, from implementing safety measures in automobiles to regulating nuclear testing, ultimately serve one purpose: to enhance the general welfare of society, including economic well-being.

To fulfill its important responsibilities, the state must possess substantial financial resources. Taxes serve as the primary source of such resources. By adjusting tax rates for different incomes, offering tax incentives, and lowering the minimum levels of taxation, the state influences the economic cycle and seeks to ensure high rates of growth. One of the main tendencies of a market economy is the existence of a mechanism for distributing income based on the principles of social justice and equity. Earlier, the irreplaceable role of the state in efficiently utilizing the material and intellectual resources of society and ensuring the economy operates at its maximum production capacity was explained. However, even when such a condition is fully established, the state alone can ensure that the market economy operates on the basis of social equality.

The issue lies in the fact that numerous factors influence income—natural talent, education, inheritance, luck, as well as distortions in governance, such as corruption and organized crime—which contribute to income inequality. It should be noted that transfer payments provided by the state to the elderly, disabled, unemployed, and other disadvantaged individuals are one of the key factors in ensuring a fair distribution of income. Another method includes state subsidies to low-income groups, as well as grants in the areas of food, housing, and healthcare. Although such subsidies are relatively small compared to total income, they are accompanied by noticeable changes in the social and material security spheres.

Despite the extensive scope of the state's intervention in the economy, the free play of forces continues to give rise to chronic issues. Problems such as inflation, unemployment, and production crises, which accompany market economies, have only lost their severity in recent decades under the influence of comprehensive state economic policies.

A Theoretical Perspective on Fiscal Policy in the Creation of the Public Sector

As society developed, the role and functions of finance, taxation, and the budget in societal life changed. The comprehensive theoretical substantiation of finance, taxation, and the budget is a relatively recent phenomenon. Before the 17th century, all concepts about finance, taxation, and the budget were random and unsystematic, making it impossible to regard them as serious theoretical works. Over time, the transformation of temporary and extraordinary taxes into regular and general payments led to their rejection by the population. Such a situation required financial science to theoretically justify taxation.

The main theories of fiscal policy emerged from the 17th century onward as reviews of important economic principles. In economic literature, these are referred to as "general fiscal policy theories." The main directions of these theories were shaped under the influence of societal economic development. Generally, fiscal policy theories refer to a system of knowledge about the essence and nature of finance, taxation, and the budget, as well as their place, role, and significance in society. In other words, fiscal policy theories reflect various models for organizing the state's financial, taxation, and budget systems.

In a broader sense, fiscal policy theories encompass both general scientific and theoretical research (general theories of finance, taxation, and budgets) and specific issues of taxation (specialized tax theories). Theories addressing the ratio among different types of taxes, the number of taxes, tax rates, and so on are called specialized tax theories. The theory of a "Unified Fiscal Policy" can be cited as an example of these specialized fiscal policy theories.

Thus, while general fiscal policy theories determine the overall purpose of taxation, finance, and the budget, specialized fiscal policy theories scientifically explain which types of taxes should be applied and their structure.

General Fiscal Policy Theories

One of the earliest general fiscal policy theories is the exchange theory. This theory is based on the reciprocal nature of taxation. The essence of the theory lies in the idea that taxpayers receive protection from external attacks and are provided with stable public conditions in exchange for the taxes they pay. This theory is only valid for the Middle Ages when military and legal protection was directly provided in exchange for taxes and fees. In such conditions, the exchange theory formally reflected the existing relationships.

During the Enlightenment, a variation of the exchange theory, known as the atomist theory, emerged. Its proponents included French Enlightenment thinkers like Sebastien Turgot, who developed the public exchange theory, and Charles Montesquieu, who proposed the social contract theory. According to this theory, taxation is the result of a contract between the state and its citizens. Taxpayers, in exchange for protection, public order, and other such services, pay taxes to the state. Just as no one can refuse the services provided by the state, no one can opt out of paying taxes. Such a contract is beneficial for citizens, as even the weakest

state can protect its citizens better and more cost-effectively than individuals can protect themselves independently. This perspective was supported by the English philosopher Thomas Hobbes and French thinkers like Butler and Honore Mirabeau.

In the first half of the 20th century, Swiss economist Jean Charles Léonard de Sismondi, in his work "New Principles of Political Economy," argued that taxes should be seen as the price paid by citizens for the services they receive from the state. The modern version of Sismondi's exchange tax theory forms the basis of contemporary exchange theories. During the same period, another theory emerged that viewed taxes as insurance premiums. Proponents of this theory included French statesman Adolphe Thiers and English economist John Ramsay McCulloch. According to them, taxes are insurance premiums paid by citizens to the state in case of risks like war, fire, or theft. However, unlike real insurance, taxes are not paid to receive compensation when risks occur but to finance the government's expenses for national defense and public order.

The insurance idea, which underpins this theory, can only be valid if the state undertakes the obligation to pay compensation to citizens in case of risk. For example, in Russia, under the "On Property in Russia" law of December 24, 1990, damages caused to property owners by criminal acts could be compensated by the state based on a court decision. However, this obligation was not directly linked to taxation and was effectively discontinued after Russia introduced a new tax system in 1992.

Thus, while the state's obligation to compensate for damages was established in Russian legislation, it was related more to political objectives than to taxation.

Classical Tax Theory

This theory was developed at a high scientific level and is associated with the names of English economists Adam Smith, David Ricardo, and their followers. Proponents of this theory viewed taxes as a type of state revenue that should cover government expenditures. Consequently, other roles of taxes, such as economic regulation, insurance payments, or service fees, were not considered.

This position was developed by Adam Smith and was based on the theory of market economy. In a market economy, meeting individual needs is ensured by granting economic and operational freedom to individuals. Adam Smith opposed the centralized management of the economy. He argued that the market economy has its own laws and that all processes occurring in the economy are subject to these laws. In his work "The Wealth of Nations," Adam Smith thoroughly analyzed the laws of the market economy and demonstrated that free competition, which is one of the main attributes of the market, leads prices to increasingly align with production costs. This, in turn, optimizes the allocation of resources within sectors.

Smith believed that the state should ensure the development of the market economy by protecting property rights. To perform these functions, the state requires appropriate resources. In a market economy, the share of direct state revenues (from state-owned properties) significantly decreases. As a result, tax revenues become the primary source for covering state expenditures. Regarding other expenses, such as the construction and maintenance of roads or the operation of judicial institutions, Smith argued that they should be financed by fees paid by interested individuals. He also believed that taxes are non-compensatory by nature, and thus fees and charges cannot be considered taxes.

Polish economist Marie Esprit Léon Walras, a representative of classical theory, argued that the sole purpose of taxes is to finance state expenditures. The concept that taxes serve as a means to fill the state treasury is linked to the "night-watchman state" concept. However, the development of economic relations led to the transformation and softening of this theory.

Proponents of neoclassical tax theory, while not denying the impact of taxes on the economy, argued that taxation must be carefully considered to avoid disrupting economic processes. It is evident that classical theory does not hold up entirely, as it is practically impossible to channel one-quarter of the gross national product into the budget without causing serious economic consequences. Tax collection limits citizens' purchasing power, reduces entrepreneurs' investment opportunities, and indirect taxes raise product prices, negatively affecting consumption. All of this demonstrates that taxation significantly influences many economic processes in society.

Keynesian Tax Theory

One of the most important economic theories in the field of taxation is Keynesian theory. This theory was developed by English economist John Maynard Keynes. The main idea of this theory is that taxes are a key tool for regulating the economy and that it is impossible to develop the economy without them. According to Keynes' ideas, expressed in his book "The General Theory of Employment, Interest, and Money," economic growth depends on monetary savings under conditions of full employment. However, achieving full employment is practically impossible. In such circumstances, large savings become a passive source of income and, since they are not invested in production, they hinder economic growth. To eliminate these negative effects, savings must be collected into the budget through taxation.

Monetarist Tax Theory

The monetarist tax theory, proposed by Chicago University professor Milton Friedman in the 1950s, is based on the quantity theory of money. According to Friedman, the economy can be regulated through monetary circulation, which depends on the quantity of money and interest rates. Unlike Keynesian economic theory, Friedman did not consider taxes the main tool for economic regulation. In his view, taxes, along with other economic mechanisms, influence monetary circulation. Through taxes, excess money is withdrawn from the population.

According to both monetarist and Keynesian theories, taxes eliminate factors that negatively affect economic development.

Supply-Side Tax Theory

The supply-side tax theory, which places relatively more importance on taxation as a factor in economic development and regulation, was formed in the mid-1980s by American economists M. Burns, G.

Stein, and A. Laffer. This theory is based on the premise that high tax rates negatively affect entrepreneurship and investment activity, which ultimately leads to a decrease in tax payments. Proponents of this theory advocate for lowering tax rates and providing significant incentives to enterprises. They argue that reducing tax rates leads to rapid economic growth.

Specialized Fiscal Policy Theories

Among specialized fiscal policy theories, one of the earliest is the theory of the ratio between direct and indirect taxes. In the early stages of European civilization's development, the adoption of direct and indirect taxes depended on the political development of society. In medieval European cities, tax systems were primarily based on direct taxes. It was believed that indirect taxes, by increasing prices, negatively affected the population's situation and were more challenging to pay. Later, as the aristocracy gained strength to suppress public resistance, indirect taxes began to be implemented more widely. Indirect taxes were especially applied to essential goods, such as salt. Thus, during the Middle Ages, indirect taxes were viewed negatively.

By the late Middle Ages, a second perspective emerged, justifying the necessity of indirect taxes. It was argued that indirect taxes enabled the implementation of equitable taxation. Nobles, who used various exemptions, avoided paying direct taxes. Proponents of indirect taxes sought to compel privileged classes to pay taxes by implementing indirect taxation. They viewed indirect taxes as a means of creating equality in taxation. Adam Smith and David Ricardo, emphasizing the principle of voluntariness, also supported indirect taxation. This principle suggested that direct taxes were heavier than indirect ones, as individuals could avoid indirect taxes by not purchasing taxed goods.

By the late 19th century, economists debating the necessity of direct and indirect taxes concluded that it was essential to balance these two types of taxation. They argued that direct taxes were necessary to ensure equality in taxation, while indirect taxes were needed for efficient collection.

The Theory of the Single Tax

Another specialized tax theory is the single tax theory. It is worth noting that this theory addresses not only taxation but also broader social and political issues. The idea of a single tax gained popularity at various times. For instance, in 18th-century England, there was a political party whose slogan was "A Single Tax on Land." Advocates of the single tax claimed that its implementation would eliminate poverty and lead to increased production across all industrial sectors.

A single tax is a unique tax applied to a specific taxation object. Different theorists have proposed various objects for single taxation, such as land, expenses, income, capital, and others. One of the earliest forms of the single tax is the tax on land rent. The idea of applying this tax was put forward by the physiocrats. They considered agriculture the primary production sector and argued that industrial activities did not contribute any net income. All wealth, they claimed, was concentrated in the land and derived from it. Therefore, they proposed a single tax on land rent as the sole source of revenue. Accordingly, this tax would be paid exclusively by landowners. To justify this single tax, they relied on the idea of the "universality of land." They argued that land is a divine gift and belongs to everyone. However, in reality, land is owned by specific individuals who hold the sole source of wealth and, therefore, should pay the single tax.

In the 19th century, Henry George advanced the idea of the "single land tax," viewing it as a means of ensuring general prosperity and creating social harmony. It should be noted, however, that the single tax theory cannot be considered a progressive theory. Despite some advantages, such as simplicity in calculation and payment, the theory is utopian and practically impossible to implement. Nonetheless, the application of a single tax in conjunction with other taxation systems could yield positive results. The idea of a single tax is also reflected in Russia's tax system. According to the federal law "On the Simplification of Accounting and Reporting for Taxation" (effective December 24, 1995), some small enterprises and entrepreneurs could pay a single tax calculated based on the results of their economic activities during the reporting period, instead of numerous federal, regional, and local taxes. The implementation of such a tax in Russia can be seen as a progressive step, as it simplifies taxation for small business entities.

Progressive and Proportional Taxation

The social and political nature of taxes has significantly influenced the theoretical aspects of taxation. This is particularly evident in the theories addressing the ratio between progressive and proportional taxes. Taxes, being a means of expropriating part of the property, reflect class and group interests as well as the balance of social forces. According to the theory of proportional taxation, taxes should be levied at a uniform rate, regardless of income level. This idea has always been supported by wealthier segments of the population, as it aligns with the principles of equality and social justice.

In contrast, progressive taxation implies that tax rates increase as income levels rise. Progressive tax rates were positively evaluated by socialist ideologues Karl Marx and Friedrich Engels, who argued in the Communist Manifesto that progressive taxation could play a role in abolishing private property and establishing socialism. Although the theory of progressive taxation emerged in the late 19th century, elements of this theory can be found in the works of Adam Smith, as well as French Enlightenment thinkers like Jean-Jacques Rousseau and Jean-Baptiste Say.

Proponents of progressive taxation argue that it reduces inequality and influences the redistribution of income and wealth.

Tax Shifting Theories

One of the fundamental issues in taxation, reflected in tax theories, is the concept of "tax shifting." Although this issue has significant practical importance, it has been underexplored. The essence of tax shifting theories lies in the idea that the distribution of tax burdens is possible only during the process of exchange.

Methods of Fiscal Policy

In a globalizing world, the independent actions of entrepreneurs do not always lead to successful economic outcomes. For this reason, it is advisable for the state to intervene in entrepreneurial activities through certain economic instruments. Currently, it is appropriate to classify the market regulation methods in the Republic of Azerbaijan as follows:

1. State methods;
2. Non-state methods.

Of course, each method has its specific characteristics. Through state methods, the government has the ability to influence the entire political and economic life of the country, which inevitably affects the economic life of the entire population. Experience shows that the state, in one way or another, identifies the opportunities to meet the needs of every citizen. The methods by which a state regulates its economy are among the most intriguing economic issues.

Since gaining independence, the Republic of Azerbaijan has been implementing its economic policies in the direction of private property ownership and the functioning of market mechanisms.

As a continuation of the political and economic reforms initiated by the national leader Heydar Aliyev, the political and economic role of our country in the modern economic environment has significantly changed, transforming Azerbaijan into a regional power. The successful reforms have been diligently continued, expanded, and brought to new heights by the successor of Azerbaijan's political-economic course, President Ilham Aliyev, resulting in the creation of a new model for state regulation of the economy through market mechanisms.

In leading countries of the world, state regulation is primarily implemented through laws, the main economic tool of taxation, regulating monetary circulation, and ensuring production infrastructure (such as industrial parks).

Based on the above, reforms should be carried out in a way that prevents discrimination among different social groups in the country. In this regard, special attention should be paid to the social functions fulfilled by economic reforms implemented by the state.

The state continually oversees the implementation of activities in areas of economic activity that are not attractive for entrepreneurship. These areas include sectors where the application of special investments is not profitable. According to global practice, these are primarily material and non-material production sectors that require long-term investments. Such areas generally include:

- Education;
- Healthcare;
- Other material production sectors.

In the modern economic environment, significant efforts are being made to direct the income generated from Azerbaijan's oil sector toward the development of a new, diversified economy.

According to economic theory, world-renowned economists P. Samuelson and V. Nordhaus believe that in a modern mixed economy, the primary economic functions of the state include the following:

1. Establishing the legal foundations for the economic activities of legal and natural persons;
2. Implementing a macroeconomic stabilization policy;
3. Facilitating the allocation of resources to improve economic efficiency;
4. Developing programs that impact income distribution.

Currently, it can be said with full confidence that the preparation of legislative acts and regulations on macroeconomic regulation in the Republic of Azerbaijan is being carried out at the necessary level under the leadership of the country's administration.

It can also be confidently stated that since the late 20th century, statehood in the Republic of Azerbaijan has been significantly strengthened and has been utilized to safeguard common interests and the overall economic system.

Another important economic strategy implemented in our country is ensuring macroeconomic stability. The priority issue in achieving macroeconomic stability is mitigating industrial cycles in the country. This, in turn, involves specific economic measures aimed at addressing unemployment and inflation in our republic.

For this purpose, the following methods are utilized:

1. Regulating the economy through taxation;
2. Regulating the money supply in the country's balance of payments.

The methods listed above individually serve to implement the state's specific economic policies. Among them, regulating the economy through fiscal and budgetary tools is the essence of the state's fiscal policy, while regulating the money supply in the balance of payments constitutes the main focus of monetary methods.

Conclusion

The monetary and financial-credit system plays a crucial role in ensuring economic stability. Intervention in the monetary and financial-credit system refers to the implementation of flexible tax policies, proper credit strategies, and the regulation of monetary circulation in the country. A positive effect of the state's influence on the economy is preventing dangerous stratification among producers and maintaining balance. The following methods, tested and proven effective in global practice, can be highlighted for ensuring competitiveness:

1. Progressive income taxation;
2. Setting low prices for goods that ensure a minimum standard of living;
3. Training and retraining of specialists, and the creation of new jobs.

When the state intervenes in the economy, the following economic elements must be consistently monitored:

- Ensuring minimum wages and pension guarantees;
- Indexing incomes as prices change;
- Providing benefits to temporarily unemployed individuals, and others.

One of the main objectives of the state's monetary policy is the issuance of additional monetary resources

into circulation to artificially enhance consumers' purchasing power. The essence of this goal is as follows:

Another fundamental issue of monetary policy is preventing deep inflation and maintaining it at a specific level.

Based on the above, it can be concluded that one of the primary tasks of the state's influence on the economy is to help distribute resources in a socially just manner. The implementation of such an economic-political approach is one of the key aspects of ensuring macroeconomic stability.

Non-state methods are also used in regulating the country's economy. In this case, the main focus is placed on the following economic elements:

- Sales markets;
- Various associations that agree on prices;
- Banks;
- Stock exchanges;
- Fairs;
- Wholesale trade centers;
- Currency auctions;
- Information systems, and others.

As the economy operates as an inseparable part of the state in a globalizing world, the methods of its regulation must be continuously improved, advanced practices must be widely utilized, and measures must be taken based on specific circumstances.

References

1. Terri Miller, Antony B. Kim, and James M. Ruberts, 2019 Index of Economic Freedom (Washington: Heritage Foundation).

2. Kane, T., Holmes, K.R., & O'Grady, M.A. (2007). 2007 Index of Economic Freedom. Washington, DC, and New York: The Heritage Foundation and Dow Jones & Company, Inc. Retrieved May 22, 2007, from http://www.heritage.org/research/features/index/downloads/Index2007.pdf.

3. Issaka Dialga & Thomas Vallée, 2015. "The Index of Economic Freedom: Methodological Matters," Working Papers hal-01178202, HAL.

4. European Bank for Reconstruction and Development, Country Strategies, 2011–2018. Available at https://www.ebrd.com/pages/country.shtml.

5. World Economic Outlook Database, April 2018. Available at https://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx.

DETERMINANTS OF INTRA-INDUSTRY TRADE BETWEEN GEORGIA AND SELECTED EUROPEAN COUNTRIES AND TURKEY

Paksadze I.,
PhD
Georgia
ORCID: 0000-0003-3772-9308
Çelik T.,
Professor
Kayseri University
Turkey
ORCID: 0000-0003-2667-4786
Rahman M.N.
Assistant Professor
Niğde Ömer Halisdemir University
Turkey
ORCID: 0000-0001-5301-1107

ABSTRACT

When Georgia's foreign trade structure is examined, it is seen that it is an important trade partner of Turkey and the European Union. Although Georgia wants to increase its foreign trade with liberalization policies, it has a foreign trade deficit because of production diversity and insufficient volume. As the financing of the foreign trade deficit with foreign capital and debt is not sustainable in the long term, measuring the level of intra-industry trade and the factors that determine trade of Georgia with its trade partners become important. In this context, the main purpose of the study is to measure Georgia's intra-industry trade with selected European countries and Turkey and to determine its determinants. The study period covers for the year 2008-2022. The Grubel-Lloyd index, that is frequently preferred in the literature, was used to measure Georgia's intra-industry trade with its trade partners, and the system generalized moments (GMM) method, that is a panel data estimation method, was used to estimate the determinants of intra-industry trade. When Georgia's average intra-industry trade index for the year 2008-2022 is examined; it is revealed that it has more intensive intra-industry trade with Germany, Italy, England, Netherlands, Greece and Turkey than other selected EU member countries. In addition, Georgia has very low intra-industry trade with Sweden, Austria, Czech Republic, Romania and Bulgaria. Furthermore, the system GMM estimation results show that the market size (GDP), per capita GDP indicating the level of development and foreign trade deficit between trading partners positively affects intra-industry trade, while the market size difference between countries, per capita GDP difference, trade imbalance and physical distance increase reduce intra-industry trade.

Keywords: Georgia, European Union, Türkiye, Intra-industry trade, GMM.

Introduction

Classical international trade theory suggests that countries should focus on producing goods in which they have a comparative advantage. However, with the deep integration of nations into the global economy after World War II, foreign trade between countries has become more complex and cannot be explained by classical trade theories. The increasing trade of industrial products, especially among developed countries, has not met the expectations that countries will specialize in certain sectors depending on their density. The increase in trade between countries with the same or similar factor endowments could not be explained by classical foreign trade theories, and intra-industry trade theory was put forward. Intra-industry trade refers to the exchange of similar products belonging to the same industry. In other words, intra-industry trade is a form of foreign trade based on the simultaneous import and export of products that fall into the same industry class but have some differences in terms of quality, appearance, brand and usage characteristics.

There are numerous studies on intra-industry trade in existing literature. These studies can be generally divided into two groups where the first group focuses on explaining the reasons for the existence of intra-industry trade while the second group focuses on measuring the extent of intra-industry trade. Although the concept of intra-industry trade was used only to explain trade between countries when it first emerged, it began to consider not only whether intra-industry trade exists or the degree of intra-industry trade, but also the factors affecting this trade in later periods. Although there are numerous empirical studies in the literature that contribute to the determinants of intra-industry trade, most of them have focused only on developed countries where trade flows are equivalent due to similar demand structures and production technologies. For this reason, studies on the determinants of intra-industry trade in developing countries have been insufficient. The production of goods and mutual trade in developing or underdeveloped countries are less compared to developed countries; however, this does not mean that intra-industry trade does not exist among underdeveloped countries.

After gaining independence in 1991, Georgia experienced political turmoil and economic fluctuations until 2008. The delays in transitioning to a liberal economy are one of the main features of this period. However, Georgia's strategic location has strengthened

Russia's control over the country, while at the same time strengthened the West's desire to get closer to Georgia, that led to increased cooperation. Following the end of the war in Georgia in 2008, the country's dependence on Russia for foreign trade has decreased, and the increase in trade with the European Union and Türkiye has been one of the main reasons for this change.

Georgia, strategically located at the center of transit trade to Europe, has attracted the attention not only to the West but also to China within the scope of the New Silk Road Project. Georgia, which is trying to gain a more active place in world trade, evaluates the transit passage of products and energy transmission lines from China as an opportunity to overcome the current account deficit problem caused by external dependency, especially in sectors such as oil and technology. Georgia anticipates that the income to be obtained from transit trade will partially cover its foreign trade deficit and therefore aims to eliminate its external deficit in the long term by developing its intra-industry trade with Europe and Türkiye. Furthermore, considering that financing the external deficit through foreign capital and partial borrowing is not sustainable, Georgia has put into many practices that encourage direct foreign capital investments. However, the fact that the foreign direct investments in the country are largely directed to non-productive areas such as construction and gambling tourism that clearly demonstrates the importance of intra-industry trade that Georgia carries out with its trade partners.

In this context, the main purpose of the study is to measure the level of intra-industry trade between Georgia, which is in the category of transition economies, and selected European countries and Türkiye, and to analyze the determinants of this trade. In this context, the intra-industry trade levels of STIC Rev4 Level 1 (1 Digit) sub-sectors were measured using the Grubel and Lloyd index. In addition, the Grubel-Lloyd index and 10 different estimation models were used to reveal the determinants of trade. First, the theoretical approaches and literature of intra-industry trade were examined. Then, the factors determining intra-industry trade and relevant academic studies in this field were discussed. In the last section, that includes econometric analyses, applications made to reveal the determinants of intra-industry trade between Georgia, selected European countries and Turkey were included.

1. Intra-Industry Trade: Theory and Literature

Intra-industry trade is a concept that has gained importance with the liberalization of world trade. With the end of World War II, countries living in close geographies and having economic relations around the world have initiated economic unification movements among themselves. In addition, during this period, multi-faceted negotiations were held within the framework of GATT for the liberalization of international trade, reduction of customs duties, removal of bureaucratic barriers in world trade and paving the way for bilateral trade. Due to all these developments, intra-industry trade, which is defined as simultaneous and reciprocal trade of similar goods in the same product category, has constituted a significant part of world trade. Intra-industry trade refers to the exchange of similar products belonging to the same industry. The concept of intra-industry trade is generally used in international trade where the same type of goods or services are both imported and exported. In this type of trade, all goods from 0 to 9 that fall into the SITC goods classification are included in the trade.

According to Nigel Grimwade (1989), an explanation for intra-industry trade cannot be found within the framework of Classical and Neo-classical trade theories. These theories only predict inter-industry specialization and trade. Traditional foreign trade theories are based on David Ricardo's and Heckscher-Ohlin theories that attempt to explain the formation of international trade. Both offer the idea of comparative advantage and an explanation of why countries trade. However, many economists state that countries with the same factor endowments will not trade domestically and will not produce goods, which suggests that these models provide no explanation for intra-industry trade. For this reason, some economists have developed new explanations for intra-industry trade. According to a view put forward by J.M. Finger in 1975, intra-industry trade was considered "unimportant" because existing classifications placed goods with heterogeneous factor endowments in a single industry. However, it is observed that intra-industry trade continues even when industries are separated in detail. Therefore, this evidence should be ignored (Finger, 1975).

In general, the most comprehensive and widely accepted explanation in the literature is Paul Krugman's New Trade Theory. According to Krugman, economies specialize in benefiting from increasing returns rather than following differences in their regional equipment (as claimed by the Neoclassical theory). Trade allows countries to specialize in a limited variety of production and thus to benefit from increasing returns (i.e. economies of scale) but without reducing the variety of goods available for consumption (Krugman, 1981).

There are also those who defend the opposite view to that advocated by J.M. Finger (1975) and Paul Krugman (1981). One of those who defend the opposite view is the American economist Donald R. Davis. Donald R. Davis argued that both the Heckscher-Ohlin and Ricardo models are still valid in explaining intra-industry trade. According to Donald R. Davis, the models developed by Heckscher-Ohlin and Ricardo show that intra-industry trade can still occur in the traditional environment even with constant returns to scale. In addition, the Heckscher-Ohlin and Ricardo models argue that countries with the same factor endowments can still trade due to differences in technology (Davis, 1995).

As can be seen, there have been multiple views and definitions regarding intra-industry trade depending on different periods. In addition, technological developments that emerged with the liberalization of world trade, mass production and product diversity increased, and thus, international trade was divided into two different types: intra-industry and inter-industry trade. On the other hand, intra-industry trade has been divided into multiple and complementary subgroups regarding the nature and characteristics of the product.

In the existing literature, there are multiple different calculation methods for measuring the level of intra-industry trade. These methods are classified into two separate groups as static and dynamic measurement methods and were put forward by different researchers in different periods (Llyod and Lee, 2002; Yuan, 2012).

Static measurement methods generally assess the level of intra-industry trade using data from a specific period. These methods measure the intensity of trade between products at a specific time period but usually provide a single snapshot and do not take into account changes over time. For example, the methods proposed by Grubel and Lloyd (1975), Greenaway and Milner (1983), Brülhart (1994), Menon & Dixon (1997) and Azhar & Elliott (2008) are static measurement methods.

Dynamic measurement methods, unlike static measurement methods, evaluate the evolution of intra-industry trade over time. These methods try to understand the dynamics of intra-industry trade by following trade flows in a certain period. Shelburne (1993) marginal intra-industry trade index (MIIT) is a dynamic measurement method. In addition, the indices put forward by Verdoorn (1960), Michaely (1962), Kojima (1964), Balassa (1966), Aquino (1978), Loertscher & Wolter (1980), Glejser et al. (1982), Hamilton and Kniest (1991), Greenaway et al. (1994), Thom and McDowell (1999) are also dynamic measurement methods and all of these indices are designed to capture changes over time (Andresen, 2010).

In this study, the Grubel-Lloyd index, which is the most frequently used index by researchers in measuring Georgia's intra-industry trade between European countries and Turkey, was used. The index, developed by Herb Grubel and Peter Lloyd, is generally formulated as follows:

$$IIT_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} * 100$$

In this equation, IIT_i is the intra-industry trade coefficient, X_i is the exporter of product i, M_i is the importer of product i, $(X_i + M_i)$ is the foreign trade volume of product i, $|X_i - M_i|$ is the foreign trade balance of product i. The intra-industry trade value measured by this equation is valued between 0 and 1. As the value approaches 0, the intra-industry trade level decreases, while as it approaches 1, the intra-industry trade level increases. When the value of exports fully covers the value of imports, the index value is equal to 100, and when exports are made and imports are not made, or vice versa, the index value is assumed to be zero (Grubel and Lloyd, 1975).

1.1.Determinants of Intra-Industry Trade

Intra-industry trade is shaped by the influence of economic, political and socio-cultural factors between countries. Country-specific determinants include elements such as a country's economic situation, per capita income level, development level, factor endowment, and level of economic and political integration. These factors significantly determine the direction and volume of trade between countries. Industry-specific factors depend on the structural characteristics of a particular sector; human capital intensity, technological development, economies of scale and degree of product differentiation are prominent elements in this context (Hartman-Hendreson and Sheldon, 1993; Bano, 2013).

Political and institutional determinants also have a significant impact on trade. Regulations such as trade agreements, tariffs, export and import incentives can directly affect the direction of trade (Loertscher and Wolter, 1980). In addition, geographical proximity, transportation costs, and common cultural ties are among the factors that facilitate trade. Border trade is generally more intense between countries with similar cultures, histories, and languages (Falvey, 1981; Sharma, 1999).

The concept of intra-industry trade, when it first emerged, was used only to explain trade between countries. However, in the 1980s, studies not only on whether there was intra-industry trade or measuring the degree of intra-industry trade but also studies that considered the factors that could affect this trade started to increase. Especially in this period, studies by authors such as Dixit and Stiglitz (1977), followed by Balassa (1979), Lancaster (1979), Tharakan (1984), Havrylyshyn & Civan (1985), Flam & Helpman (1987), Manrique (1987), Ballance et al. (1992) have made significant contributions to the literature. Studies investigating the factors determining intra-industry trade have gained momentum since the 2000s. Bhattacharyya (2002), Thorpe & Zhang (2005), Stanley & Clark (2006), Sunde et al. (2009), Zhang & Clark (2009), Sawyer et al. (2010), Mulenga (2012), Yuan (2012), Sotomayor (2012), Saray (2013), Lapinska (2014), Trupkiewicz (2015), Nisa (2017), Justyna et al. (2019), Vidya & Prabheesh (2019), Nguyen et al. (2020), Ozer (2021), Gonzalez et al. (2022), Ekayanti et al. (2023) and Aggarwal (2023) have comprehensively examined the factors affecting intra-industry trade in different periods and different regions. These studies have made valuable contributions to literature with theoretical and empirical approaches, allowing us to better understand the dynamics of intra-industry trade.

When the intra-industry trade dynamics of Georgia with its selected trading partners are examined, it is seen that economic factors such as market sizes and income differences, as well as factors such as geographical distance and foreign trade balance are decisive. While economic size and level of development play a role in increasing trade, factors such as physical distance and trade imbalances can have negative effects. In this context, both economic and socio-cultural factors are among the basic elements shaping Georgia's trade relations.

2. Models and Variables Used in Georgia's Intra-Industry Trade Analysis

The model generally used in intra-industry trade analysis is as follows:

$$IIT_i = f(X_{ik})$$

In the equation, IIT_i represents the intra-industry trade rates measured for country i. X_{ik} The equation represents the explanatory variables expected to have an effect on intra-industry trade. Table 1 below shows the explanatory variables used in the model and the theoretically expected coefficient signs.

Table 1

Determinants of Intra-Industry Trade

Explanatory Variables	Expected Signs
Market Sizes of Countries (GDP $)	+
Market Size Differences of Countries (GDPD$)	-
Development Level of Countries (GDPPRC $)	+/-
Development Level Differences Between Countries (GDPPRCD $)	-
Physical Distance Between Countries (DIS, Kilometers)	-
Border Trade and Same Sea Sharing (BTR)	+
Openness Level of the National Economy to the Outside World (EO%)	+
Foreign Trade Imbalance (FTI $)	-

Source: Table created by the author.

The analysis of the determinants of Georgia's intra-industry trade with selected European countries and Türkiye was carried out individually for each group of goods coded from 0 to 9 according to STIC Rev4 Level 1 (1 Digit). The period of the analysis was determined as 2008 to 2022. The reason for choosing the data period as 2008 to 2022 is that there is no restriction in accessing the data of all selected countries at the same time and that Georgia's mutual trade with Europe and Türkiye intensified due to the war between Georgia and Russia in 2008. The countries included in the analysis are Austria, Germany, Belgium, Bulgaria, United Kingdom, Czech Republic, France, Netherlands, Switzerland, Italy, Spain, Poland, Romania, Greece, Ukraine, Sweden, Latvia, Lithuania, Moldova and Türkiye, respectively. The intra-industry trade volumes of the countries used in the analysis and the independent variables of the established models were calculated with the Grubel and Lloyd index. In addition, data for all variables used in the analysis were obtained from the World Bank, International Monetary Fund, Turkish Statistical Institute and Georgian Statistical Institute. All monetary data used are in US Dollars.

3. Econometric Method: Dynamic Panel Data Generalized Method of Moments (GMM)

When the studies that make estimations with the standard panel data method are examined, it is seen that the time dimension is generally smaller than the number of observations. In these estimations, when the T-time dimension is smaller than the N-observation number, the least squares estimation method gives inconsistent results. When the T-time dimension is smaller than the N-observation number, the dynamic panel data (GMM) estimation method gives more accurate results (Hayakawa, 2005). For this reason, the dynamic panel data estimation method (GMM) was preferred in the study to reveal the determinants of Georgia's intra-industry trade with selected European countries and Türkiye.

The basic ideas of GMM are based on the studies of Anderson & Hsiao (1981, 1982), Hansen (1982), Arellano & Bond (1991), Blundell & Bond (1998). In dynamic panel data analysis, the generalized method of moments is divided into two as first difference-GMM and system-GMM under different assumptions. The first model including dynamic panel data is the first difference model. In other words, in the first stage, the first difference is taken to eliminate the observed heterogeneity, then the difference-GMM method is applied by including the previous period value of the dependent variable as an instrumental variable in the model (Arellano & Bond, 1991). In existing literature, this method is known as the first difference method or the Arellano-Bond estimator. Arellano-Bover (1995) and Blundell-Bond (1998) constructed the system-GMM model by considering that the first differences of the instrumental variables are uncorrelated with the fixed effects. By combining the difference and level equations in the system-GMM model, more instrumental variables can be included in the model, thus the estimates of the system-GMM approach are stronger and more reliable than the difference-GMM approach (Arellano and Bover, 1995). For this reason, the system-GMM estimation method is used extensively in econometric analyses.

The system-GMM estimator is based on the moment conditions given in the equation below (Blundell and Bond, 1998).

$$\gamma_s = \frac{\beta'_{-1} Z_1 W_N^{-1} Z_1' \beta}{\beta'_{-1} Z_1 W_N^{-1} Z_1' \beta_{-1}} \; ; \; \beta_i = (\Delta y_i' y_i')'$$

The validity of the System-GMM estimation results is checked with two different tests (Sargan-Hansen and Autocorrelation). The Sargan-Hansen test provides information about whether the instrumental variables fully reflect the main variables, their endogeneity and suitability. The second test checks the first- and second-degree autocorrelation status in the error terms (Hansen, 2007).

Within the framework of the explanations above, the estimation models to be used in this study are given in Tables 2 and 3 below. The data related to the dependent variable, intra-industry trade variable, in the estimation models in question are the previously calculated Grubel-Lloyd index values. Again, the explanatory variables given in the tables below are presented in Table 1. When Table 1, which shows the IIT levels given in the second part of the study, is carefully examined, it is seen that Georgia has intensive intra-industry trade with selected European countries and Turkey in the product groups with STIC codes 0, 1, 2, 5 and 6, while intra-industry trade is weak in the product groups with codes 3, 4, 7, 8 and 9. Therefore, the determinants of intra-industry trade are estimated separately and one by one for the product groups with intensive and weak trade. The estimated econometric equations are given in Tables 2 and 3 below.

Table 2

List of Estimation Models for Goods Groups Where IIT is Strong

Model 1 (STIC 0)	$IIT_{FALA} = \beta_0 + \beta_1 IIT_{FALA,t-1} + \beta_2 GDP_{FALA,t} + \beta_3 GDPPRC_{FALA,t} + \beta_4 GDPD_{FALA,t} + \beta_5 GDPPRCD_{FALA,t} + \beta_6 EO_{FALA,t} + \beta_7 FTI_{FALA,t} + \beta_8 DIS_{FALA,t} + \varepsilon_{FALA,t}$
Model 2 (STIC 1)	$IIT_{BAT} = \beta_0 + \beta_1 IIT_{BAT,t-1} + \beta_2 GDP_{BAT,t} + \beta_3 GDPPRC_{BAT,t} + \beta_4 GDPD_{BAT,t} + \beta_5 GDPPRCD_{BAT,t} + \beta_6 EO_{BAT,t} + \beta_7 FTI_{BAT,t} + \beta_8 DIS_{,BAT,} + \varepsilon_{BAT,t}$
Model 3 (STIC 2)	$IIT_{CMIEF} = \beta_0 + \beta_1 IIT_{CMIEF,t-1} + \beta_2 GDP_{CMIEF,t} + \beta_3 GDPPRC_{CMIEF,t} + \beta_4 GDPD_{CMIEF,t} + \beta_5 GDPPRCD_{CMIEF,t} + \beta_6 EO_{CMIEF,t} + \beta_7 FTI_{CMIEF,t} + \beta_8 DIS_{CMIEF,t} + \varepsilon_{CMIEF,t}$
Model 4 (STIC 5)	$IIT_{CARP} = \beta_0 + \beta_1 IIT_{CARP,t-1} + \beta_2 GDP_{CARP,t} + \beta_3 GDPPRC_{CARP,t} + \beta_4 GDPD_{CARP,t} + \beta_5 GDPPRCD_{CARP,t} + \beta_6 EO_{CARP,t} + \beta_7 FTI_{CARP,t} + \beta_8 DIS_{CARP,t} + \varepsilon_{CARP,t}$
Model 6 (STIC 6)	$IIT_{MGCCM} = \beta_0 + \beta_1 IIT_{MGCCM,t-1} + \beta_2 GDP_{MGCCM,t} + \beta_3 GDPPRC_{MGCCM,t} + \beta_4 GDPD_{MGCCM,t} + \beta_5 GDPPRCD_{MGCCM,t} + \beta_6 EO_{MGCCM,t} + \beta_7 FTI_{MGCCM,t} + \beta_8 DIS_{MGCCM,t} + \varepsilon_{MGCCM,t}$

NOTE: i in the equations represents the i[th] country in that commodity group, and t represents the period 2008-2022. All variables in the models are in logarithmic form.

In Table 2, the 1st Model is the econometric equation created to estimate the determinants of IIT among the countries under study in the STIC 0 coded live animals and foodstuffs (FALA) goods group. Similarly, the 2nd Model is the STIC 1 coded beverage and tobacco products (BAT), the 3rd Model is the STIC 2 coded raw materials excluding fuel (CMIEF), the 4th Model is the STIC 5 coded chemical industry products not specified elsewhere (CARP) and the 5th Model is the STIC 6 coded processed goods divided into main classes (MGCCM) group.

Table 3

List of Estimation Models for Goods Groups Where IIT Is Weak

6. Model (STIC 3)	$IIT_{MYYAU} = \beta_0 + \beta_1 IIT_{MFLRM,t-1} + \beta_2 GDP_{MFLRM,t} + \beta_3 GDPPRC_{MFLRM,t} + \beta_4 GDPD_{MFLRM,t} + \beta_5 GDPPRCD_{MFLRM,t} + \beta_6 EO_{MFLRM,t} + \beta_7 FTI_{MFLRM,t} + \beta_8 DIS_{MFLRM,t} + \varepsilon_{MFLRM,t}$
7. Model (STIC 4)	$IIT_{AVOFW} = \beta_0 + \beta_1 IIT_{AVOFW,t-1} + \beta_2 GDP_{AVOFW,t} + \beta_3 GDPPRC_{AVOFW,t} + \beta_4 GDPD_{AVOFW,t} + \beta_5 GDPPRCD_{AVOFW,t} + \beta_6 EO_{AVOFW,t} + \beta_7 FTI_{AVOFW,t} + \beta_8 DIS_{AVOFW,t} + \varepsilon_{AVOFW,t}$
8. Model (STIC 7)	$IIT_{MTE} = \beta_0 + \beta_1 IIT_{MTE,t-1} + \beta_2 GDP_{MTE,t} + \beta_3 GDPPRC_{MTE,t} + \beta_4 GDPD_{MTE,t} + \beta_5 GDPPRCD_{MTE,t} + \beta_6 EO_{MTE,t} + \beta_7 FTI_{MTE,t} + \beta_8 DIS_{MTE,t} + \varepsilon_{MTE,t}$
9. Model (STIC 8)	$IIT_{MMA} = \beta_0 + \beta_1 IIT_{MMA,t-1} + \beta_2 GDP_{MMA,t} + \beta_3 GDPPRC_{MMA,t} + \beta_4 GDPD_{MMA,t} + \beta_5 GDPPRCD_{MMA\,t} + \beta_6 EO_{MMA,t} + \beta_7 FTI_{MMA,t} + \beta_8 DIS_{MMA,t} + \varepsilon_{MMA,t}$
10. Model (STIC 9)	$IIT_{CTNCE} = \beta_0 + \beta_1 IIT_{CTNCE,t-1} + \beta_2 GDP_{CTNCE,t} + \beta_3 GDPPRC_{CTNCE,t} + \beta_4 GDPD_{CTNCE,t} + \beta_5 GDPPRCD_{CTNCE,t} + \beta_6 EO_{CTNCE,t} + \beta_7 FTI_{CTNCE,t} + \beta_8 DIS_{CTNCE,t} + \varepsilon_{CTNCE,t}$

NOTE: In the equations, i represents the i. country in that commodity group, and t represents the period 2008-2022. All variables in the models are in logarithmic form.

In Table 3, Model 6 is the econometric equation created to estimate the determinants of IIT among the countries under study in the STIC 3 coded mineral fuels, oils and related products (MFLRM) commodity group. Similarly, Model 7 is the STIC 4 coded animal, vegetable fats and liquid oils (AVOFW), Model 8 is the STIC 7 coded machinery and vehicles (MTE), Model 9 is the STIC 8 coded miscellaneous manufactured goods (MMA) and Model 10 is the STIC 9 coded unclassified goods (CTNCE) group.

3.1. GMM Analysis Results

The results of the two-stage GMM analysis, which will reveal the determinants of Georgia's intra-industry trade with 19 selected European countries and Türkiye, are presented in Tables 4 and 5 below. The first table shows the estimation results for the commodity groups where Georgia's intra-industry trade with the selected countries is intense, and the second table shows the estimation results for the commodity groups where Georgia's intra-industry trade with the selected countries is weak.

Table 4

SGMM Estimation Results in Goods Groups with Strong Intra-Industry Trade

Variables / Models	IIT_{FALA}	IIT_{BAT}	IIT_{CMIEF}	IIT_{CARP}	IIT_{MGCCM}
$SGMM_{FALA}$	0.4649676***	-	-	-	-
$SGMM_{BAT}$	-	0.30001397*	-	-	-
$SGMM_{CMIEF}$	-	-	0.486227***	-	-
$SGMM_{CARP}$	-	-	-	0.134541***	
$SGMM_{MGCCM}$	-	-	-	-	0.5474846***
GDP	0.1010087*	0.1797271***	0.0978106**	0.000769**	0.0816287*
GDPPRC	-0.1422677**	-0.132751	-0.042353	-0.1282528*	0.0361753
GDPD	-0.0089912**	-0.0057106	-0.0064632***	-0.0022311	-0.0028104
GDPPRCD	0.0061874	-0.0011726	-0.0075214***	-0.0007967	-0.0042914***
EO	-0.821008	0.1982964*	0.0073531	-0.81716	0.1311932***
FTI	-0.2250801	0.3858897	-0.002181	-0.2098346	0.2945231*
DIS	0.707524	0.0936284	-0.3390965***	-0.2442514**	0.0987748*
Number of Observations	300	300	300	300	300
Number of Countries	20	20	20	20	20
AR (1)	-3.49***	-2.41***	-2.97***	-2.23**	-3.00***
AR (2)	0.26**	0.79*	0.03***	0.62**	-1.12*
Sargan	13.72***	4.94**	5.28**	11.82**	17.21***

Note: *_ (0.10) 10% significant, **_ (0.5) 5% significant, ***_ (0.01) 1% significant.

Table 5

SGMM Estimation Results for Goods Groups with Weak Intra-Industry Trade

Variable / Model	IIT_{MFLRM}	IIT_{AVOFW}	IIT_{MTE}	IIT_{MMA}	IIT_{CTNCE}
$SGMM_{MFLRM}$	0.3927172***	-	-	-	-
$SGMM_{AVOFW}$	-	0.3242382*	-	-	-
$SGMM_{MTE}$	-	-	0.6065375***	-	-
$SGMM_{MMA}$	-	-	-	0.5199604***	-
$SGMM_{CTNCE}$	-	-	-	-	0.0711615***
GDP	0.069557	0.0577147	0.0153901	0.061306**	0.1156984**
GDPPRC	0.0508412	0.0846235	-0.0847165***	0.049436	0.0932772
GDPD	-0.0031868	-0.0019007	0.0004806	-0.0040701**	-0.0054795**
GDPPRCD	-0.0012791	-0.0028337	0.0020149	-0.0010589	-0.0026552
EO	-0.0219399	0.00183	0.153571***	0.099748	0.0891602
FTI	0.1453947	0.1693716	0.2126612	-0.0276455	0.2260115
DIS	-0.1649955**	-0.1176474	0.015272	-0.1669674***	-0.2692776**
Number of Observations	300	300	300	300	300
Number of Countries	20	20	20	20	20
AR (1)	-2.22**	-1.75*	-2.98***	-2.70***	-2.96***
AR (2)	0.29*	-0.64	-1.68*	-0.55	0.53
Sargan	8.18	5.64	25.76***	4.05	7.29***

Note: *_ (0.10) 10% significant, **_ (0.5) 5% significant, ***_ (0.01) 1% significant.

The most important determinant of Georgia's intra-industry trade with the countries under study in general in all STIC level (1) product groups, as expected theoretically, has been found to be gross domestic product. The high production potential of countries creates higher national income and increases product diversity and demand for these goods. Therefore, as national income increases, product demand from Georgia's trade partners will increase in all product groups, and the same result will be valid for product demands from European countries and Turkey from Georgia, and the mutual intra-industry trade volume will increase. It should be noted that Georgia needs to increase product diversity for mutual strong intra-industry trade with its trade partners. Although the country provides production incentives, control and additional incentive policies need to be implemented for these incentives to be directed from the tourism and construction sectors to the industrial sector and the R&D investments that feed it. In addition, the sale of agricultural and livestock sector products and minerals sold as raw materials as processed products will provide higher value-added income to the country. Again, for this transformation, industrial investments need to be revitalized in the country.

The second important factor determining Georgia's intra-industry trade with its trade partners in all product groups is the distance between countries. Theoretically, as the distance between countries increases, transportation costs increase, and thus intra-industry trade is negatively affected by this situation. As expected theoretically in this study, as the distance between countries increases, Georgia's intra-industry trade with Europe and Türkiye decreases. Georgia is a country dependent on foreign countries for its oil needs,

but sea transportation, especially with Europe, provides a great advantage over land transportation. While trade is carried out by land due to its border with Turkey, encouraging and making sea transportation to Europe relatively cheaper compared to other alternatives will positively affect Georgia's intra-industry trade.

In the study, the gross domestic product difference, which represents the difference in the size of the market between Georgia and selected European countries and Türkiye, which determines the intra-industry trade, is estimated to be the third important factor determining the intra-industry trade of agriculture and animal husbandry, raw materials, manufactured goods and unclassified goods. Especially in agriculture-animal husbandry and raw material minerals, the insufficiency of domestic demand due to being a small country causes these products to be demanded by countries with relatively larger production and economies, and as the national income difference between Georgia and these countries increases, the intra-industry trade is negatively affected. Therefore, the theoretical sign of the income difference between countries is estimated to be negative, as expected. For Georgia to achieve balance in intra-industry trade in the relevant product groups, it needs to increase its industrial investments for production and accordingly increase product diversity, as we mentioned above.

The per capita national income and openness rate, which are among the determinants of intra-industry trade with Georgia's trade partners, were estimated to be statistically significant only in 3 out of 10 product groups. The fact that the per capita national income, which represents the development and wealth levels of countries, is generally insignificant indicates that Georgia's agricultural and livestock products, which are assumed to have an elasticity of demand less than 1, and the raw material minerals that are the basic inputs of the chemical and industrial sectors, are essential goods and their demand depends on the total national income, which indicates the production potential of the countries, rather than personal income. For European countries and Türkiye, whose industries are quite developed and whose demand power is higher than Georgia's, these products are considered essential goods, and their demand depends on total production. In addition, as in oil-producing countries, a high level of per capita national income does not always mean that the country is developed. It is quite natural for Georgia that the openness rate, which is one of the determinants of intra-industry trade, is significant in the group of beverages and tobacco, processed goods and machinery and equipment products. Georgia has increased the sales of these products, especially to Europe, after 2008, following the mutual free trade agreements. Therefore, we can say that the increase in Georgia's mutual intra-industry trade has been realized with the increase in the country's openness to the outside world. However, for intra-industry trade in other sectors to increase due to openness to the outside world, as mentioned before, Georgia needs to increase its industrial production and product diversity.

The last two determinants of intra-industry trade between Georgia and the countries under study, the per capita income difference and the inter-country mutual trade imbalance variables, which show the development difference of the countries, are generally statistically insignificant in all commodity groups. As stated in the previous paragraph, since per capita national income is not an effective factor in Georgia's intra-industry trade with the trade partners in question, it is natural that there is no per capita income difference. In addition, a significant portion of the products that Georgia produces and exports are products that concern industrial and total demand rather than personal demand. The per capita income difference and the increase in this difference do not mean that the country is developed under all circumstances, as in the example of oil-producing countries. Finally, the trade differences between countries have not had a significant effect on Georgia's intra-industry trade. We can say that one of the important reasons for this situation is that a country with high energy dependency, for example, must buy this product even if it has a deficit in mutual trade. Georgia is still a country that is dependent on foreign countries for some industrial products, technology and energy due to its production structure. As mentioned before, intra-industry trade may be positively affected, especially when industrial investments are encouraged, as product diversity and income increase. However, if energy needs cannot be met domestically, external dependency will continue.

Conclusion and Recommendation

In this study, to reveal the determinants of intra-industry trade of 10 sub-sectors of SITC Rev4 level (1) goods classification with selected European countries and Türkiye, econometric estimations were made separately for each goods group using the system generalized method of moments. When the analysis results are evaluated, it is shown that as the market size (GDP) of the countries increases, intra-industry trade with Georgia's trade partners in sub-sectors 0, 1, 2, 5, 6, 8 and 9 of SITC goods classification increases, as expected theoretically. As the market size difference between Georgia's trade partners and the countries decreases, intra-industry trade increases in sectors 0, 2, 8 and 9, as expected theoretically. As the trade openness of Georgia with its trade partners increases, intra-industry trade increases in sectors 1, 6 and 7, as expected theoretically. As the physical distance between Georgia's trade partners and the countries increases, intra-industry trade decreases in sectors 2, 3, 5, 8 and 9, as expected theoretically. However, in 6 sectors, the variables of physical distance and trade imbalance between countries gave positive coefficient signs, contrary to the theoretically expected negative signs. In addition, the variable of GDP per capita, which expresses the level of development of countries, gave negative coefficient signs, contrary to the theoretically expected positive signs, in sectors 0, 5 and 7. As the level of development of countries increases, the decrease in intra-industry trade in sectors 0, 5 and 7, and the increase in intra-industry trade with the increase in trade imbalance and physical distance between countries in 6 sectors are out of expectations, but similar results are frequently encountered in the literature.

The results of this econometric analysis show that Georgia's industrial sector is weak, and this situation negatively affects intra-industry trade. In this context,

it is emphasized that the country should focus more on industrialization to strengthen intra-industry trade. In this direction, incentives should be increased especially for the industrial sector and R&D investments to encourage Georgia's industrial production. Directing foreign direct investments in tourism and construction sectors to local production, and investments to be made especially in industrial and technology-based sectors can increase economic diversity and create employment. Georgia needs to increase its product diversity to develop intra-industry trade with its trade partners. It is important to increase the added value of these products by increasing the sales of agricultural, livestock products and raw materials as processed products. Increasing product diversity will reduce Georgia's foreign trade deficit and strengthen its economic resilience. In addition, increasing energy independence and encouraging investments in green energy resources are also important requirements for the sustainability of Georgia's economic growth strategies.

References

1. Grimwade, N. (1989). International Trade: New Patterns of Trade, Production and Investment. Oxford University Press on behalf of the Royal Institute of International Affairs, 65(3), 542-553

2. Heckscher, E. & Ohlin, B. (1991). Heckscher-Ohlin trade theory (H. Flam & M. J. Flanders, Eds.). MIT Press. (Original work published 1933)

3. Finger, J. M. (1975). Trade overlap and intra-industry trade. Economic inquiry, 13(4), 581-589

4. Krugman, P. R. (1981). Intraindustry specialization and the gains from trade. Journal of political Economy, 89(5), 959-973.

5. Davis, D. R. (1995). Intra-industry trade: a Heckscher-Ohlin-Ricardo approach. Journal of international Economics, 39(3-4), 201-226.

6. Lloyd, P. J., & Lee, H. H. (Eds.). (2002). Frontiers of research in intra-industry trade (Vol. 34). Houndmills, Basingstoke, Hampshire, New York: Palgrave Macmillan.

7. Yuan, L. (2012). Intra-industry trade between Sweden and middle income countries. Master Thesis, KTH Industrial Engineering and Management.

8. Grubel, H. ve Lloyd, P. J. (1975). Intra Industry Trade the Theory and Measurement of International Trade in Differentiated Products (I. Edition). London and Basingstoke: The Macmillan Press Ltd.

9. Greenaway, D., & Milner, C. (1983). On the measurement of intra-industry trade. The Economic Journal, 93(372), 900-908.

10. Brülhart, M. (1994). Marginal intra-industry trade: measurement and relevance for the pattern of industrial adjustment. Weltwirtschaftliches Archiv, (H.3), 600-613.

11. Menon, J., & Dixon, P. B. (1997). Intra-industry versus inter-industry trade: Relevance for adjustment costs. Weltwirtschaftliches Archiv, (H. 1), 164-169.

12. Azhar, A. K., & Elliott, R. J. (2008). On the measurement of changes in product quality in marginal intra-industry trade. Review of World Economics, 144, 225-247.

13. Shelburne, R. C. (1993). Changing trade patterns and the intra-industry trade index: A note. Weltwirtschaftliches Archiv, (H. 4), 829-833.

14. Verdoorn P.J. (1960). The intra-bloc trade of benelux. in economic consequences of the size of nations. Proceedings of a Conference held by the International Economic Association, 291-329.

15. Michaely, M. (1962). Multilateral balancing in international trade. The American Economic Review, 52(4), 685-702.

16. Kojima, K. (1964). The pattern of international trade among advanced countries. Hitotsubashi Journal of Economics, 5(1), 16-36.

17. Balassa, B. (1966). Tariff reductions and trade in manufacturers among the industrial countries. The American Economic Review, 56(3), 466-473.

18. Aquino, A. (1978). Intra-industry trade and inter-industry specialization as concurrent sources of international trade in manufactures. Review of World Economics, 114(2), 275-296.

19. Loertscher, R., & Wolter, F. (1980). Determinants of intra-industry trade: Among countries and across industries. Review of World Economics, 116(2), 280-293.

20. Glejser, H., Goossens, K., & Eede, M. V. (1982). Inter-industry versus intra-industry specialization in exports and imports (1959–1970–1973). Journal of International Economics, 12(3-4), 363-369.

21. Hamilton, C., & Kniest, P. (1991). Trade liberalisation, structural adjustment and intra-industry trade: a note. Weltwirtschaftliches Archiv, 127(2), 356-367.

22. Greenaway, D., Hine, R. C., Milner, C., & Elliott, R. (1994). Adjustment and the measurement of marginal intra-industry trade. Review of World Economics, 139 (3), 418-427.

23. Thom, R., & McDowell, M. (1999). Measuring marginal intra-industry trade. Weltwirtschaftliches Archiv, 135(1), 48-61.

24. Andresen, M. A. (2010). A cross-industry analysis of intra-industry trade measurement thresholds: Canada and the United States, 1988–1999. Empirical Economics, 38, 793-808.

25. Hartman, D. A., Henderson, D. R., & Sheldon, I. M. (1993). A cross-section analysis of intra-industry trade in the US processed food and beverage sectors. Agricultural and Resource Economics Review, 22(2), 189-198.

26. Bano, S. (2013). Horizontal, Vertical and Marginal Intra-Industry International Trade and Their Determinants: Evidence for New Zealand And Australia. 54 New Zealand Associations of Economists (Nzae) Annual Conference, 3-5 July 2013. Wellington.

27. Falvey, R. E. (1981). Commercial policy and intra-industry trade. Journal of international economics, 11(4), 495-511.

28. Sharma, K. (2000). The Pattern and Determinants of Intra-Industry Trade in Australian Manufacturing. Australian Economic Review, 33(3), 245-255.

29. Dixit, A. K., & Stiglitz, J. E. (1977). Monopolistic competition and optimum product diversity. The American economic review, 67(3), 297-308.

30. Balassa, B. (1979). Intra-industry trade and the integration of developing countries in the world economy. World Bank.

31. Lancaster, K. (1979). Variety, equity, and efficiency: product variety in an industrial society. Columbia University Press. 1979

32. Tharakan, P. M. (1984). Intra-industry trade between the industrial countries and the developing world. European Economic Review, 26(1-2), 213-227.

33. Havrylyshyn, O., & Civan, E. (1985). Intra-industry trade among developing countries. Journal of Development Economics, 18(2-3), 253-271.

34. Flam, H. & Helpman, E. (1987). Vertical product differentiation and North-South trade. The American Economic Review, 77(5), 810-822.

35. Manrique, G. G. (1987). Intra-industry trade between developed and developing countries: The United States and the NICs. The Journal of Developing Areas, 481-494.

36. Ballance, R. H., Forstner, H., & Sawyer, W. C. (1992). An empirical examination of the role of vertical product differentiation in North-South trade. Weltwirtschaftliches Archiv, 128(2), 330-338.

37. Bhattacharyya, R. (2002). Vertical and horizontal intra industry trade in some Asian and Latin American less developed countries. Journal of Economic Integration, 17(2), 273-296.

38. Thorpe, M., & Zhang, Z. (2005). Study of the measurement and determinants of intra-industry trade in East Asia. Asian Economic Journal, 19(2), 231-247.

39. Zhang, Y., & Clark, D. P. (2009). Pattern and determinants of United States' intra-industry trade. The International Trade Journal, 23(3), 325-356.

40. Sunde, T., Chidoko, C., & Zivanomoyo, J. (2009). Determinants of Intra Industry Trade between Zimbabwe and its Trading Partners in the Southern African Development Community (1990-2006). Journal of Social Sciences 5(1), 16-21.

41. Thorpe, M., & Zhang, Z. (2005). Study of the measurement and determinants of intra-industry trade in East Asia. Asian Economic Journal, 19(2), 231-247.

42. Sawyer, W. C., Sprinkle, R. L., & Tochkov, K. (2010). Patterns and determinants of intra-industry trade in Asia. Journal of Asian Economics, 21(5), 485-493.

43. Mulenga, M. C. (2012). Determinants of intra-industry trade between Zambia and it's trading partners in the Southern African Development Community (SADC). Ethiopian Journal of Economics, 21(1), 107-132.

44. Yuan, L. (2012). Intra-industry trade between Sweden and middle income countries. Master Thesis, KTH Industrial Engineering and Management.

45. Sotomayor, M. (2012). Patterns and determinants of intra industry trade for the Mexican non-maquiladora manufacturing Industry. The Journal of Business Inquiry, 11(1), 33-57.

46. Saray, M. (2013). Türkiye'nin endüstri içi ticaretinin belirleyicileri: temel diş ticaret partnerleri ile panel veri analizi. Ph.D. Thesis.

47. Łapinska, J. (2014). Determinants of intra-industry trade in agricultural and food products between Poland and EU countries. Danube, 5(3), 159-172.

48. Trupkiewicz, M. (2015). Determinants of the horizontal and vertical intra-industry trade between Norway and the European Union. Master's thesis.

49. Nisa, F. C. (2017). Patterns and determinants of intra-industry trade between indonesia and trading partner countries. Journal of Developing Economies, 2(1), 27-37.

50. Justyna, L, Grzegorz, K & Radosław, D. (2019). Country-specific determinants of intra-industry trade in clothing and footwear between poland and european union countries. BazTech, 27(4), 1-6.

51. Vidya, C. T., & Prabheesh, K. P. (2019). Intra-industry trade between India and Indonesia. Bulletin of Monetary Economics and Banking, 21, 511-530.

52. Nguyen, H. M., Quan, B. Q. M., LE Huong, V., & Tran, T. V. (2020). Determinants of intra-industry trade between vietnam and countries in tpp. Journal of Asian Finance, Economics and Business, 7(1), 123-129.

53. Özer, Ö. (2021). Türkiye otomotiv sektöründe endüstri içi ticareti etkileyen faktörler üzerine ekonometrik bir analiz. Master's thesis.

54. González, C. V., Muñoz, C. A. P., Bolaños, J. F., & Aguilera-Prado, M. (2022). Regional determinants of Colombian intra-industry trade. International Journal of Trade and Global Markets, 15(4), 391-405.

55. Ekayanti, D. F., & Setiawina, N. D. (2023). Determinants of Indonesia's Intra-Industry Trade of Cosmetic Commodity (HS Code 3304) with Trade Partners Of APEC-4 Countries. European Journal of Business and Management Research, 8(1), 77-85.

56. Aggarwal, S. (2023). The empirical measurement and determinants of intra-industry trade for a developing country. Journal of Applied Economic Sciences (JAES), 18(81), 182-220.

57. Hayakawa, K. (2005). Small sample bias properties of the system GMM estimator in dynamic panel data models. Economics letters, 95(1), 32-38.

58. Anderson, T. W., & Hsiao, C. (1981). Estimation of dynamic models with error components. Journal of the American Statistical Association, 76(375), 598-606

59. Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. Journal of Econometrics, 18(1), 47-82.

60. Hansen, L. P., & Singleton, K. J. (1982). Generalized instrumental variables estimation of nonlinear rational expectations models. Econometrica: Journal of the Econometric Society, 50(5), 1269-1286.

61. Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies, 58(2), 277-297.

62. Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, 68(1), 29-51

63. Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. Journal of econometrics, 87(1), 115-143.

64. Hansen, L. P. (2007). Generalized method of moments estimation. Macroeconometrics and time series analysis, 20(4), 1-14.

JURIDICAL SCIENCES

WHY SUPPORT THE FRENCH NEW BILL AGAINST FOOD WASTE?

Derambarsh A.
deputy mayor in the town of Courbevoie. He is at the origin of the law against food waste passed on 3rd February 2016 in France. In Sweden in 2019, he received the «WIN WIN Gothenburg Sustainability Award».[1]
Affiliated with YEREVAN STATE UNIVERSITY (ARMENIA) for seeking Ph.D in Law in 12.00.01 specialization (Theory and History of State and Law, history of state and legal teachings)

ABSTRACT

The objective of this analysis is to highlight the urgency of quickly obtaining a new effective law against food waste.

Indeed, the alarming situation with regard to the social and environmental emergency requires a change in the law.

Indeed, with on the one hand an increase in impoverishment in our country and increasingly long queues at the « soup kitchen » and on the other hand the emergence of worrying global warming, citizens expect effective, innovative and adapted legal tools.

Let us recall that the French law of 3rd February 2016 had positive consequences that we will study.

However, we must go further with a new bill against food waste in order to adapt the legal framework to the current situation.

This is the objective of this legal analysis.

Keywords: Food Waste, European Law, sustainable development, Food lost, Bill, French Law, Food Waste, FAO.

INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) estimates that thirty percent of the food produced worldwide is wasted.

This amounts to one out of every three foods worldwide.

However, according to the Food and Agriculture Organization (FAO), 783 million people globally faced hunger in 2022, and 3.1 billion people lacked access to a good food in 2021.

At the same time, the organization estimates that, globally, « 13% of food is lost in the distribution chain, from post-harvest to pre-retail and that an additional 17% of food is wasted at the household, food service and retail levels. »[2] [3]

The demand for food items has increased globally in recent decades due to changes in eating patterns and demographic growth.

The restrictions that agriculture faces—such as yield limits, technological integration, natural disasters, climate change, urbanization-related loss of agricultural lands, and scarcity of water resources—are placing growing pressure on agricultural productivity.

To fulfill the food supply, reducing losses and waste might be a key lever in addition to raising agricultural productivity.

It is impossible to distinguish clearly between the two concepts of « losses » and « waste » due to the wide variety of circumstances under which they arise across nations.

According to the FAO, 30% of food produced worldwide is wasted.

1.3 billion tons of food, or more than half of the world's grain supply, are lost or wasted annually worldwide, from agricultural production to ultimate consumption.

The issue at hand is worldwide: 670 million and 630 million tons of food are wasted annually in wealthy and developing nations, respectively.

According to FAO estimates, there will be an additional 2.3 billion people on Earth by 2050, bringing the total population to more than 9 billion. By 2100, there will be more people on the planet than 11 billion.

Food production will need to expand in order to keep up with the population's continued need for food.

Demand for food will continue to increase and it will be necessary to intensify food production to feed this population.

If this trend continues, the FAO estimates that global food production will have to increase by 40 to 70% by 2050 to meet needs.

It won't be sufficient to increase output at this rate of waste.

By examining the true demands of the consumer, we must investigate the strategies that should be used at every link in the food chain.

At every level, progress is achievable.

To create solutions that both « feed more » and « feed better » for a growing population, all stakeholders must band together.

Food waste and food insecurity are therefore two complex and interdependent phenomena. Food waste is a major problem, both environmentally and socially.

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[1] « Nobel Prize for sustainable development: lawyer Arash Derambarsh rewarded »: https://clever-energies.com/en/nobel-prize-for-sustainable-development-lawyer-arash-derambarsh-rewarded/

[2] FAO - 2022

[3] United Nations Environment Program, 2021

It represents a loss of valuable resources and can have a negative impact on people in food insecurity.

Therefore, the concept of food insecurity is often reduced to the question of access to sufficient food in quantity and quality.

The French law of 3rd February 2016 quickly proved its beneficial effects:

- More than 10 million meals are distributed each year in France.

- A 22% increase in food donations to charities.

However, due to the increase in impoverishment within the middle class and the establishment of increasingly long queues for the "soup kitchen", added to this a decrease in food donations to charities, it is necessary to provide even bolder responses.

Hence the filing of a new French bill against food waste in order to go further.

It is precisely because there is a social emergency and a crisis at the level of the food chain that it is appropriate to legally regulate these dysfunctions and economic imbalances.

So, can a new legal framework better regulate the food donation system ?

Our analysis responds to this problem with a requirement to accelerate the legislative process at the national level.

MAIN PART

I- A food scandal in front of social and environmental emergency

For a long time, food contributions were the subject of a controversy as most supermarkets tossed away their unsold stock instead of donating it to the underprivileged or nonprofit organizations. [4]

The fact that the Observatory of Inequalities estimates that 5.3 million individuals in France lived below the poverty level in 2023 makes this scenario much more concerning.[5]

Therefore, in order to put an end to this plague, specific answers had to be given.

The #StopFoodWaste movement led to the adoption of a legislation in France requiring retailers to give unsold food, preventing over 10 million meals from ending up in landfills and resulting in a 22% increase in food contributions to charitable organizations.[6]

Every grocery store in the European Union continues to discard more than 40 kg of food every night, despite the fact that more than 95.3 million people (or 22% of the population) live in poverty and frequently struggle to provide for their families in 2022.[7]

The #StopFoodWaste campaign's straightforward solution to this issue was to pass a national law encouraging stores to donate unsold food instead of throwing it out.

Passed on 3rd February 2016 [8], the new law seeks to tackle food waste by obliging all French supermarkets to give away their unsold food and distribute it to those in need, ensuring that nothing is wasted. Supermarkets are free to support the aid association or charity of their choice, and every citizen can apply to create an authorised association to assist in food distribution.

Over 10 million meals are prevented from ending up in landfills each year thanks to the regulation, which has also increased food donations to social assistance organizations by more than 22%. In addition to mobilizing volunteers and streamlining the distribution of food contributions through affiliated organizations, the initiative has increased public awareness of the problem of food waste at the municipal level.

II- The French city of Courbevoie as a driving force against food waste

Since the adoption of the law against food waste, voted on 11th February 2016, supermarkets have been required to donate their unsold food to charities. A world first.

In accordance with **LAW No. 2016-138** of 11th February 2016 relating to « *the fight against food waste* »[9], supermarkets whose sales area exceeds the surface area threshold of 400 square meters are required to donate their unsold consumable food to a charity. Failing this, the fine is 3,750 euros.

In 2019, an amendment increased the penalties in force. The one targeting food retailers that have not signed a donation agreement with an association, goes from a third-class fine (of a maximum amount of 450 euros) to a fifth-class fine (1,500 euros maximum). The amount of the administrative fine incurred for the destruction of consumable foodstuffs increases from 3,750 euros to 10,000 euros.[10]

Senator Esther BENBASSA explained the purpose of her amendment in the following terms on 20th September 2019:

« *It has been noted that some distribution players are still recalcitrant when it comes to applying the 2016 Law. It is therefore deemed necessary by the information report of June 12, 2016 on the evaluation of Law No. 2016-138 to make the penalties incurred more stringent so that they are more dissuasive.*

The penalty for non-compliance is currently punishable by a fixed penalty of the third class. This

[4] The Telegraph « Iceland staff 'pour bleach onto waste food to stop homeless people eating it' »: https://www.telegraph.co.uk/foodanddrink/foodanddrinknews/7564402/Iceland-staff-pour-bleach-onto-waste-food-to-stop-homeless-people-eating-it.html

[5] France Info: https://www.francetvinfo.fr/societe/plan-pauvrete/precarite-en-2023-5-3-millions-de-personnes-vivaient-sous-le-seuil-de-pauvrete-en-france_6304863.html

[6] Anti-food waste law: what results after 18 months ? (Le Figaro – 2018): https://www.lefigaro.fr/economie/le-scan-eco/2018/10/16/29001-20181016ARTFIG00007-loi-anti-gaspillage-alimentaire-quel-bilan-apres-18-mois.php

[7] Poverty in Europe (Statista 2023): https://fr.statista.com/infographie/17748/niveaux-de-pauvrete-en-france-et-en-europe/

[8] Law No. 2016-138 of 11th February 2016 relating to the fight against food waste: https://www.legifrance.gouv.fr/jorf/id/JORFARTI000032036290

[9] LOI n° 2016-138 du 11 février 2016 relative à la lutte contre le gaspillage alimentaire: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000032036289/

[10] Amendement présenté par la sénatrice Esther BENBASSA: https://www.senat.fr/amendements/2018-2019/728/Amdt_213.html

amendment therefore proposes to increase it to a fine of the fifth class.

The penalty for destroying consumable foodstuffs is an administrative fine of 3,750 euros, which currently only applies to distributors in the food sector. This amendment proposes to increase this fixed fine to 10,000 euros ».

Thus, this law has quickly proven its beneficial effects:

- More than 10 million meals are distributed each year in France.

- A 22% increase in food donations intended for charitable associations.

This assessment is therefore positive, but we must go further and improve the law due to the increase in impoverishment in our country and the long queues for the « Meal Center ».[11]

Indeed, charities complain of a drop in donations. We must therefore find new solutions.

Since 2020, the City of Courbevoie has been pursuing a dynamic and bold policy to combat food waste and hunger.

And the results are remarkable: more than 500,000 meals saved and distributed to charities.

On 31st Friday January 2025, Courbevoie city welcomed agents of the Food and Agriculture Organization of the United Nations (FAO) for a major international conference.[12]

Many guests were present, including **Jacques KOSSOWSKI** (Mayor of Courbevoie city), **Divine NAGANJE NIJE** (Deputy Director of the Agri-Food Systems and Food Safety Division of FAO), **Myriam ANNETTE** (International Expert, Prevention and Reduction of Food Losses and Waste, at the FAO Regional Office for Europe and Central Asia), **Reza NAJIB** (FAO Programme Officer), **Roselyne BACHELOT-NARQUIN** (former Minister), **Jean-Jacques BOUYA** (Minister of State of Congo Brazzaville), **Frédéric SIMONIN** (Starred Chef, Meilleur Ouvrier de France 2019**), Franck PAPAZIAN** (President MediaSchool and co-president of the CCAF), **Manon MONTESSUIT** (chef), **Nabil ZEMMOURI** (Anti-waste Chef), Karim BOUAMRANE (Mayor of Saint-Ouen-sur-Seine city), **Joelle CECCALDI RAYNAUD** (Mayor of Puteaux city and President of POLD) and **Marie-Do AESCHLIMANN** (French Senator).

The United Nations agents were able to note that indeed, more than 500,000 meals were saved and redistributed to charitable associations so that the poor (middle class representing single mothers or fathers raising several children, retirees, unemployed or students) could eat their fill.

And thanks to these results, the city of Courbevoie has been recognized as an « ***FAO Green City*** ». [13]

And this change provides solutions to the current social situation in our country which is alarming.

This social situation also demonstrates that even in a city that appears « well-off », poverty has multiple facets. Poverty is increasing and the middle class is declining.

Thus in an alarming report, Secours Catholique estimated that nearly 10% of French people resort to food aid.[14]

Indeed, « between 5 and 7 million people » had recourse to food aid in 2020, warns Secours Catholique in its annual report on the state of poverty in France published on the basis of data from the General Directorate for Social Cohesion (DGCS).[15]

The city of Courbevoie has therefore shown inventiveness in its fight against food waste. [16]

The city of Courbevoie has therefore shown inventiveness in its fight against food waste.

It was therefore decided that with the help of several start-ups and social and economic actors, a charter against food waste would be voted on each year in all spheres of activity in the city:

• 2020 with all supermarkets located in the city without delimitation of surface area

• 2021 with hospital catering

• 2022 with school catering

• 2023 with food stores (food stores, restaurants, bakeries, markets)

• 2024 with retirement homes and nursing homes.

These commitment charters, a first in France, have a multiple objective:

• Create synergies so that everyone can take part in this fight and adapt their practices

• Participate in raising awareness among the general public about the fight against food waste

• Contribute to reducing the economic impact of this waste

• Set up food donation partnerships for associations in accordance with the law

• Promote partnerships with municipal associations

• Organize « anti-waste » promotions, particularly for products close to their use-by date (UBD)

• Offer wholesale or unit sales in order to adapt the quantities purchased and reduce packaging

• Promote the development of fresh products, and develop awareness-raising marketing operations (operation « Ugly Fruits and Vegetables », etc.)

• Conduct a discussion with suppliers in order to define a control strategy against food waste (product quality charters, etc.)

[11] « L'appel des Restos du cœur, révélateur des difficultés de tout un secteur face à la hausse des besoins »: https://www.lemonde.fr/societe/article/2023/09/07/l-appel-des-restos-du-c-ur-revelateur-des-difficultes-de-tout-un-secteur-face-a-la-hausse-des-besoins_6188233_3224.html

[12] « Le combat de Courbevoie contre le gaspillage alimentaire inspire d'autres élus et collectivités »: https://www.echoidf.fr/de-nouvelles-actions-contre-le-gaspillage-alimentaire/

[13] « Green Cities Initiative » (FAO): https://www.fao.org/green-cities-initiative/network/en

[14] « Pauvreté en France: 10% de la population a eu besoin d'une aide alimentaire en 2020 » (Université Paris Saclay): http://www.ritm.universite-paris-saclay.fr/poverty-in-france-10-of-the-population-needed-food-aid-in-2020/

[15] Site Ville de Courbevoie: https://www.ville-courbevoie.fr/2195/lutte-contre-le-gaspillage-alimentaire.htm

[16] The law on Food Waste - From Courbevoie to Assembly: https://resource.co/article/law-food-waste-courbevoie-assembly-10198

• Act to recover waste.

On the strength of all this work, the FAO designated the city of Courbevoie as a « ***World Green City*** » in 2024, thus granting it formal recognition.

III-A new bill proposal to go further

It is precisely on this alarming situation that Senator Marie-Do AESCHLIMANN was asked to propose a new law to go further.

A « *Bill to strengthen the fight against food waste* » was therefore submitted to the Senate on 20th January 2025 and whose Text bears the reference number 247 (2024-2025).

The proposal was simple: modify the law against food waste promulgated on February 11, 2016.

• Reduce the current ceiling of 400 m2 imposed on supermarkets to reduce it to at least 100 m2 in order to include more than 5,000 additional points of sale.

• Increase the current fines of the 5th class representing 10,000 euros to 20,000 euros against supermarkets that continue to throw away unsold edible food.

It is precisely Senator Marie-Do AESCHLIMANN who is carrying this « *Bill to strengthen the fight against food waste* » tabled in the Senate on 20th January 2025 and whose Text bears the reference number 247 (2024-2025).

Here is the explanatory statement of ***Senator Marie-Do AESCHLIMANN***

Ladies and Gentlemen,

Every year, millions of tons of food are wasted in France, even though part of the population struggles to eat properly. This aberration, which is at once ethical, social and economic, requires renewed mobilization against food waste. Under Article L. 541-15-1 of the Environmental Code resulting from Law No. 2020-105 of 10th February 2020 relating to the fight against waste and the circular economy, food waste is defined as "any food intended for human consumption which, at any stage of the food chain, is lost, thrown away or degraded".

On a global scale, the equivalent of one billion meals would have been wasted every day in 2022, according to a report by the United Nations Environment Programme (UNEP). A waste that the director of UNEP1(*) describes as a "global tragedy".

In France, according to data from the Ministry of Agriculture and Food Sovereignty, food waste represented 4.3 million tons of food in 2022.

The worrying increase in food insecurity - which today affects 16% of the French population2(*) - makes throwing away edible food even more unacceptable. For the year 2023, it is estimated that 2 to 3 million3(*) people benefited from food aid distributed by associations.

This development is closely linked to the context of food inflation. After an 11% price increase in 2022, the Observatory published by rural Families recorded a further 16% price increase for fruits and vegetables in 2023.

In addition, according to the Observatory of Food Vulnerabilities created by the Nestlé Foundation, 37% of French people declared themselves to be food insecure in 2023, compared to 11% in 2015. This study also reveals that young people aged 18-24 are particularly affected, as are women, single people and single-parent families4(*).

With an estimated cost of 16 billion euros per year in France and 1,000 billion dollars for the global economy5(*), food waste has consequences that are not negligible on the economic level.

Finally, its environmental cost is particularly significant since it represents 8 to 10% of global greenhouse gas emissions6(*). According to the Waste and Resources Action Program (WRAP), if it were considered a country, food waste would be the "third largest emitter of greenhouse gases behind the United States and China". In France, the Agency for Ecological Transition (ADEME) estimates this impact at 15.3 million tonnes of CO2 equivalent, or 3% of all our emissions7(*).

The fight against food waste is therefore a major ethical, ecological, social and economic challenge for our society. Since signing the National Pact to Combat Food Waste in 2013, France has resolutely taken up this issue by strengthening its legislative arsenal in order to raise awareness and involve all stakeholders in the food chain in the fight against food waste, in particular through the practice of food donations, which is an essential lever in the fight against poverty.

Thus, as a result of the successive laws adopted over the last ten years, the list of stakeholders affected by the obligation to conclude food donation agreements with associations has continued to grow. Initially applied to distributors with a sales area of more than 400 m², this obligation has been extended to operators of collective catering serving more than 3,000 meals per day as well as to operators in the agri-food industry and wholesale trade whose turnover exceeds 50 million euros.

At the same time, the associative world, communities, but also companies and players in the food sector, have also committed to developing virtuous initiatives aimed at reducing waste. This is the case, for example, of the city of Courbevoie, in Hauts-de-Seine, where under the leadership of Arash Derambarsh, deputy mayor, a Charter of Commitment against Food Waste signed with local stakeholders has made it possible to save and redistribute 400,000 meals in four years. In 2024, this proactive approach earned Courbevoie the title of "green city" awarded by the Food and Agriculture Organization (FAO), the specialized agency of the United Nations (UN)8(*).

Despite real awareness at all levels since 2013, due to a lack of tools and indicators, it has not been possible to accurately assess the volume of food waste sources and their evolution. The objective assigned by the anti-waste law for a circular economy (AGEC) of February 20, 2020, proclaiming a goal of reducing food waste by 50% by 2025 compared to 2015, has consequently proven to be ineffective. However, the 2025 horizon is nonetheless a pivotal date in the fight against this scourge. The volume of 4.3 million tons of wasted food, measured in 2022, remains alarming in light of the food insecurity issues facing our country. This figure highlights the contrast between stated ambitions and concrete actions, recalling the urgency of intensifying our efforts to reduce waste while ensuring a better

redistribution of food resources to vulnerable populations.

At the origin of more than a third of food waste, the agri-food industry, distribution and out-of-home consumption still represent a considerable source of food that should be valorized in order to limit losses, develop donations and meet the growing need for food aid.

This law intends to act more specifically on this source by broadening the scope of the actors concerned, by strengthening the obligation for these actors to communicate their data on wasted food annually and by toughening the sanctions applicable to companies that make them unfit for consumption.

***Article 1st** extends the scope of the obligation for businesses and operators to propose agreements to donate their unsold goods to food aid associations in order to combat waste. On the one hand, by lowering the threshold of businesses concerned by the said obligation from 400 m2 to 200 m2, which would allow the inclusion of some 5,000 local businesses in the scope of the law. On the other hand, by including food wholesale operators whose annual turnover exceeds 25 million euros, agri-food industry operators whose turnover exceeds 25 million euros and collective catering operators whose number of meals prepared exceeds 2,000 meals per day in this system. This article provides for the submission of a summary document of the donations made by these operators no later than 1 February of each year. This must be sent to the services of the General Directorate for Competition, Consumer Affairs and Fraud Control (DGCCRF). The Government must also submit, within twelve months, a report on the quality and compliance of donations to associations.*

***Article 2nd** draws conclusions from the shortcomings in the application of the law by strengthening its control. Indeed, the DGCCRF investigation carried out throughout 2021 resulted in 345 establishments visited, 66 warnings, and 2 injunctions. The rate of establishments in anomalous is 20.87%. The anomalies noted are the absence of a proposed agreement, agreements not signed or not respecting the required formalities9(*). The operators concerned will also have to establish a quantified and exhaustive assessment, on an annual basis, of the quantities of food wasted.*

***Article 3rd** toughens the sanctions against companies that make food unfit for consumption by replacing the fixed fine set at a maximum of 0.1% with a fine of between 0.1% and 0.5% of turnover. The aim is to combat the downward trend in donations within the large-scale distribution sector, deplored by many associations10(*).*

***Article 4th** constitutes the financial guarantee of this bill.*

** 1 UN, "UN Food Waste Index Report: World Wastes More Than a Billion Meals a Day," UN Environment Programme, March 27, 2024.*

** 2 Marianne Bléhaut, Mathilde Gressier, Antoine Bernard de Raymond, "The Resourcefulness of People Who Don't Always Have Enough to Eat," Crédoc, September 2023.*

** 3 Food Bank Study: "Profiles" Who Are the People Who Receive Food Aid?*

** 4 Nestlé France Foundation, "1st Observatory of Food Vulnerabilities," November 16, 2023.*

** 5 Ministry of Ecological Transition and Territorial Cohesion, Food Waste, June 12, 2024.*

** 6 UN, op. cit..*

** 7 "State of play of the masses of food waste and its management at the different stages of the food chain", ADEME, May 2016.*

** 8 Louise Simondet, "Fight against food waste: the city of Courbevoie rewarded by the United Nations", France 3 Paris-Île-de-France, October 25, 2024.*

** 9 Directorate General for Competition, Consumer Affairs and Fraud Control, "Professionals: how to avoid food waste".*

** 10 In their 2023 activity report, the ANDES association notes, for example, that the share of donations from large retailers in the supply of solidarity grocery stores has fallen, from 35% in 2022 to 22% in 2023.*

The overhaul of the agri-food system, aid for charitable associations and the fight against hunger therefore require the vote on this « Bill aimed at strengthening the fight against food waste » put forward by Senator Marie-Do AESCHLIMANN and which should be supported.

CONCLUSION

As we have analyzed, the social situation is alarming. And faced with this, citizens are legally helpless.

Indeed, the legal tools made available to citizens must be updated and systematically adapted in order to respond to daily concerns: combating food waste and helping to reduce hunger.

As studied in the main part, it is necessary to vote on a new law against food waste because food donations have decreased. However, since the legal framework is insufficiently adapted, this bill will be welcome.

References

1. «Food waste: why we had to make supermarkets give it away» (Arash Derambarsh – Resource): https://resource.co/article/food-waste-why-we-had-make-supermarkets-give-it-away-10853

2. «For a European law against food waste» (The president of the Hauts-de-France region, Xavier Bertrand, Arash Derambarsh, deputy mayor in Courbevoie and Marc Simoncini, entrepreneur, are calling for a European law against food waste - JDD): https://www.lejdd.fr/Politique/xavier-bertrand-veut-une-loi-europeenne-contre-le-gaspillage-alimentaire-3772679

3. «French councillor calls on Europe to adopt 'food waste' supermarket law» (Arash Derambarsh – Guardian): https://www.theguardian.com/world/2015/jul/09/french-food-waste-councillor-calls-on-ec-supermarkets-law

4. «Let's put an end to food waste in Europe» (Arash Derambarsh – Le Monde): https://www.lemonde.fr/idees/article/2015/07/21/mettons-fin-au-gaspillage-alimentaire-en-europe_4692338_3232.html

5. «Why we had to bring mass distribution to bear on food waste» (Arash Derambarsh – Huffington

Post): https://www.huffingtonpost.fr/actualites/article/pourquoi-nous-devions-faire-plier-la-grande-distribution-sur-le-gaspillage-alimentaire_71285.html

6. Åsa Stenmarck (IVL), Carl Jensen (IVL), Tom Quested (WRAP), Graham Moates (IFR): «Estimates of European food waste levels» FUSIONS (2016)

7. BAKKER E. DE, DAGEVOS H., 2012, «Reducing Meat Consumption in Today's Consumer Society: Questioning the Citizen-Consumer Gap», Journal of Agricultural and Environmental Ethics, 25, 6, p. 877-894.

8. Balanza, R, Garcıa-Lorda, P. Perez-Rodrigo, C., Aranceta, J., Bullo Bonet, M., Salas-Salvado, J. (2007) Trends in food availability determined by the Food and Agriculture Organization's food balance sheets in Mediterranean Europe in comparison with other European areas. Public Health Nutrition: 10(2), 168–176.

9. BARNARD A.V., 2016, Freegans: Diving into the Wealth of Food Waste in America, Minneapolis, Univ Of Minnesota Press, 280 p.

10. BLAIR D., SOBAL J., 2006, "Luxus Consumption: Wasting Food Resources Through Overeating", Agriculture and Human Values, 23, 1, p. 63-74.

11. BRADSHAW C., 2013, "The environmental business case and unenlightened shareholder value", Legal Studies, 33, 1, p. 141-161.

12. COHEN L., 2003, A Consumers' Republic: The Politics of Mass Consumption in Postwar. America, New York, Vintage, 576 p.

13. DESOUCEY M., 2010, «Gastronationalism: Food Traditions and Authenticity Politics in the European Union», American Sociological Review, 75, 3, p. 432 455.

14. ERIKSSON M., STRID I., HANSSON P.-A., 2015, «Carbon footprint of food waste management options in the waste hierarchy – a Swedish case study», Journal of Cleaner Production, 93, p. 115-125.

15. EVANS D., 2014, Food Waste: Home Consumption, Material Culture and Everyday Life, Londres, Bloomsbury Academic, 136 p.

16. EVANS D., MCMEEKIN A., SOUTHERTON D., 2012, «Sustainable Consumption, Behaviour Change Policies and Theories of Practice», dans WARDE A., SOUTHERTON D. (dirs.), The Habits of Consumption, Helsinki, Finland, Helsinki Collegium for Advanced Studies, p. 123-129.

17. EVANS, D., CAMPBELL, H., MURCOTT, A. (dirs.), 2013, Waste Matters: New Perspectives on Food and Society, 1e édition, Malden, MA, Wiley-Blackwell, 250 p.

18. Farmers: the reasons for despair. Bankruptcies, lobbies, malnutrition, pollution - the consequences of a system» (Arash Derambarsh, Eric de la Chesnais - Plon): https://www.lisez.com/livre-grand-format/agriculteurs-les-raisons-dun-desespoir/9782259252522

19. For a European law against food waste» (Arash Derambarsh – Le Figaro): https://www.lefigaro.fr/vox/politique/2016/06/03/31001-20160603ARTFIG00377-pour-une-loi-europeenne-contre-le-gaspillage-alimentaire.php

20. For a rehabilitation of the French agri-food system» (Arash Derambarsh – Huffington Post): https://www.huffingtonpost.fr/economie/article/pour-une-remise-en-etat-du-systeme-agroalimentaire-francais_95926.html

21. FRIEDMANN H., MCMICHAEL P., 1989, «Agriculture and the State System: The Rise and Decline of National Agricultures, 1870 to the Present», Sociologia Ruralis, 29, 2, p. 93–117.

22. GENTIL E.C., GALLO D., CHRISTENSEN T.H., 2011, «Environmental evaluation of municipal waste prevention», Waste Management, 31, 12, p. 2371-2379.

23. GENTILINI U., 2013, «Banking on Food: The State of Food Banks in High-income Countries», IDS Working Papers, 415, 18 p.

24. GEREFFI G., HUMPHREY J., STURGEON T., 2005, «The governance of global value chains», Review of International Political Economy, 12, 1, p. 78-104.

25. GEREFFI G., KORZENIEWICZ M., 1994, Commodity Chains and Global Capitalism, Praeger (Contributions in economics and economic history), 350 p.

26. GILLE Z., 2012, «From Risk to Waste: Global Food Waste Regimes», The Sociological Review, 60, p. 27–46.

27. GOODMAN D., DUPUIS E.M., GOODMAN M.K., 2013, Alternative Food Networks: Knowledge, Practice, and Politics, 1ère édition, New York, Routledge, 320 p.

28. HALL K.D., GUO J., DORE M., CHOW C.C., 2009, «The Progressive Increase of Food Waste in America and Its Environmental Impact», PLoS ONE, 4, 11, p. e7940 (en ligne).

29. Law No. 2016-138 of 11th February 2016 relating to the fight against food waste in France

30. Law of January 2, 2023 relating to the fight against food waste in Spain

31. Manifesto against Food Waste» (Arash Derambarsh - Fayard): https://www.fayard.fr/livre/manifeste-contre-le-gaspillage-9782213693866/

32. MICHELETTI M., 2003, Political Virtue and Shopping: Individuals, Consumerism, and Collective Action, Palgrave Macmillan, 262 p.

33. MIDGLEY J.L., 2013, «The Logics of Surplus Food Redistribution», Journal of Environmental Planning and Management, 57, 12, p. 1872-1892.

34. MOURAD M., 2016, «Recycling, recovering and preventing "food waste": competing solutions for food systems sustainability in the United States and France», Journal of Cleaner Production, 126, p. 461-477.

35. NEFF R.A., SPIKER M.L., TRUANT P.L., 2015, «Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors», PLoS ONE, 10, 6, p. e0127881 (en ligne).

36. PACKARD V., 1960, The Waste Makers, New York, Pocket Books, 340 p.

37. Proposed law aimed at combating food waste in France (17th January 2023)

38. QI D., ROE B.E., 2017, «Foodservice Composting Crowds out Consumer Food Waste Reduction Behavior in a Dining Experiment», American Journal of Agricultural Economics, 99, 5, p. 1159–1171.

39. REDLINGSHÖFER B., COUDURIER B.,

GEORGET M., 2017, «Quantifying food loss during primary production and processing in France», Journal of Cleaner Production, 164, p. 703-714.

40. Report of the debates in the Senate concerning the vote on the law against food waste (3rd February 2016)

41. SMIL V., 2004, «Improving Efficiency and Reducing Waste in Our Food System», Environmental Sciences, 1, 1, p. 17-26.

42. Supermarket food waste 'must be banned by EU and US» (Arash Derambarsh - The Independent): https://www.independent.co.uk/news/world/europe/supermarket-food-waste-must-be-banned-by-eu-and-us-demands-french-politician-arash-derambarsh-a6884191.html

43. “Investigation of consumer attitudes, practices and food waste for three food items, to use as input in new packaging designs that aim to reduce food waste” (Helén Williams, Fredrik Wikström, Annika Lindström, Kristina Wickholm, Ann Lorentzon, 2017)

44. Fredrik Wikström, Helén Williams: “Packaging design that reduces food waste and increases recycling” (2023)

45. GARCIA-GARCIA G., WOOLLEY E., RAHIMIFARD S., 2015, «A Framework for a More Efficient Approach to Food Waste Management», International Journal of Food

46. Lisa Mattsson, Helén Williams: “Avoidance of Supermarket Food Waste—Employees’ Perspective on Causes and Measures to Reduce Fruit and Vegetables Waste” (2022)

47. Ng, M. et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013.The Lancet. May 29, 2014

48. “Avoiding food becoming waste in households - The role of packaging in consumers’ practices across different food categories” (Helén Williams, Annika Lindström, Jakob Trischler, Fredrik Wikström, Zane Rowe, 2020): https://kau.diva-portal.org/smash/record.jsf?pid=diva2%3A1440471&dswid=-1009

49. “Avoiding food becoming waste in households: The role of packaging in consumers’ practices across different food categories” (Helén Williams, Annika Lindström, Jakob Trischler, Fredrik Wikström): https://kau.diva-portal.org/smash/record.jsf?pid=diva2%3A1440471&dswid=-1009

50. “COP26 as the convergence of the corporate food-climate agendas” (Tomaso Ferrando): https://repository.uantwerpen.be/desktop/irua

51. “Food Waste In America: One Big Issue, Many Possible Solutions” (Refed): https://refed.org/articles/guest-blog-food-waste-in-america-one-big-issue-many-possible-solutions/#:~:text=35%25%20of%20all%20food%20goes,the%20food%20and%20beverage%20industry.

52. “Food Waste In America: One Big Issue, Many Possible Solutions” (Branch Food): https://www.branchfood.com/blog/food-waste-in-america-refed

53. ADEME (2014). Source: http://ecocitoyens.ademe.fr/mes-dechets/stop-au-gaspillage-alimentaire/a-savoir

54. ALBAL. Source: http://www.al-bal.fr/save_food_abal_fr,2910.html

55. Buurman, R., Velghe, J. Les supermarchés et le gaspillage alimentaire. CRIOC. Edition 2013. Source: www.oivo-crioc.org

56. Buzby, Jean C., Hodan Farah Wells, Bruce Axtman, and Jana Mickey. Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data. EIB-44, U.S. Dept. of Agriculture, Econ. Res. Serv. March 2009. Source: http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib44.aspx#.U6QmY_l_v1Q

57. Combris, P. 2006. Le poids des contraintes économiques dans les choix alimentaires. Cahiers de nutrition et de diététique. 41 (5): 279-284 in: Esnouf, C. Russel, M. Bricas, N. (Coord), 2011. duALine - durabilité de l’alimentation face à de nouveaux enjeux. Questions à la recherche, Rapports Inra-Cirad (France), 236 p. Source: http://www.cirad.fr/publications-ressources/edition/etudes-et-documents/dualine

58. de Sadeleer, Nicolas; Poncelet, Charles. Contestation des actes des institutions de l'Union européenne à l'épreuve de la Convention d'Ahrus. In: Revue Trimestrielle de Droit Européen, no.1, p. 7-34 (janvier-mars 2013). http://hdl.handle.net/2078.3/143196

59. de Sadeleer, Nicolas. Climate Change Litigation in the EU. In: ANU Center for European Studies Briefing paper, (2021). http://hdl.handle.net/2078.3/253340

60. de Sadeleer, Nicolas. Droits fondamentaux et protection de l'environnement dans l'ordre juridique de l'UE et dans a CEDH. In: Revue européenne du droit de la consommation, no.1, p. 25-51 (2011). http://hdl.handle.net/2078.3/143065

61. de Sadeleer, Nicolas. Enforcing EUCHR Principles and Fundamental Rights in Environmental Cases. In: Nordic Journal of International Law, no.81, p. 39-74 (2012). http://hdl.handle.net/2078.3/143136

62. de Sadeleer, Nicolas. Les droits fondamentaux menacés par le changement climatique selon la Cour constitutionnelle allemande. In: Justice en ligne, (2021). http://hdl.handle.net/2078.3/253366

63. de Sadeleer, Nicolas. Les enjeux de l’harmonisation des règles de protection de l’environnement. In: Revue du Droit de l'Union Européenne, Vol. 2021, no.3, p. 149-163 (2021). http://hdl.handle.net/2078.3/253355

64. de Sadeleer, Nicolas. Les pouvoirs publics belges responsables pour une politique climatique déficiente. In: Justice en ligne, (2021). http://hdl.handle.net/2078.3/253361

65. Decree relating to the Walloon Agricultural Code (27th March 2014)

66. Esnouf, C., Jean, S., Redlingshöfer, B. Les nouveaux enjeux liés à la durabilité des systèmes alimentaires. Innovations Agronomiques. 24 (2012), 121-132. Source: http://www6.inra.fr/ciag/Revue/Volume-24-Novembre-2012

67. EUFIC. Food Today. How to minimise food waste. 05/2012.

68. Eurostat 2010 in: Pertes et gaspillages alimentaires: causes, impacts et propositions. Barilla Center for Food & Nutrition (BCFN). 2012. Source: http://www.barillacfn.com/wp-content/uploads/2012/11/WEB_FRA.pdf

69. FAO 2011. Food Loss Reduction Strategy. Source: http://www.fao.org/fileadmin/user_upload/ags/publications/brochure_phl_low.pdf

70. FAO 2011. Gustavsson, J., Cederberg., C. Sonesson, U. 2011. Source: http://www.fao.org/docrep/014/mb060e/mb060e00.pdf

71. FAO 2011. Produire plus avec moins. Guide à l'intention des décideurs sur l'intensification durable de l'agriculture paysanne. Rome. 2011. Source: http://www.fao.org/docrep/014/i2215f/i2215f.pdf

72. FAO 2013. Food wastage footprint. Impacts on natural resources. Summary report. 2013. Source: http://www.fao.org/docrep/018/i3347e/i3347e.pdf

73. FAO 2014. Save food: global initiative on food loss and waste production. Source: http://www.fao.org/save-food/principaux-resultats/fr/ Angl. http://www.fao.org/save-food/key-findings/en/

74. FINE F., LUCAS J.-L., CHARDIGNY J.-M., REDLINGSHÖFER B., RENARD M., 2015a, «Food losses and waste in the French oilcrops sector», OCL, 22, 3, p. A302 (en ligne)

75. Fondation Louis Bonduelle. Les 7èmes Rencontres de la Comportements alimentaires et gaspillage: pertes alimentaires, déni et contradictions. 20 mai 2014. Source: http://www.fondation-louisbonduelle.org/france/fr/tout-sur-la-fondation/les-rencontres-de-la- fondation-louis-bonduelle.html

76. Food in the lives of Paris and Chicago residents" (Thesis Coline Ferrant – 17th december 2020): https://www.theses.fr/2020IEPP0006

77. Food supply procurement: the influence of politics on food supply chains and the governance of local public food services" (Thesis Yoan Robin – 22nd december 2017): https://www.theses.fr/2017PA01E055

78. Foresight. The Future of Food and Farming: Challenges and choices for global sustainability (2011). Final Project Report. The Government Office for Science, London. Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

79. France Nature Environnement. Du gaspillage alimentaire à tous les étages. Dossier thématique. Décembre 2013. Source: http://www.fne.asso.fr/fr/nos-dossiers/dechets/gaspillage-alimentaire/agir.html

80. Gooch, M., Marenick, N., Laplain, D. Dent, B. Cut Waste, GROW PROFIT. Reducing food waste by addressing the disconnect between the attitude and behaviour of producers and managers of businesses situated along the value chain. Value Chain Management International. May 30, 2013.

81. Guardian: https://www.theguardian.com/world/2015/may/25/french-supermarkets-donate-food-waste-global-law-campaign

82. Gunders,D. Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill. Natural Resources Defense Council. August 2012. IP:12-06-B2012. Source: http://www.nrdc.org/food/files/wasted-food-ip.pdf

83. History Food Banks. Source: http://www.banquealimentaire.org/

84. Independent: https://www.independent.co.uk/life-style/food-and-drink/news/man-behind-campaign-for-french-supermarkets-to-donate-waste-food-wants-to-take-law-global-10276028.html

85. La lutte contre le gaspillage alimentaire en France et aux Etats-Unis: mise en cause, mise en politique et mise en marché des excédents alimentaires" (Thesis Marie Mourad – 2nd october 2018): https://www.theses.fr/2018IEPP0014

86. Laisney, C., Soyeux, A., Redlingshöfer, B. (Juillet 2013) Source: http://agriculture.gouv.fr/IMG/pdf/CEP_Document_de_travail_no7_Gaspillages_alimentaires_cle0a419d.pdf

87. L'autorégulation en tant que stratégie hors marché. Une étude exploratoire sur les mécanismes transformant l'environnement hors marché des entreprises" (Thesis Agnieszka Majewska – 14th february 2023): https://www.theses.fr/2023UPSLD012

88. Lundqvist, J., C. de Fraiture and D. Molden. Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief. Stockholm International Water Institute (SIWI), 2008. Source: http://www.siwi.org/documents/Resources/Policy_Briefs/PB_From_Filed_to_Fork_2008.pdf

89. Luxemburger Wort: https://www.wort.lu/de/international/gaspillage-alimentaire-appel-a-juncker-57504feeac730ff4e7f615c3

90. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. BMJ. 1994; 308(6934): 945–948.Source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2539799/pdf/bmj00435-0025.pdf

91. Ministère de l'Écologie, du Développement durable, des Transports et du Logement (2011). Rapport intermédiaire de l'étude relative au gaspillage alimentaire. Juillet 2011. Source: http://www.developpement-durable.gouv.fr/IMG/Rapport%20interm%C3%A9diaire_VF-1.pdf

92. Misonne, Delphine. Droit du climat et de l'environnement - Chronique 2022. In: Journal de droit européen, Vol. 290, no.290, p. 310-318 (2022). http://hdl.handle.net/2078.3/265290

93. Misonne, Delphine. L'actualité des communs à la croisée des enjeux de l'environnement et de la culture. In: Revue interdisciplinaire d'études juridiques, Vol. 81, no. 81, p. 59-82. http://hdl.handle.net/2078.3/207747

94. Misonne, Delphine. L'ambition de l'Accord de Paris sur le changement climatique. Ou comment, par convention, réguler la température de l'atmosphère terrestre ?. In: Aménagement - environnement: urbanisme et droit foncier, Vol. Double numéro spécial "Climat", no. 4, p. 8-26 (2018). http://hdl.handle.net/2078.3/190896

95. Misonne, Delphine. Lire le rapport du GIEC à la lumière de l'affaire Urgenda (et vice-versa). In: Plateforme wallonne pour le GIEC - Lettre

d'information, Vol. 11, no. Octobre 2018, p. 11 (2018). http://hdl.handle.net/2078.3/207759

96. Nanocarbon from food waste: dispersions and applications" (Thesis Aikaterini Kampioti – 9th december 2016): https://www.theses.fr/2016BORD0364

97. O'Brien, D., Aldeen, H.T. Hunger in America 2006. America's second harvest - the nation's food bank network fourth national hunger study. Source: www.hungerinamerica.org

98. Oxfam 2013. Cooper, N., Dumpleton, S. Walking the breadline. Oxfam, Church Action on Poverty. 2013. Source: http://historyofsocialwork.org/1967_food_banks/2013%20OXFAM%20Walking%20the%20Breadline.pdf

99. Pacte national de lutte contre le gaspillage alimentaire. Ministère de l'Agriculture, de l'Agroalimentaire et de la forêt. 2013. Dossier de presse. 14 juin 2013. Source: http://alimentation.gouv.fr/IMG/pdf/250913-Pacte-gapillageAlim_cle4da639.pdf

100. Poverty USA. 2014. Source: www.povertyusa.org

101. Preparatory study on food waste across EU 27. Bio Intelligence Service. European Commission (DG ENV). October 2010.

102. Réduction du gaspillage alimentaire - État des lieux et pistes d'action. Rapport final. Ministère de l'Écologie, du Développement durable, et de l'Energie. Novembre 2012. Source: http://www.developpement-durable.gouv.fr/IMG/pdf/Rapport_final_gaspillage_alimentaire_nov2012.pdf

103. Résolution du Parlement européen du 19 janvier 2012 sur le thème «Éviter le gaspillage des denrées alimentaires: stratégies pour une chaîne alimentaire plus efficace dans l'Union européenne». Parlement européen. Source: Europa (2011/2175(INI)).

104. Restaurants du cœur. Source: http://www.restosducoeur.org/

105. Sambon, Jacques. Les voies de recours en matière d'accès à l'information environnementale: diversité et complexité des régimes applicables. In: Aménagement - environnement, Vol. 2021, no.2, p. 73 (2021). http://hdl.handle.net/2078.3/267609

106. SMED (2011) in Food waste volumes in Sweden. 2012. Swedish Environment Protection Agency. Source: http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8695-4.pdf?pid=11892

107. Source: http://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf

108. Source: http://www.eufic.org/article/en/artid/How-to-minimise-food-waste/

109. Source: www.cutwastegrowprofit.com

110. Soyeux, A. La lutte contre le gaspillage, une solution d'avenir ? Ministère de l'Agriculture et de la Pêche. Service de la statistique et de la prospective. Prospective et Evaluation. Analyse N° 5. Mars 2009. Source: http://agriculture.gouv.fr/IMG/pdf/_Analyse_5_La_lutte_contre_le_gaspillage.pdf

111. Süddeutsche Zeitung: https://www.sueddeutsche.de/wirtschaft/lebensmittel-verschwendungcontainern-1.4331886

112. The "greening" of empire: the European Green Deal as the EU first agenda - Political geography - ISSN 0962-6298-105 (2023) p. 1-10 (Diana Vela Almeida, Vijay Krishnan Kolinjivadi, Tomaso Ferrando, Brototi Roy, Héctor Herrera, Marcela Vecchione Gonçalves, Gert Van Hecken): https://repository.uantwerpen.be/desktop/irua

113. TNS SOFRES. Les Français et le gaspillage alimentaire. 2012. Source: http://www.tns-sofres.com/etudes-et-points-de-vue/les-francais-et-le-gaspillage-alimentaire

114. Tomaso Ferrando and Julie Mansuy: «The European Action against Food Loss and Waste: Co-Regulation and Collisions on the Way to the Sustainable Development Goals» (University of Warwick - November 2018): https://wrap.warwick.ac.uk/109189/

115. University of Stuttgart. Too good for the bin. 2012. Source: https://www.zugutfuerdietonne.de/uploads/media/TooGoodForTheBin.pdf

116. USDA 2014. Source: http://www.usda.gov/oce/foodwaste/

117. Venkat, K. The Climate Change and Economic Impacts of Food Waste in the United States. Int. J. Food System Dynamics 2 (4), 2011, 431-446. Source: http://www.cleanmetrics.com/pages/ClimateChangeImpactofUSFoodWaste.pdf

118. WRAP 2012. Household Food and Drink Waste in the United Kingdom. Final report. 2012. Source: www.wrap.org.uk

119. "D(i)ritto al cibo" (Andrea Segré - 2022);

120. "Lo spreco alimentare in Italia e nel mondo" (Andrea Segré, E. Risso - 2023).

121. L'insosténibile pesatezza dello spreco alimentairere: dallo spreco zero alla dieta mediterranea (Andrea Segré - 2022);

MEDICAL SCIENCES

ANALYSIS OF HOSPITALS IN BULGARIA - SITUATION AND PERSPECTIVES

Zlatanova T.,
Professor in the Department of Health Management and Health Economics, Faculty of Public Health „Prof. Tzekomir Vodenicharov, MD, DSc", Medical University – Sofia
ORCID ID 0000- 0003-1057-6516
Lazarova M.,
Chief assistant professor in the Department of Health Management and Health Economics, Faculty of Public Health „Prof. Tzekomir Vodenicharov, MD, DSc", Medical University – Sofia
ORCID ID 0000-0003-2163-8751
Popov N.
Professor in the Department of Health Management and Health Economics, Faculty of Public Health „Prof. Tzekomir Vodenicharov, MD, DSc", Medical University – Sofia
ORCID ID 0000-0001-6154-4253

ABSTRACT

What is presented in this article are data on the number and distribution of state and municipal hospitals and the beds in them. Bulgaria has a dense network of hospitals - a total of 241 by 2022, including state, municipal and private medical establishments. The total number of hospitals hasn't changes significantly in the past 10 years, but the number of beds in them has been raising gradually from 47 thousand to 54 thousand in 2022. Bulgaria's hospital structure is characterised by overcapacity that isn't reflective of the population's realised need for hospital treatment. The hospital infrastructure available is unevenly distributed across the country's territory, with an over-concentration of hospital structures in the largest cities and a insufficient capacity for satisfying the basic hospitalisation needs in the smaller province centres.

Keywords: state hospitals, municipal hospitals, number, distribution, beds.

INTRODUCTION

Hospital healthcare is the most complex sector in the healthcare system. Hospitals continue to increase many and varied problems despite a series of reforms and changes in search of better and more efficient solutions [4,5]. Regardless of the fact that the priority of any progress in the last 30 years continues to improve the access of Bulgarian citizens to qualified medical care, as well as the increase in the improvement of medical services in practice is not happening [1].

MATERIAL AND METHODS

The purpose of this article is to analyze the number and distribution of state and municipal hospitals in our country for the period 2011-2022.

To realize this goal, the following tasks have been completed:

1. Analysis of normative documents regulating the structure, distribution and activity of medical facilities for hospital medical care.

2. Analysis of the number of medical facilities for inpatient care and beds in them for the period 2011-2022.

The following research methods were used: comparative analysis, documentary method, graphic method for visualizing the obtained results. Various regulatory documents, reporting documents from the NHIF, reports and strategies have been studied.

RESULTS DISCUSSION

Hospitals in Bulgarian are registered as trade companies in accordance with the requirements of trade act, and as such have to follow all requirements of the trade legislations, such as accounting, deadlines, documentation and information availability. It follows that their accounting documents should be available for access by the public to look at and analyse in the Trade Register.

Medical establishments for hospital care in our country are defined in Article 9 of the Medical Establishment Act as hospitals for active treatment, hospitals for continuous treatment, rehabilitations hospitals, hospitals for continuous treatment and rehabilitation. They can be multi-profiled or specialised [10]. Their activity is also regimented in detail in Chapter 4 of the same act. Legislation determines the availability requirements for national and regional hospital maps, which indicate the place and manner of hospital health services needed by the population. The location of hospitals across the territory of the country is chosen based on these maps.

Under the current legislation and the concept for health care system development, health services within the scope of hospital care are structured into the following 3 levels, as follows [9]:

The first level of hospital service has a predominantly local character. The second level of hospital service has a predominantly regional character. The third level of hospital service has a predominantly national character. At that level, in addition to the activities at the third and second level, there are a specialised and ultraspcialised hospital services, which include activities in the scope of all medical specialities, including the incorporation of new medical technologies for diagnostics and treatment, diagnosing and treating rare illnesses, medical scientific research, etc.

The populations hospital care needs are planned for in the Nation Health Map of Bulgaria at the regional and national level. The indicator used is the internationally recognised measure of capacity - "1 hospital bed", which has been used in developing of the currently used

National Health Map. Bulgarian legislation clearly defines a hospital bed (by types and medical specialities) as a measure of capacity, including the activities conducted on it, as wells as the requirements for a hospital bed, according to the established medical standards, including personnel, the medical equipment, spaces, organisations, etc. needed for the activity that guarantee the activity's quality. I.e. after determining the needed number of beds for conducting a particular activity, based on the all the resources, be they human or material, for its realisation can be planned for [6,7,8].

In line with to the adopted regulations on the structure and content of the regional and National Health Maps and the approved Methodology for the development of the Regional Health Maps, the concrete needs for hospital beds and medical activities are planned at the district level according to type and level of competence of the respective structures for all districts, as well as the types of medical activities to be planned at the regional level. The hospital services needs and the capacity needed for their satisfaction, using this methodology, is determined first at the local level, and then the capacity needed for these activities is planned for at the regional and national level based on the levels of hospital service.

The hospital health map currently mostly covers the medical establishments for hospital care that are present, and does not recommend closing excess capacity (the legislation also doesn't set out to determine the capacity as either sufficient or excessive). There is not enough exact information on healthcare not only on the supply but also on demand, which could provide the opportunity for analysing capacity and taking appropriate decisions. According to the newest data by Eurostat Bulgaria has the largest number of hospital beds in the EU compared to the population with 792.3 beds per 100 000 people, whereby the average for the EU is 524.8 beds for 2021. According to the National Health Insurance Fund's information, the beds in use in hospitals rarely go over 50% capacity.

Hospitals in Bulgarian are registered as trade companies in accordance with the requirements of trade act, and as such have to follow all requirements of the trade legislations - for example: accounting, deadlines, documentation and information availability. This means that their accounting documents should be available for access by the public to look at and analyse in the Trade Register.

There is an important question regarding the ownership of capital in those trade companies. Depending on who owns the capital, the hospitals can be divided into state hospitals (in which case the capital is owned by the Ministry of Healthcare), municipal hospitals (in which case the capital is owned by a municipality) and private hospitals. This distinction is used in the current analysis, as at this stage we will not be touching on the private hospital care establishments [2,3].

The main activity performed by hospitals is the diagnostics and treatment of diseases. The majority of these activities are covered by the NHIF, and a minor part is paid directly by the patients, while an insignificant part of the financing received by hospitals comes from health insurance companies. Therefore, clinical pathways are the main tool used to finance the treatment of hospitalised patients [6].

Bulgaria has a dense network of hospitals - a total of 241 by 2022, including state, municipal and private medical establishments. The total number of hospitals hasn't changes significantly in the past 10 years, but the number of beds in them has been raising gradually from 47 thousand to 54 thousand in 2022 [10].

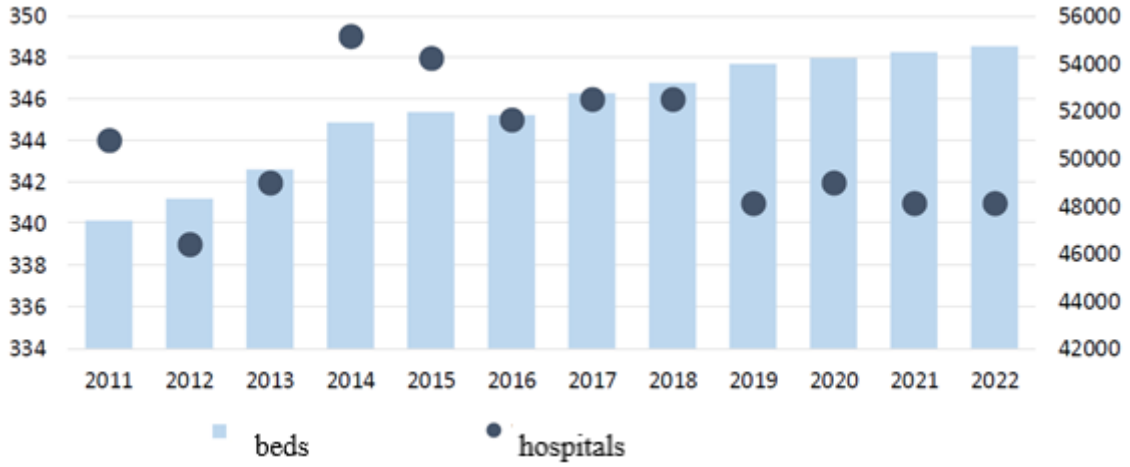

Figure 1. Number of hospitals and bed available in them for the 2011-2022 period.
Source: https://ime.bg/wp-content/uploads/2024/02/hospitals_ime.pdf

In 2022 there were 189 state and municipal hospitals functioning in Bulgaria. 68 were state hospitals, while 121 were municipal. There is a hospital in every of 28 Provinces and in 104 (out of 265) municipalities, usually in the municipality's center town. The majority of hospital is in the capital Sofia. There are seven in Varna, 6 in Plovdiv, five in Vratsa, Veliko Tarnovo and Burgas. There are four hospitals in Haskovo, Stara Zagora, Ruse and Blagoevgrad, and 3 in Pernik. There are 2 hospitals in another 12 towns, and one in each of the remaining 81 towns [10].

The formation of health islands with more hospital care facilities around the capital and Pernik; around Vratsa, Burgas and Varna is of interest. For some of them, the well-developed network is explained by the legacy of state hospitals from the past, which are still

maintained today; by the presence of a medical university around which a whole plethora of medical establishments has been formed; and by purely geographical factors, which do not allow easy concentration of patients. However, the municipalities that lack public hospitals are of greater interest - those around Plovdiv and Pazardzhik, in Dobrudja around Dobrich and Varna, in northwestern Bulgaria, whose residents travel to Vratsa and most probably to the capital when they require hospital treatment [7]. These are most often municipalities that either have a limited population, or are situated in proximity to larger municipalities or province centers.

CONCLUSION:

Bulgaria's hospital structure is characterised by overcapacity that isn't reflective of the population's realised need for hospital treatment. The hospital infrastructure available is unevenly distributed across the country's territory, with an overconcentration of hospital structures in the largest cities and a insufficiant capacity for satisfying the basic hospitalisation needs in the smaller province centres. The current structuring of the hospital beds is ineffective, with a pre beds for active treatment being predominant, while the availability of beds for long-term care is extremely low. According to R. Grozdanova [1], restructuring the hospital sector would require active policy targeted at overcoming the growing imbalances in the population's access to hospital care in the smaller settlements and the over-concentration of hospital capabilities in specific centres by mechanising the National Health Map and incorporating effective regulations for the process of opening new hospitals and hospitalisation structures. Neglecting these problems and postponing adequate government action for their resolution has an extremely adverse impact on the development of the health care system, and consequently on the long-term health of the citizens.

References

1. Grozdanova R., Realities and challenges in the hospital sector - heart hospital capacity or deepening inequalities, magazine Health Policy and Management, vol. 24, no. 2, 2024, S., ISSN 1313-4981, pp. 24-26
2. Yaneva, R. The contemporary hospital, problems and challenge, Kontakti Magazine, vol. 3 (91), 2013, S., ISSN 1311-7939, 46-50 p.
3. Yaneva R., T. Petrova-Gotova. A comparative analysis of the activity of hospitals in Bulgaria. Upravlenie i Obrazovanie Magazine, vol. 16 (1) 2020, pub. "Prof. Dr. Asen Zlatanov" - Burgas University, ISSN 13126121, 46-55p.
4. Stoyanov H., Yaneva, R. Analysis of the Revenues of Large Public Hospitals in Bulgaria. Journal of science Lyon №49/2023. 8-12. ISSN 3475-3281. https://doi.org/10.5281/zenodo.10450732
5. https://www.nhif.bg/bg/hospitals/beds
6. https://www.mh.government.bg/media/filer_public/2023/09/01/gggg.pdf
7. https://265obshtini.bg/map/406
8. https://www.strategy.bg/StrategicDocuments/View.aspx?lang=bgBG&Id=1592
9. https://lex.bg/laws/ldoc/2134670848/ - MEDICAL ESTABLISHMENTS ACT
10. https://ime.bg/wp-content/uploads/2024/02/hospitals_ime.pdf

PEDAGOGICAL SCIENCES

ПРИМЕНЕНИЕ СОВРЕМЕННЫХ ТЕХНОЛОГИЙ В ОБРАЗОВАТЕЛЬНОМ ПРОЦЕССЕ

Давлетова А.Х.
кандидат педагогических наук, доцент,
Евразийский национальный университет имени Л.Н. Гумилева
Тұрлан А.Т.
магистрант ОП "Педагогика и психология"
Западно-Казахстанский инновационно-технологический университет

THE USE OF MODERN TECHNOLOGIES IN THE EDUCATIONAL PROCESS

Davletova A.,
Candidate of Pedagogical Sciences, Associate Professor
L.N. Gumilyov Eurasian National University
Turlan A.
Master's degree student of the Pedagogy and Psychology educational program,
West Kazakhstan Innovation and Technology University

АННОТАЦИЯ

В статье рассматривается актуальность применения современных технологий в образовательном процессе как одного из ключевых факторов повышения качества обучения. Описаны примеры внедрения интерактивных досок, облачных платформ, искусственного интеллекта, игровых технологий. Выделены преимущества использования технологий, в том числе доступность знаний, повышение качества образования и эффективности управления учебным процессом. Также затронуты основные трудности внедрения, такие как неравенство доступа и недостаточная квалификация педагогов. В заключение подчёркиваются перспективы дальнейшего развития технологий в образовании и их значение для формирования цифрового общества.

ABSTRACT

The article examines the relevance of the use of modern technologies in the educational process as one of the key factors in improving the quality of education. Examples of the implementation of interactive whiteboards, cloud platforms, artificial intelligence, and gaming technologies are described. The advantages of using technology are highlighted, including the availability of knowledge, improving the quality of education and the effectiveness of educational process management. The main difficulties of implementation, such as unequal access and insufficient qualifications of teachers, are also touched upon. In conclusion, the prospects for the further development of technologies in education and their importance for the formation of a digital society are emphasized.

Ключевые слова: современные технологии, образовательный процесс, цифровизация, индивидуализация обучения, искусственный интеллект, геймификация, интерактивные платформы, онлайн-обучение, инновации в образовании.

Keywords: modern technologies, educational process, digitalization, individualization of learning, artificial intelligence, gamification, interactive platforms, online learning, innovations in education.

Актуальность применения современных технологий в образовательном процессе как одного из ключевых факторов повышения качества обучения обусловлена стремительными изменениями в обществе и необходимостью подготовки учащихся к жизни в цифровую эпоху. Современные технологии являются неотъемлемой частью всех сфер жизни, включая образование, экономику и науку. Умение пользоваться ИТ-инструментами становится ключевой компетенцией, необходимой для успешной интеграции в профессиональную деятельность. Использование технологий позволяет адаптировать образовательный процесс к индивидуальным потребностям учащихся. Например, платформы с искусственным интеллектом предоставляют персонализированные задания, что способствует лучшему усвоению материала. Улучшение качества образовательного процесса. Цифровые инструменты позволяют визу. Расширение образовательных возможностей. Облачные технологии и онлайн-платформы обеспечивают учащимся доступ к знаниям независимо от их географического положения. Это особенно важно для сельских и удалённых регионов. Подготовка к рынку труда будущего. Многие современные профессии требуют знаний в области программирования, анализа данных, работы с искусственным интеллектом. Применение современных технологий в образовательном процессе актуально как средство повышения качества обучения, создания равных возможностей для учащихся и формирования компетенций, востребованных в современном обществе. Эти технологии способствуют адаптации образовательной системы к вызовам цифровой эпохи, делая её более эффективной, гибкой и доступной.

Автор Широких А.А. в учебном пособии «Информационные технологии в профессиональной деятельности» изложил современные тенденции развития информационных и коммуникационных технологий, раскрыты подходы и принципы использования информационных технологий в профессиональной деятельности, инновационные методики организации образовательного процесса на основе информационных технологий. [2]

Таким образом, применение современных технологий в образовании открывает широкий спектр возможностей, которые значительно повышают качество и эффективность обучения. Среди ключевых преимуществ можно выделить:

Доступность знаний, повышение качества образования, эффективность управления учебным процессом.

Методы

Методика применения современных технологий в образовательном процессе

1. Использование интерактивных досок и планшетов.

Презентации: создание интерактивных презентаций с возможностью взаимодействия учащихся с контентом. Работа с текстом: выделение, подчёркивание, добавление заметок и комментариев. Графические инструменты: рисование, добавление форм, линий, стрелок и других графических элементов. Демонстрация видео и аудио: просмотр и прослушивание материалов прямо на доске.

Рисунок 1. Использование интерактивных досок и планшетов.

Ученные Шарипов Ф.В., Ушаков В.Д. в своей работе «Педагогические технологии дистанционного обучения» раскрываются различные концепции обучения, теоретические основы дистанционного обучения (ДО), вопросы проектирования образовательного процесса, характеристики различных педагогических технологий, проблемы материально-технического, программного, информационно-методического и кадрового обеспечения ДО; рассматриваются различные модели ДО. Особое внимание уделяется вопросам организации различных видов занятий, контроля и оценки результатов обучения; дается краткий обзор использования системы ДО за рубежом и в России. Текстовый материал дополнен графическими моделями. [1]

В нашем случае мы рассматриваем, применение онлайн-платформ для обучения. Видео лекции: просмотр записанных лекций в любое удобное время. Тесты и задания: выполнение заданий и прохождение тестов онлайн. Форумы и чаты: обсуждение тем с другими студентами и преподавателями. Обратная связь: получение комментариев и рекомендаций от преподавателей.

Рисунок 2. Применение онлайн-платформ для обучения.

Работа с электронными учебниками и ресурсами доступ к материалам: возможность скачивания или онлайн-чтения материалов. Интерактивные элементы: встроенные тесты, задания, видео и аудио. Адаптация под разные устройства: возможность чтения на планшетах, смартфонах и компьютерах. Применение мобильных технологий. Мобильные приложения: доступ к материалам и заданиям с мобильных устройств. SMS-уведомления: получение информации о предстоящих событиях и заданиях.

В учебном пособии О. В. Семендяевой «Аудиовизуальные технологии обучения» рассматривается подготовка будущих педагогов к обоснованному и эффективному использованию современных технических, аудиовизуальных и информационно-коммуникационных технологий (ИКТ) в учебном процессе. Пособие также может быть полезно преподавателям различных кафедр для ознакомления с видами и возможностями современных технических устройств. [4]

В современном мире образовательные технологии открывают новые возможности для обучения. Вот несколько примеров их использования:

1. Аудиокниги и подкасты позволяют слушать материалы в любое время и в любом месте,

что особенно удобно для студентов с плотным графиком.

2. Онлайн-конференции дают возможность проводить вебинары и онлайн-встречи для обсуждения тем и обмена мнениями.

3. Чаты и форумы помогают учащимся общаться, обмениваться идеями и получать поддержку.

4. Групповые проекты позволяют совместно работать над проектами и заданиями, развивая навыки командной работы.

5. Автоматизированные тесты упрощают процесс проверки знаний и помогают отслеживать прогресс.

6. Онлайн-портфолио позволяет демонстрировать достижения и проекты, что полезно для карьерного роста.

7. Электронные журналы облегчают отслеживание успеваемости и посещаемости, предоставляя студентам и преподавателям удобный доступ к информации.

Применение технологий для исследовательской работы.

Аналитические инструменты: использование инструментов для анализа данных.

Электронные библиотеки: доступ к научным статьям и исследованиям.

Совместная работа: сотрудничество с коллегами и экспертами. Развитие навыков критического мышления.

Анализ информации: оценка достоверности и надёжности источников. Критическое мышление: анализ и оценка информации с разных точек зрения.

Самостоятельная работа: развитие навыков самостоятельного поиска информации.

Применение современных технологий в образовательном процессе позволяет сделать обучение более эффективным, доступным и интерактивным. Важно адаптировать методики под разные уровни подготовки студентов и использовать разнообразные инструменты для достижения поставленных целей.

Современные технологии играют ключевую роль в развитии образовательного процесса. Они способствуют повышению качества обучения, делают его более доступным, интерактивным и эффективным. Инновации в сфере информационных технологий трансформируют традиционные методы преподавания и открывают новые возможности для студентов и преподавателей.

Искусственный интеллект в образовании

Искусственный интеллект (ИИ) внедряется в образовательный процесс для персонализации обучения. Системы на основе ИИ анализируют успеваемость учащегося, выявляют пробелы в знаниях и предлагают индивидуальные программы обучения. Также чат-боты помогают студентам находить нужную информацию и отвечать на их вопросы в любое время.

Дополненная и виртуальная реальность

Технологии дополненной (AR) и виртуальной реальности (VR) делают обучение более наглядным и интересным. Например, студенты-медики могут проводить виртуальные операции, а школьники изучать исторические события, «перемещаясь» в прошлое с помощью VR. Эти технологии повышают вовлеченность учащихся и помогают лучше усваивать материал.

Геймификация образовательного процесса

Игровые элементы в обучении повышают мотивацию учащихся. Платформы, такие как Kahoot!, Duolingo и Quizlet, предлагают интерактивные задания, которые превращают процесс обучения в увлекательную игру. Это особенно полезно для детей, так как игровой формат помогает легче запоминать информацию.

Облачные технологии и цифровые библиотеки

Благодаря облачным технологиям учащиеся и преподаватели могут хранить и обмениваться учебными материалами в любое время. Google Classroom, Microsoft Teams и другие платформы позволяют организовать совместную работу над проектами, обмениваться файлами и получать обратную связь от преподавателей. Цифровые библиотеки дают доступ к огромному количеству учебных материалов, статей и исследований.

В условиях стремительного развития цифровых технологий и их интеграции во все сферы человеческой деятельности особое значение приобретает вопрос их использования в образовании. Внедрение современных технологий в процесс обучения способствует его оптимизации, повышению гибкости и доступности, а также позволяет адаптировать содержание образования под индивидуальные потребности и особенности учащихся.

Применение цифровых технологий в образовательном процессе способствует решению ряда задач:

Повышение мотивации учащихся. Использование интерактивных элементов, мультимедийных материалов и игровых механик в процессе обучения способствует повышению интереса и вовлечённости учащихся. Индивидуализация обучения. Применение адаптивных систем обучения позволяет адаптировать содержание и темп обучения под индивидуальные потребности и особенности каждого учащегося.

Улучшение качества образования. Использование цифровых технологий позволяет обеспечить доступ к актуальным и качественным образовательным ресурсам, а также предоставляет учащимся возможность самостоятельно исследовать и анализировать информацию.

Выводы

Современные технологии играют ключевую роль в развитии образовательного процесса. Они способствуют повышению качества обучения, делают его более доступным, интерактивным и эффективным. Инновации в сфере информационных технологий трансформируют традиционные методы преподавания и открывают новые возможности для учащихся и учителей. В условиях стремительного развития цифровых технологий и их интеграции во все сферы человеческой деятельности особое значение приобретает вопрос их использования в образовании. Внедрение современных тех-

нологий в процесс обучения способствует его оптимизации, повышению гибкости и доступности, а также позволяет адаптировать содержание образования под индивидуальные потребности и особенности учащихся. Внедрение цифровых технологий в образовательный процесс требует тщательного планирования и подготовки. Необходимо учитывать особенности целевой аудитории, доступные ресурсы и возможности, а также определить цели и задачи использования технологий. Перспективным направлением развития цифровых технологий в образовании является создание адаптивных систем обучения, которые будут учитывать индивидуальные потребности и особенности каждого учащегося. Такие системы позволят обеспечить персонализированный подход к обучению и повысить его эффективность.

Таким образом, применение цифровых технологий в образовательном процессе является актуальным и перспективным направлением развития образования. Оно способствует повышению качества образования, адаптации обучения под индивидуальные потребности учащихся и повышению их мотивации.

Литература

1. Шарипов Ф. В. Педагогические технологии дистанционного обучения [Электронный ресурс] / Ф. В. Шарипов, В. Д. Ушаков. — Москва: Университетская книга, 2016. — 304 с. — Режим доступа: http://www.iprbookshop.ru/66326.html

2. Широких А. А. Информационные технологии в профессиональной деятельности [Электронный ресурс]: учебное пособие. Направление подготовки 050100.68 – «Педагогическое образование» / А. А. Широких. — Пермь: Пермский государственный гуманитарно-педагогический университет, 2014. — 62 с. — Режим доступа: http://www.iprbookshop.ru/32042.html

3. Садвакасова З. М. Социально-педагогические технологии в организациях образования [Электронный ресурс]: учебно-методическое пособие / З. М. Садвакасова, А. К. Асаубаева. — Алматы: Казахский национальный университет им. аль-Фараби, 2013. — 304 с. — Режим доступа: http://www.iprbookshop.ru/70416.html

4. Семендяева О.В. Аудиовизуальные технологии обучения [Электронный ресурс]: учебное пособие / О.В. Семендяева. – Кемерово: Кемеровский государственный университет, 2011. – 156 с. – Режим доступа: http://biblioclub.ru/index.php?page=book&id=232473

PHILOLOGICAL SCIENCES

ПРИРОДА ЧЕЛОВЕЧЕСКОЙ ЛИЧНОСТИ В ФИЛОСОФСКОЙ КОНЦЕПЦИИ А.П.ЧЕХОВА

Смагулова Б.
Кандитат филологических наук, старший преподаватель
Казахский национальный универитет имени Абая
Кокенова З.
магистр педагогических наук, старший преподаватель
Казахский национальный универитет имени Абая
Байнайманова Ж.А.
магистр, преподаватель
Казахский Национальный Аграрный Исследовательский Университет
Ярмухамедова А.
Заместитель директора по учебной работе Гимназия №35

THE NATURE OF THE HUMAN PERSONALITY IN A.P. CHEKHOV'S PHILOSOPHICAL CONCEPTION

Smagulova B.,
Candidate of philology, senior Lecturer
Kazakh National Pedagogical University named after Abay
Kokenova Z.,
Senior Lecturer,
Kazakh National Pedagogical University named after Abay
Bainaimanova Zh.,
Master, lecturer
Kazakh National Agrarian Research University
Yarmukhamedova A.
Deputy Director for Academic Affairs Gymnasium №35

АННОТАЦИЯ

Представление А.П. Чехова об окружающем мире определило ракурс его личностного взгляда на его героев и обстоятельства, в которых они объективно находятся. Это представление о характере связи событий и реальных фактов и способе их отражения в человеческом сознании легло в основу калейдоскопа тем и мотивов, лежащих в основе сюжетных поворотов произведений русского писателя.

Ведущим в мировосприятии А.П. Чехова являлся гносеологический подход, при котором окружающая человека действительность интересна писателю не как предмет художественного воссоздания, а как философский способ отношения к ходу мирового развития, в центре которого помещена человеческая личность.

ABSTRACT

A.P. Chekhov's idea of the world around him determined the angle of his personal view of his heroes and the circumstances in which they are objectively located. This idea of the nature of the connection between events and real facts and the way they are reflected in the human mind formed the basis of the kaleidoscope of themes and motives underlying the plot twists of the works of the Russian writer.

Leading in the worldview of A.P. Chekhov was the epistemological approach, in which the reality surrounding a person is interesting to the writer not as a subject of artistic reconstruction, but as a philosophical way of attitude to the course of world development, in the center of which the human person is placed.

Ключевые слова: поэтика, художественная система, повествователь, авторская концепция, реалистический метод, гносеологический подход.

Keywords: poetics, artistic system, narrator, author's concept, realistic method, epistemological approach.

В чеховском творчестве исследование композиционного и сюжетного уровня литературного текста остается крайне важным, так как дает основание судить об авторской позиции при воссоздании окружающего мира и человеческих отношений, следуя так называемой поэтике объективности.

Одним из методов достижения секрета художественного мастерства А. П. Чехова является сопоставительный анализ. В чеховском творчестве происходит некое «соприкосновение и варьирование объектной формы подачи художественного материала и субъектного подхода к оценке событий, явлений или человеческих характеров, когда читатель явственно слышит голос самого повествова-

теля» [1, 77]. Художественный мир А. П. Чехова обладает аналитическим восприятием отображения реальности и отличается идейной и тематической целостностью. Литературные тексты писателя, содержащие прозу и драматургию, объединяются в некое пространство мысли и творческого вдохновения и «дают возможность выявлять особенность раннего и зрелого творчества писателя» [2, 93]. Поиски некой доминанты или смыслового стержня всего чеховского литературного наследия приведет к опасности нивелирования произведений, относящихся к самым разным периодам писательского становления.

Наиболее плодотворным представляется литературоведческий подход, когда поэтика А.П. Чехова исследуется как единая художественная система. Эта система основана на принципах объективного воссоздания человеческих характеров и неожиданных обстоятельств при видимой случайности отпора самого литературного материала.

Художественный нарратив строится на трех основных опорах, которые представляют собой фигуры повествователя, героя и самого автора. Такая концепция исключает отождествление автора или повествователя с главным персонажем произведения и позволяет разграничить между собой персоналии автора и рассказчика. Еще А.С. Пушкин на заре становления реалистического метода анализа литературного материала утверждал априори заданную разницу между собственно автором и повествователем, живущем в координатах времени и пространства определенного литературного текста.

Если рассматривать творчество А.П. Чехова с точки зрения становления и эволюции художественной манеры, то можно увидеть, что в ранних произведениях превалирует субъектная подача и очевидны авторские реакции при характеристике изображаемых персонажей. В более поздний период усиливается «объективизация художественного рассказа и художественная действительность воссоздается преимущественно с позиции и видения различных персонажей» [3, 81]. Сопоставление этих видений дает возможность читателю понять авторские замечания и главную мысль, заложенную в литературном тексте.

Определенные комические и драматические ситуации раскрываются в художественном нарративе через воспринимающее сознание конкретного героя и дают возможность судить о его моральной позиции, нравственной зрелости и объеме его жизненного опыта. В литературоведении высказывалось мнение о видимой случайности тех тем и сюжетов, которые составляют основу литературных произведений А.П. Чехова. Утверждение о заведомой случайности отбираемого писателем литературного материала говорит о неправильности подхода к анализу совокупности особенностей художественного мира А.П. Чехова. Однако художественный «эффект упрощения и создания иллюзии беспорядочности и хаотичности возможен лишь при выраженной усложненности построения художественного текста» [4, 49].

Философский постулат или определенная идея, которая лежит в основе реализации авторского замысла, не является у А.П. Чехова догматичной. Она не находит полной и конечной реализации в дискуссиях и внутренних размышлениях персонажей. Напротив, это философская мысль или идеологическая установка имеет плавающий, нечеткий, почти пунктирный характер. Читатель не обнаруживает в литературном тексте предысторию зарождения идеи и не прослеживает конечный этап ее развития. Писателя прежде всего «интересует сам процесс бытования определенной идеи или философской позиции в воспринимающем сознании конкретной личности» [5, 37].

Человеческая душа, по мнению писателя, проходит извилистый путь своего земного бытия и подвергается самым различным влияниям окружающего ее внешнего мира. В этом смысл отбор сюжетов чеховских рассказов является «одним из ракурсов авторского видения действительности и сложно взаимосвязан с другими составляющими литературного текста» [6, 85].

В художественном нарративе А.П. Чехова происходит смысловая трансформация определенного события, которая становится отправной точкой движения и развития сюжетного действия. А.П. Чехов воссоздает действительность с потрясающей степенью правдоподобия, и одна сюжетная деталь взаимодействует «с целой цепью различных знаковых деталей и мотивов, которые в итоге позволяют понять действительную позицию самого писателя» [7, 29].

Эмоционально-образные связи, которые обнаруживают авторский ракурс видения действительности, дают возможность исследовать природу чеховской объективности при репрезентации определенного события и образа художественного персонажа. В авторском отношении к герою всегда заложена некая доля иронии, которая преподносится как насмешка самой действительности.

Одним из знаковых особенностей чеховского повествования является открытый характер принципа объективного воссоздания действительности, который «последовательно реализуется на всех уровнях структуры литературного текста» [8, 79].

Представление А.П. Чехова об окружающем мире определило ракурс его личностного взгляда на его героев и обстоятельства, в которых они объективно находятся. Это представление о характере связи событий и реальных фактов и способе их отражения в человеческом сознании легло в основу калейдоскопа тем и мотивов, лежащих в основе сюжетных поворотов произведений русского писателя.

Ведущим в мировосприятии А.П. Чехова являлся гносеологический подход, при котором окружающая человека действительность интересна писателю не как предмет художественного воссоздания, а как философский способ отношения к ходу мирового развития, в центре которого помещена человеческая личность.

Гносеология предполагает непрерывный процесс поиска истины и позволяет писателю углублять проблематику своих литературных текстов.

Чеховская поэтика «направлена на раскрытие законов окружающего мира как целостной системы с помощью эстетического способа его восприятия» [9, 129].

В чеховском художественном тексте изначально заметна внутренняя смысловая диалогичность, когда «происходит взаимодействие внутреннего мира литературного образа и читательского опыта» [10, 73].

Писатель стремится активировать когнитивную сферу своего воображаемого читателя, не пытаясь навязать ему определенные философские или идеологические концепции. А.П, Чехов был внутренне уверен, что глубинные вопросы земного человеческого бытия вечны, а ответы на них преходящи и часто исторически обусловлены.

В философской и эстетической концепции А.П. Чехова как писателя очевидны принципы позитивизма, в основе которого все же лежит внутренняя вера в человеческие силы и возможности на пути познания вечных истин. Но чеховская гносеология построена на убеждении в том, что процесс мировой эволюции живого и неживого последователен и бесконечен, и поэтому «любые человеческие взгляды и объяснения действительности сами по себе всегда будут оставаться в значительной доле относительными и гипотетическими» [11, 109].

Исследуя литературное творчество А.П. Чехова, необходимо говорить о художественной философии писателя, которая заключает в себе всю многогранную картину его представлений, суждений и взглядов на объективную реальность и человеческую природу. Эта картина преломляется и отображается в его сознании в опосредованной форме в виде литературного текста, предлагаемого воображаемому читателю.

Художественная философия предполагает не конкретные оценочные характеристики и критерии, а аналитический подход к оценке явлений, событий и человеческих характеров. Критике казалось, что у философской концепции А.П. Чехова нет некого объединяющего идеологического стержня. Он считался автором, который с эмпирических позиций предоставляет читателю фотографический снимок реальности и выступает в роли агностика, который не ставит своей целью постигать или объяснять какие-либо законы окружающего человека объективного мира.

А.П. Чехова нельзя с определенной уверенностью отнести к какому-либо философскому направлению или школе. Дело в том, что все творчество русского писателя «глубоко философично по своей природе, в нем нет определенной идеологической установки, которая прослеживается и тем самым проясняет авторскую позицию в произведениях Л. Толстого или Ф. Достоевского» [12, 83].

Однако в действительности чеховский взгляд на мир не эмпиричен по своей подлинной сути и его внешняя случайность в отборе сюжетов и тем является мнимой, так на самом деле писатель был подлинным художником и мыслителем.

Картина человеческого бытия и окружающего мира предстает в художественном повествовании А.П. Чехова во всем многообразии сопровождающих ее человеческих знаний, догадок и представлений. Процесс мирового развития виделся писателю «в образе некого бесконечного потока, в котором взаимодействуют и сталкиваются самые различные течения и силы» [13, 53]. Но при всей хаотичности своего взаимного контакта эти силы и течения дополняют и взаимообогащают друг друга. Окружающий человека мир кажется пространством, наполненным явлениями, событиями и процессами, которые лишены внешней логики и какой-либо определяемой человеческим разумом иерархией, но при этом парадоксальным образом составляют некое единое целое, именуемое мирозданием.

А.П. Чехов обращается к человеческой личности как к уникальному субъекту познания, который наделен собственной ценностной ориентацией. Она продиктована его жизненным опытом и социальной средой, в которой эта личность объективно существует.

Окружающее человека мироздание выступают в роли некой абсолютной данности, а человеческие знания о мире имеют относительный характер. При этом в философской концепции А.П. Чехова важно не антологическое, а гносеологическое начало. То есть в основе репрезентации окружающей действительности важно не что является объектом воспроизведения, а как и под каким углом зрения он отражается и объясняется человеческим сознанием.

При гносеологическом подходе к художественному творчеству важен метод осознания человеком окружающего его космоса и земного бытия и принципы человеческой ориентации в этом бесконечном пространстве при «конечности конкретной человеческой жизни» [14, 385].

В основе художественного рассказа у А.П. Чехова часто лежит обычный случай или происшествие, которое прерывают заведенный рутинный ход жизни его героя, как правило ничем неприметного обывателя. Житейская мелочь разрушает привычное и во многом шаблонное представление чеховского героя о жизни, выбивает его из привычной колеи, и действительность поворачивается к нему своей какой-то сложной и крайне запутанной стороной.

Чеховский герой неожиданно для себя делает некое открытие, но подобное прозрение или внезапно возникшее озарение не меняет его нравственные ориентиры и не приносит ему морального возрождения или нравственного роста, как это происходит в романах Л. Толстого и Ф. Достоевского. В результате своего так называемого открытия герой А.П Чехова ничего не достигает в философском или мировоззренческом смысле. Открытия, с которым столкнула его жизнь, приносит герою лишь внутреннее беспокойство и еще раз убеждает в трудности познания законов жизни.

Писатель раскрывает в своем творчестве не суть жизненных явлений и фактов, а реакцию и субъективное представление о них художественных персонажей. Более того, А.П. Чехов внимательно исследует возможность разных субъективных интерпретаций одного и того же явления или события. В центре авторского внимания неизменно

остается способность человека идти по пути непрерывного познания реальности, а также степень его ориентации в окружающем мире. Философская концептуальность художественного мира А.П. Чехова основана на глубинном исследовании самой природы человеческого познания. Писатель не стремится, в отличие, например, от Достоевского облечь в художественную форму при помощи картин и литературных образов свою философскую теорию или определенную идею.

Решение глобальных вопросов, связанных с теорией познания, вовсе не являлось задачей Чехова как философа. Его прежде всего интересовала личность современника, который проживал свою жизнь в обстоятельствах и социально-политических рамках России второй половины девятнадцатого столетия. Концептуальная основа художественного мира А.П. Чехова складывалась на принципе исследования человеческих судеб, которые проходили процесс формирования собственных представлений о жизни. Гносеологическая основа художественного метода русского писателя обнаруживала связь с принципом здорового скептицизма, «суть которого в индивидуализации каждого частного случая, которая непрерывно корректируется изменяющейся действительностью» [15, 281].

А.П. Чехов определял категорию объективности в качестве основополагающего тезиса авторской картины мира. Объективность определяет, с точки зрения писателя, правильность постановки той проблемы или вопроса, который формирует идейно-тематическое ядро литературного текста. Объективность не означает равнодушное фотографирование зла или добра, светлых или темных сторон окружающей действительности и не служит основой для порицания автора за отсутствие нравственных принципов, моральных критериев или идеалов.

Художественный текст не является проповедью и не должен быть перегружен каким бы то ни было морализаторством. Чеховское понимание объективности предполагает «отсутствие любой произвольности, которая препятствует верному пониманию авторской задачи и прерывает естественное развитие сюжетной линии» [16, 77]. Писатель становится в этом случае любопытным наблюдателем и внимательным исследователем окружающего мира, а читателю предлагается роль со-исследователя. Особенно это характерно в жанре малого рассказа, когда Чехов мастерски сжимает собственно авторский текст, оставляя лишь единичные замечания или авторские ремарки. Автор как бы «предоставлял своим персонажам право действовать и говорить самостоятельно, но это вовсе не означало полное устранение авторского голоса и его точки зрения из литературного контекста» [17, 99].

В этом смысле важно понять, что в чеховском нарративе важен сам характер авторского присутствия, в основе которого лежит принцип художественного опосредованного выражения действительности в диалектическом единстве объективного и субъективного.

В концепцию реалистического метода воссоздания окружающей человека действительности входит максимально большее соответствие содержания литературного текста и фактов и событий объективной реальности.

Чеховская художественная манера складывалась в этом смысле на базе творческого освоения предшествующей литературной традиции. В более ранних произведениях писателя очевидна большая активность его голоса, который стремится донести до читателя обобщающую мысли или сентенцию предложенной темы.

Литература

1. Полоцкая Э.А. А.П. Чехов Движение художественной мысли М., 2004- 199с.

2. Сухих И.Н. Проблемы поэтики А.П. Чехова. – М., - 2008. – 287с.

3. Абрамович С.Д. Концепция личности у Чехова-повествователя, - Киев, 1990

4. Художественный метод Чехова. – Ростов-на-Дону, 2002. – 401с.

5. Венцлова Т.О. Чехов как представитель «реального искусства» // Чеховиана. Чехов и «серебряный век». – М., 2006. – С.35-44

6. Билинскис Я.С. О художественной системе Чехова // Чеховские чтения в Ялте: Чехов в меняющемся мире. – М., 2003. - С.84-92

7. Бочаров М.Д. Сюжеты русской литературы. – М., 2009. – 187с.

8. Творчество Чехова. – Ростов-на-Дону, 2008. – 403с.

9. Гиршман Н.И. Повествователь и герой // Чехов и Лев Толстой. - М., 2008. – С. 126-139

10. Цилевич Л.М. Стиль чеховского рассказа. – Даугавпилс, 2004. – 207с.

11. Бочаров М.Д. Сюжеты русской литературы. – М., 2009. – 187с.

12. Дрозда М. Нарративные маски зрелого Чехова. – М., 2000. – 400с.

13. Коберник А.А. Метаморфозы художественной формы в творчестве Чехова (Проблемы изображения) // Метаморфозы культурных форм. – СПБ, 2004. – С.52-54

14. Драгомирецкая Н.В. Объективизация слова героя // Типология стилевого развития XIX века. – М., 2007. – С. 383-420

15. Видуэцкая И.П. Способы создания иллюзии реальности в прозе зрелого Чехова // В творческой лаборатории Чехова. – М., 1974. – С. 279-295

16. Линков В.Я. Художественный мир А.П. Чехова. М., 2002. – 402

17. Гришечкина Н.П. Пушкин и Чехов: повествование «в тоне и духе героев» // Литература и фольклорная традиция. – Волгоград, 1997. – С.98-107

СТРУКТУРА ЛИРИКИ М. ЦВЕТАЕВОЙ В АСПЕКТЕ АНГЛОЯЗЫЧНОЙ РЕЦЕПЦИИ

Сиргебаева С.Т.
Ассоцированный профессор
Т.Жургенов Казахская национальная академия искусств
Ибраева Ж.Б.
Ассоциированный профессор,
Казахский национальный педагогический
университет имени Абая
Даутова С.
Магистр, старший преподаватель
Казахский Национальный Аграрный Исследовательский Университет
Бекбаева Д.Р.
Старший преподаватель, лингвистический центр
Универистета Международного бизнеса

STRUCTURE OF M. TSVETAEVA'S LYRICS IN TERMS OF ENGLISH-LANGUAGE RECEPTION

Sirgebayeva S.,
Associate Professor
T.Zhurgenov Kazakh National academy of arts.
Ibrayeva Zh.,
Associate Professor
Kazakh national pedagogical university named after Abay
Dautova S.,
Senior lecturer
Kazakh National Agrarian Research University
Bekbaeva D.
Senior Lecturer at the Language Center of the
University of International Business

АННОТАЦИЯ

Литературный текст М. Цветаевой представляет собой синтез ярких сравнений, лапидарных метафор и эпитетов. Поэтесса включает в текст синонимы, антонимы и цепочки однокоренных слов, которые создают стихию языковой игры, приём понятие синонимии понимается очень широко. Символическое уподобление объектов и явлений в художественном мире М. Цветаевой происходит не по принципу лексического родства, а в глубоком философском смысле.

В лирических поэмах М. Цветаевой сюжет в традиционном понимании замещается картинами различных эмоциональных состояний и душевных реакций лирической героини. Внутренняя монологическая речь отражала глубины индивидуального сознания и нуждалась в языковых средствах, которые могли бы передать моменты рождения мысли и живое восприятие действительности.

ABSTRACT

The literary text of M. Tsvetaeva is a synthesis of vivid comparisons, lapidary metaphors and epithets. The poetess includes in the text synonyms, antonyms and chains of root words that create the element of the language game, the concept of synonymy is understood very widely. The symbolic likening of objects and phenomena in the artistic world of M. Tsvetaeva does not take place according to the principle of lexical kinship, but in a deep philosophical sense.

In the lyrical poems of M. Tsvetaeva, the plot in the traditional sense is replaced by paintings of various emotional states and emotional reactions of the lyrical heroine. Internal monological speech reflected the depths of individual consciousness and needed linguistic means that could convey the moments of birth of thought and a living perception of reality.

Ключевые слова: критика, поэзия М. Цветаевой, поэтический стиль и язык, художественное слово.

Keywords: criticism, poetry of M. Tsvetaeva, poetic style and language, artistic word.

В стихах М. Цветаевой нет стилевого единства, и она свободно варьирует высокую лексику и литературные обороты с разговорными и даже просторечными выражениями.

М. Цветаева сталкивает в лирическом тексте напевный стих и короткие отрывистые фразы. Стихотворный метр и синтаксис создают при пересечении своих структур повышенную экспрессию поэтического текста. Русская поэтесса активно использует переносы, которые разрушают привычный рисунок стихотворной строки. Поэтесса применяет особенно эффективный приём, когда ставит перенос в конце строфы. Такой способ постановки рождает продолжительную паузу, позволяя сохранить

запас воздуха и нисходящую интонацию при произношении следующих слов. Состояние острого душевного разлада и боли, раздирающей на части сердце. М. Цветаева передаёт при помощи синтаксического переноса: «Связь? Нет, разлад». Пауза является средством напряжения, к которому поэтесса прибегает, чтобы ярче передать эмоциональный порыв и трагизм переживаемой ситуации: «Паузами – пересадками//…Паузами, перерывами//… Паузами, перерубами//… Паузами — ложь, раз спазмами//Вздоха…» [1, 29].

Литературные тексты М. Цветаевой вызывали довольно значительные трудности у переводчиков. Например, стихотворение «Ты, меня любивший фальшью…» построено на основе синтаксической и интоционной симметрии. Тире значительно усиливает паузу, которая разделяет чётную и нечётную строки. Внезапный финал любовной истории, который рождает у лирической героини высокий уровень её эмоционального потрясения, создаётся в поэтическом тексте трёхкратными повторами, усиливающими ритм и энергетику стиха. Этот повтор контрастирует с двумя финальными строчками. Рефлексия лирической героини по поводу утраченных любовных чувств подчёркивается паузами, которые усиливаются при помощи восклицательных знаков: «Истины – и правдой лжи//дальше. Некуда! -За рубежи» Лирическая героиня пытается осознать происходящее, призывая на помощь рассудок и логику, и безжалостно выносит сама себе приговор, который в стихотворном тексте подчёркивается использованием двоеточия: «Ты меня не любишь больше: // Истина в пяти словах».

Перевод на английский язык труден тем, что английская фраза структурируется присутствием глагола. В английском переводе Фейнштейна из трёх цветаевских повторов сохраняются только два, без симметрии и без сохранения цветаевских пауз. Но англоязычный текст «всё же сохраняет градацию нарастания эмоционального напряжения, которое отличало оригинал» [1, 53].

Более внимательное отношение к ритмичной организации и пунктуационным особенностям первоисточника можно увидеть в другом переводе Мак Даффа. В этом англоязычном варианте удаётся сохранить длину цветаевской строки и симметрию начальных и конечных строк стихотворения М. Цветаевой.

В переводе также удаётся передать этапы нарастания эмоционального взрыва в душе лирической героини, который стал следствием её крайне болезненных драматических переживаний. Стихотворный ритм стиха сохраняет резко прерывистый и пульсирующий характер. Переводчик передает спад эмоционального напряжения и фиксирует момент, когда в воспалённом сознании героини всё же включается холодный и безжалостный к сентиментам голос рассудка: “You don’t love me any more://That’s the truth in six words” [2, 59].

Стихотворная строка держится на кратких и предельно сжатых синта5сических формах, и при этом сохраняется плавность перетекания одних лексических единиц в другие: “You, who loved me – beyond all distance!//Beyond boundaries” [2, 60].

Сама М. Цветаева говорила о первичности ритмической организации стиха в процессе поэтического творчества: «Указующее – слуховая дорога к стиху: слышу напев, слов не слышу. Слов ищу» [2, 74].

М. Цветаева признана читательской аудиторией и критикой подлинным мастером полифонии. В её лирике живёт гармоничный синтез разговорных интонаций и народной частушки. Поэтесса владеет искусством стилистики, построенной на коротких, односложных словах, а в жанре русской частушки используются четверостишия с перекрёстной рифмой. М. Цветаева также строит многие лирические произведения с хорейной основой и чередует длинные и краткие строчки.

Прерывистый ритм цветаевского стиха создаёт эффект рубленной интонации, подчёркивающей категоричность и крайнюю убеждённость лирической героини в подлинности своих впечатлений и выводов: «Каждый стих – дитя любви.//Нищий незаконорожденный //Сердцу рай и позор//Кто отец?//…Может царь, может вор» [2, 71].

В английском переводе не слышится категоричности и предельной убежденности лирической героини, хотя большинство лексики составляют односложные слова. Английские читатели желали видеть в переводе лирики М. Цветаевой нечто, максимально близкое по содержанию и форме к оригиналу. Но М. Цветаева и с точки зрения русской лексики, синтаксиса, и с поэзией грамматики была смелым экспериментатором. Но в области рифмы и метра в глазах англоязычного адресата все эти новаторские для русской языковой культуры находки выглядели устаревшими, даже архаичными, так как «англоязычная поэзия давно отошла от правил силлабо-тоники и не придерживалась упорядоченного порядка чередования ударных и безударных слогов» [3, 78].

В стихотворении М. Цветаевой «Как правая и левая рука» переводчик пытается сохранить максимально возможно размер и ритм оригинального текста. Первоисточник содержит множество облегчённых стоп, построенных на пятистопном ямбе. В переводном тексте такой ритмический рисунок сохраняет только первое двустишие.

Уже во втором двустишии вместо пятистопного ямба появляется четырёхстопный, где используются сокращенные формы слов и дополнительные ударения. Такой подход переводчика воспринимается англоязычным читателем как консервативный и уже не отвечающий духу и веяниям современной поэзии.

В лирике М. Цветаевой можно встретить достаточное количество неточных и диссонансных рифм. В них ей была ценна возможность различных сдвигов в характере и расположении тех звуков, которые хотелось рифмовать. Для поэтической русской традиции начала XX столетия эта особенность превратилась в одну из основных тенденций, что подтверждалось многочисленными экспериментами в этой области в литературном наследии многих авторов, в числе которых В. Хлебников, В. Маяковский и многие другие.

М. Цветаева часто строила стихотворную строку на мужских открытых и закрытых рифмах, а в «женских рифмах неточность у неё проявлялась в интервокальной поэзии» [4, 19].

Экспериментальные рифмы особенно отчётливо выделяются в поэзии М. Цветаевой на фоне точных рифм, которые всё же у неё преобладают. Воспроизведение точных рифм при переводе цветаевских текстов на английский язык чаще всего представляет непосильную задачу, и поэтому они заменяются неточными консонансными и ассонансными рифмами, которые создают благозвучие и упорядоченность стихотворной строки с точки зрения переводного языка.

Трудность заключается и в новом способе цветаевской рифмовки строки, где чередуются слоги чётные и нечётные. В английском языке рифмовка нечётных слогов не происходит, что делает невозможным адекватно передать перекрёстную рифму первоисточника.

В качестве примера можно привести стихотворение М. Цветаевой «Молодость моя. Моя чужая молодость». Иная ситуация складывается, если М. Цветаева выбирает попарную рифмовку, как в стихотворении «В огромном городе моём - ночь», где в английском варианте перевода удаётся сохранить точную мужскую рифму.

В синтаксической структуре цветаевских текстов очень часто почти нет глаголов , что является для вдумчивого читателя приглашением к сотворчеству и возможностью предложить свой вариант поэтической фразы: «Сей поцелуй без звука://Губ столбняк.//Так государыням руку,//Мертвым – так...» [4, 42].

Такой экспериментаторский синтаксис укладывался у М. Цветаевой в элептические конструкции, но очень тяжело поддавался англоязычному переводу.

Особую проблему составляли английские артикли и предлоги, которые размывали сжатость и предельную семантическую лаконичность цветаевской поэзии. Вместо глагольных форм М. Цветаева очень часто прибегает к деепричастным оборотам, а так как эта конструкция не обладает категорией времени и модальности, то субъект действия в поэтическом тексте может быть нечётко определен. Такая неопределенность «позволяет вывести смысл литературного текста конкретики определённой частной ситуации к глубокому обобщающему философскому смыслу» [5, 75].

Русская словообразовательная система позволяет приставке придавать исходному слову многообразные оттенки и значения. В лирике М. Цветаевой приставка «рас» – может стать ядром наращивания всё новых смыслов, раскрывая концептуальное значение разорванности и разъединения: «вёрсты, мили, дали распаяли, расслоили, расселили» («Расстояния, вёрсты, мили», 1925). Английский перевод находит возможность транслировать этот приём также одинаковыми префиксами: “dispersed”, “disconnected”, “dissected”.

В поэзии М. Цветаевой придавалось новое значение стёртой семантике слова. При использовании народной этимологии и обращении к исконным корням славянской культуры. Далёкие по значению объекты и явления в воображении поэтессы связываются в едином контексте, порождая смысловое тождество: «Прошлогодний хворост – венки – слова//Пламень – пышет с подобной пищи!».

М. Цветаева использовала тире для графического выделения экспрессии поэтического текста. Англоязычные переводчики отказывались от этого приёма, что вело к семантическому нарушению поэтической фразы. Но в поэме «Крысолов» переводчик удачно сохраняет цветаевское тире и тем самым воспроизводит энергию импульса стихотворной строки: «Мыслью – вестью, страстью – выстрелом» - “Like a thought - a massage – a short – a passion?”.

Русская поэтесса прибегает в своём творчестве к свёрнутым метафорам, которые не переводятся в буквальном смысле на английский язык. Природу русского фольклора характеризуют явления плеоназма и параллелизма, которые не развиты в англоязычной языковой традиции, что составляет также специальную проблему при художественном переводе.

В тексте М. Цветаевой используются повторы отдельных слов и фраз, которые вызывают у читателя необходимые автору аллюзии и ассоциации: «Отказываются быть.//В Бедламе нелюдей//Отказываюсь — жить.//С волками площадей» («Март»). Стихотворение «Март» построено на семантических повторах, но в англоязычном переводе ритмичность цветаевского текста нарушена и в полной мере «не сохранена смысловая нагруженность поэтического текста, так как присутствуют только три синтаксических повтора из четырёх» [6, 93].

Однако есть примеры англоязычных переводов цветаевской поэзии, когда повторы являют собой удачный художественный приём, сохраняя ритмический рисунок и семантическую наполненность поэтической фразы: “O, sorrow flood my eyes” – «О, слёзы на глазах!»; “O, Czechia in tears” – «О, Чехия в слезах».

Литературный текст М. Цветаевой представляет собой синтез ярких сравнений, лапидарных метафор и эпитетов. Поэтесса включает в текст синонимы, антонимы и цепочки однокоренных слов, которые создают стихию языковой игры, приём понятие синонимии понимается очень широко. Символическое уподобление объектов и явлений в художественном мире М. Цветаевой происходит не по принципу лексического родства, а в глубоком философском смысле. Синонимия предполагает «множество вариантов субъективной интерпретации и даёт возможность придания каждому последующему синониму в цепи сопоставляемых новые оттенки смыслов» [7, 63].

Монологичность и глубокий лиризм поэзии М. Цветаевой был понятен англоязычному читателю, так как ролевая лирика входила в национальную языковую традицию. Разговорная тональность нарратива подкреплялась открытыми контактными формами взаимодействия с воображаемым читателем в виде вопросов и восклицаний. Лирический

монолог изначально предполагал ожидаемую адресацию и в русской традиции имел глубокие фольклорные корни.

Основа русского лирического монолога кроется в его исповедальном характере и предельной искренности. В этом состоит его существенное отличие согласно англоязычной ментальности и особенностей национального культурного кода. В англоязычных текстах даже в ролевой лирике сохраняется некая дистанция между автором и его лирическим персонажем. Англосаксонская сдержанность не располагает к предельной открытости душевных порывов и рассматривается как пафосная и несколько фальшивая.

М. Цветаева создала свой собственный поэтический стиль и язык, который отражал её восприятие действительности и концептуально соотносился с художественным процессом её исторической эпохи. Новаторские эксперименты русской поэтессы в области художественного слова отвечали новым тенденциям модернизма в лице наиболее талантливых представителей русского символизма, футуризма, имажинизма и других течений в отечественной поэзии.

Происходил процесс размывания прежде устоявшихся жанровых структур. Новое время силами новых авторов внедрило понятие жанровой вариативности и модальности, провозглашая концепт неосинкретизма, который делал допустимым совмещение различных типов текстов, стилей и в целом трансформацию понятия „художественный метод”.

М. Цветаева вовсе не относилась к числу тех, кто шёл навстречу любым новаторствам с художественным словом. Однако тонкий художественный вкус, умение соблюсти чувство меры позволяли ей демонстрировать лучшие образцы поэтического искусства своего времени. Её индивидуальная манера развивалась в концепции модернизма, но поэтесса очень тщательно относилась к стилю и языковой форме своих произведений. Модернистская эстетика совмещалась в лирике М. Цветаевой с чёткой композиционной структурой. Поэтесса утверждала триединство звука, слова и смысла. В качестве подлинной основы любого значительного художественного творчества.

М. Цветаева серьёзно относилась к иррациональному аспекту литературного процесса, разделяя представления модернизма о том, что язык сам по себе принадлежит к области магического. Согласно такому подходу слово понималось не в качестве некого формального знака предмета, а наделялось само по себе свойством духовности.

Её лирика представая живое воспроизведение глубоко личных эмоций и переживаний в «их непосредственном развитии, представляя перед читателем в виде своеобразного потока авторского сознания» [8, 137].

В лирических поэмах М. Цветаевой сюжет в традиционном понимании замещается картинами различных эмоциональных состояний и душевных реакций лирической героини. Внутренняя монологическая речь отражала глубины индивидуального сознания и нуждалась в языковых средствах, которые могли бы передать моменты рождения мысли и живое восприятие действительности.

Творчество М. Цветаевой позволяет проследить основаные тенденции художественного словотворчества XX столетия, выражавшиеся, в частности, в том, что мышление и восприятие окружающего мира и рефлексия этого процесса становились всё более философски обобщающими и ассоциативными. Конечная смысловая целостность художественного текста складывалась из довольно обширных текстовых частей, которые структурировались также на основе так называемого ассоциативного синтаксиса, как например, в «Поэме лестницы» М. Цветаевой: «Гамма запахов// От подвала - до // Крыши стряпают…» [8, 139].

Русская поэтесса очень тщательно оттачивала инструментовку своей лирической фразы. Звук становился у неё объёмным, получал чёткие рельефные особенности и за счёт аллитераций воспринимался почти физически: «Даль, отдалившая мне близь,// Даль, говорящая: «Вернись!» [8, 140].

М. Цветаеву мало занимало всё то, что лежит на поверхности и объективно существует в мире привычных вещей и предметов. Ей всегда хотелось перейти грань, рубеж обыденности, повседневной рутинности и оказаться в пространстве непознанного и необъяснимого только с позиции строгой логики. Эксперименты М. Цветаевой в области словотворчества были многогранны. Она использовала ряды паронимов и смело разъединяла слова. Это разделение порой приводило поэтессу к открытию первоначального, глубинного значения слова и позволяло иначе оценить потенциальные возможности, изначально заложенные в его семантике. Например, слово «расстояние» означало не только некое отдаление, но и приобретало новые смысловые оттенки: это не только отдаление от чего-то, но и жизнь, жизненное состояние некой внутренней оторванности, это стояние порознь, отдельно от чего-то или кого-то.

Литературные тексты М. Цветаевой предусматривают множество прочтений. В «Поэме Воздуха» описание объективного события, когда был впервые в истории в июне 1919 года британскими летчиками был успешно осуществлён трансатлантический перелёт, осмысливаются как бесконечные возможности человеческого духа, способного к преодолению любых границ пространства и времени.

Многозначность поэтического слова М. Цветаевой позволяет расширить банальное значение одного слова и соединить его со словом, имеющим более широкий философский смысл. В «Новогоднем» слово «сплёты» ассоциируется и с житейским бытовым значением «сплетни», и со словом «сплетение», означающим неразрывное единство жизненного начала и смерти, как его изначально заданного финала: „жизнь и смерть давно беру в кавычки,//Как заведомо-пустые сплёты».

М. Цветаева ждала от своего читателя сопереживания и очень вдумчивого погружения в её художественный мир.

В лирике М. Цветаевой можно найти примеры самоцитатности, когда она ожидает от своего адресата знания своих предыдущих текстов. Самоцитатность и насыщенность поэтического произведения библейскими аллюзиями и отсылками к текстам других литературных авторов превращает художественное наследие русской поэтессы в один сплошной связанный воедино текст, «наполненный ассоциациями, знаковыми деталями, символами и ёмкими художественными образами» [9, 175].

М. Цветаева никогда не находилась в рамках и пределах концепции одного конкретного литературного направления или художественного метода. Критика обнаруживала в её поэзии поэтические приёмы и эстетические находки, связанные с символизмом, акмеизмом, эстетическим футуризмом, но саму поэтессу это мало занимало.

В процессе литературного творчества она усматривала важнейшую роль бессознательного, и в этом критика находила созвучие с эстетикой символизма.

Откровенное непринятие мещанства и низменной меркантильности сближали эстетическую поэзию М. Цветаевой с поэзией футуристов.

Англоязычная критика находила в творчестве русской поэтессы высочайший интеллектуальный уровень, непревзойдённую высочайшую степень оригинальности и новаторства её поэзии и присущую ей филигранность и сложность литературной техники.

Русская эмиграция двадцатых годов прошлого века очень много сделала для популяризации поэзии М. Цветаевой в Великобритании. М. Цветаева посещала Англию, но чувствовала себя там порой не совсем уютно, так как не владела английским языком.

В Англии стали выходить в свет научные работы с тщательным исследованием поэзии М. Цветаевой. Солидный анализ поэтики лирики русской поэтессы содержался в монографии С. Карлинского, который собрал множество разнообразного материала, отрывающего многогранность личности М. Цветаевой и обозначающего ее место в мировом художественном процессе. Жизненный и творческий путь М. Цветаевой нашел отражение в эссе, сохранившихся письмах и обобщенном библиографическом материале.

В 60-ые годы XX столетия русская читающая аудитория получила возможность познакомиться с первым научно подготовленным изданием стихов М. Цветаевой. Собрание цветаевских произведений публиковались в эти годы и в Америке. И. Бродский написал предисловие к двухтомному сборнику цветаевской лирики, который увидел свет в Нью-Йорке.

Исследования англоязычных авторов позволяли приобщиться к русской национальной культуре и ощутить богатство русского языка и его возможности в овладении поэтической техникой. Критики, среди которых Элен Фейнштейн, Питер Франс, Рональд Хингли и многие другие, пытались исследовать стилистику и ритмику цветаевской поэзии в контексте литературного движения её эпохи и рассматривали проблематику произведений русской поэтессы в историческом контексте.

Была сделана удачная попытка сопоставить литературное творчество М. Цветаевой с поэтическим наследием её современников, в числе которых были такие выдающиеся персоны, как А. Ахматова, Б. Пастернак, И. Мандельштам.

Поэзия М. Цветаевой рассматривалась как общекультурный феномен, который определил мировоззрение и творческую манеру многих западноевропейских и американских поэтов. Стилистика, синтаксис и ритмическая организация цветаевской лирики послужила мощными стимулом к поэтическим открытиям, которые определили литературное развитие не только отечественного словесного искусства, но и будущих выдающихся достижений в области мировой культуры.

Литература

1. Айзенштейн Е. Построен на созвучиях мир. Звуковая стихия М. Цветаевой. СПб, 2000. - 403с.

2. Цветаева М. Собрание сочинений в 7-ми томах. –Т.6, кн,2,-М., - 1998.

3. Livingstone A. Marina Tsvetaeva and Russian Poetry// Melbourne Slavonic studies. - 2007. - P. 109-120

4. Mirsky D. A Russian letter: Recent Developments in poetry: Poetry and politics // the Londov Mercury. - 2011.- T.IV .-19 p.

5. Карлинский S. Marina Tsvetaeva Poetry. - N.Y.-2007.208 p.

6. Mc.Duff Note on translatiry Tsvetaeva// Marina Tsvetaeva . Selected Poems. Newcastle- upon- Tyne, 2008.-107 p.

7. Nayden M. A note on the Translation// Marina Tsvetaeva. After Russia// Trasi, by M.M. Nayden with S. Yastremssi- Ann arbot, 2012. — p. 62-69.

8. От символизма до обернутое. Поэзия русского модернизма.-М.,2001.-297с.

9. Минералов Ю.И. Теория художественной словесности(поэтика и индивидуальность. - М, 1999.-283с.

НРАВСТВЕННЫЕ КАТЕГОРИИ ЛИЧНОГО СЧАСТЬЯ И НРАВСТВЕННОГО ДОЛГА В СВЯЗИ С ПОНЯТИЕМ И СОДЕРЖАНИЕМ И СОДЕРЖАНИЕМ КУЛЬТУРНОЙ ПАМЯТИ В ПРОЗЕ И. ТУРГЕНЕВА

Цой А.А.
доктор педагогически х наук, доцент
Казахский Национальный медицинский университет
имени С. Асфендиярова
Тохтамова Р.К.
Старший преподаватель, лингвистический центр
Универистета Международного бизнеса
Бердышева Г.А.
Старший преподаватель,
Казахский Национальный Аграрный Исследовательский Университет
Унайкулов К.Р.
Магистр
Казахский национальный универитет имени Абая

MORAL CATEGORIES OF PERSONAL HAPPINESS AND MORAL DUTY IN CONNECTION WITH THE CONCEPT AND CONTENT AND CONTENT OF CULTURAL MEMORY IN PROSE BY I. TURGENEV

Tsoy A.,
Doctor of Pedagogical Sciences, Associate Professor
Kazakh National Medical University named after S. Asfendiyarov
Tokhtamova R.,
Senior Lecturer at the Language Center of the
University of International Business
Berdisheva G.,
Senior Lecturer
Kazakh National Agrarian Research University
Unaikulov K.
Master
Kazakh National Pedagogical University named after Abay

АННОТАЦИЯ

Мировоззрение И. Тургенева изначально диалектично. Образ лишнего человека в тургеневских повестях 1850-х годов расширяется и усложняется. Вечные архетипы, порожденные эстетикой сентиментализма и романтизма и живущие в далёкую эпоху античности, а также философское видение природы и человека в наследии Гегеля и Шопенгауэра, дают писателю возможность раскрыть всю гамму духовных исканий и эмоциональных переживаний его героев и самому присутствовать в философских дискуссиях на уровне репрезентации авторской позиции.

Личностную основу представления о категории счастья во многом составляет культурная память. Это особенно характерно для творчества И. Тургенева, который разрабатывал проблему достижения личного счастья своих героев, исходя из особенностей своего этического и философского взгляда на окружающий мир, что позволяет говорить об автобиографической основе его литературных текстов.

ABSTRACT

The worldview of I. Turgenev was initially dialectical. The image of an extra person in Turgenev's stories of the 1850s expands and becomes more complicated. The eternal archetypes generated by the aesthetics of sentimentalism and romanticism and living in the distant era of antiquity, as well as the philosophical vision of nature and man in the heritage of Hegel and Schopenhauer, give the writer the opportunity to reveal the full range of spiritual searches and emotional experiences of his heroes and be present in philosophical discussions at the level of representation of the author's position.

The personal basis of the idea of the category of happiness is largely cultural memory. This is especially characteristic of the work of I. Turgenev, who developed the problem of achieving the personal happiness of his heroes, based on the peculiarities of his ethical and philosophical view of the world around him, which allows us to talk about the autobiographical basis of his literary texts.

Ключевые слова: ментальная сущность, культурная память, культурная традиция, саморефлексия, интроспекция, архетип.

Keywords: mental essence, cultural memory, cultural tradition, self-reflection, introspection, archetype.

Понятие человеческого счастья является ментальной сущностью и входит в область личностного сознания в ряду таких фундаментальных понятий, как любовь, жизнь, смерть. Представление о счастье отдельной личности субъективно, но в этом личностном аспекте очень важен некий базовый архетипический элемент, который охраняет эстетические, исторические и национальные особенности той эпохи и той социально-общественной среды, в которой находится определенный человек.

Личностную основу представления о категории счастья во многом составляет культурная память. Это особенно характерно для творчества И. Тургенева, который разрабатывал проблему достижения личного счастья своих героев, исходя из особенностей своего этического и философского взгляда на окружающий мир, что позволяет говорить об автобиографической основе его литературных текстов.

Осмысление содержания проблемы счастья и его возможного достижения в человеческой жизни проходит через всю мировую культурную традицию. Об достижении счастья писали также выдающиеся умы античности и средневековья как Аристотель, Эпикур, Фома Аквинский и многие другие. Эта же проблема входила в интересы Гельвеция, Канта и Фейербаха в последующие исторические эпохи. Однако философский спор о счастье по сути сводился к двум позициям: первая в понятиях эвдемонизма признавала изначально стремление личности быть счастливой в своей земной жизни, а вторая установка, «сформулированная в категориях деонтологизма, считала счастье следствием следования добродетели и признания основополагающих моральных норм» [1, С. 19].

В античном мире Эпикура отстаивалось право человека на телесные и духовные наслаждения, в силу чего счастье понималось как достигнутое удовольствие. С той точкой зрения были согласны теоретики «разумного эгоизма» и в эпоху Нового времени.

Стоики, такие как Сенека и Спиноза, признавали источником счастья добродетель, а счастливым становится человек, который перед лицом смерти не отказывается от своих убеждений, отстаивая, тем самым вопреки всему своё нравственный выбор.

И. Тургенев был согласен с тем, что счастье состоит в возможности отдельной личности продуктивно реализовать свои возможности. Отсюда представление о счастье индивидуально и характеризует и тип личности, и её интересы, и желания. Проблема человеческого счастья разрабатывается И. Тургеневым в повестях 1850-х годов, героем которых является так называемый «лишний человек» своего времени. В повести «Затишье» (1854) в этом ключе разрабатывается образ Веретьева. Он выделяется своими способностями из мелкопоместной дворянской среды. Но свою образованность, энергичность, артистизм и музыкальную одаренность Веретьев растрачивает впустую. Он не заражен саморефлексией, не думает о будущем и предпочитает жить одним днём. Влюбленная в него Марья Павловна слушает его шутливый тон по отношению к себе и с горечью говорит, что он так прошутит впустую всю свою жизнь. Но его внешне шутовская натура скрывает собственное осознание полной жизненной бесполезности, и потому содержание счастья укладывается «в швырянии себя куда хочешь» [2, Т. IV, С. 400], «Были бы две-три женщины, да, извините за откровенность, вино и человеку, право, ничего не останется желать» [2, Т. IV, С. 410].

Для характеристики взаимоотношений Веретьева и Марьи Павловны И. Тургенев использует цитирование пушкинского стихотворения «Анчар». В нем раб, посланный владыкой за смертельным ядом, смиренно выполняет приказ и также безропотно принимает собственную гибель. Это стремление к жертвенности отличает и Веретьев в Марье Павловне. Он говорит, что в ней совершенно отсутствует эгоизм, который заменяется заботой о других и откровенно признается, что не стоит такой степени её привязанности. Возникает культурный диалог между пушкинским текстом и тургеневским нарративом, и «возникшие ассоциативные параллелями активизируют культурную память читателя» [3, С. 291].

Проблема счастья связана с категориями чувственного и духовного и траектория её раскрытия заявлена уже в эпиграфе повести И. Тургенева «Фауст» – «Отречься ты должен отречься». Эта фраза из одноименной трагедии Гёте характеризует эмоциональный тон, структуру и композиционные особенности тургеневского текста. Художественный нарратив, данный автором в эпистолярной форме, представляет собой поток сознания героя, сосредоточенного на саморефлексии. Переживание гётевского «Фауста» приводит тургеневского героя к мысли о том, что весь его прежний жизненный опыт оставляет всё же что-то важное, чего он ещё не изведал.

Подобно Фаусту Павел Александрович хочет испытать неувиденные и ускользающие от него мгновения ощущения счастья.

Взаимоотношения тургеневского героя с Верой Николаевной – это история нравственного испытания и искушения любовью. Девушка воспитывалась её матерью в ограниченных рамках общения и образования, исключавших любое чтение художественных текстов, способных мотивировать её эмоциональное возбуждение и душевные волнения.

Павел Александрович искушает её ум и воображение чтением гётевского «Фауста», и она пробуждается, как от тяжёлого сна, и начинает отходить от рационального, прагматичного подхода к жизни, навязанного ей её матерью.

В нарративе И. Тургенева дана история предков Веры Николаевны, которая репрезентует связь человеческой судьбы со судьбами и жизненными историями предшествующих поколений. Несчастная в личной жизни, мать Веры Николаевны госпожа Ельцова не хотела повторения своего жизненного пути в судьбе своей дочери и поэтому всеми усилиями ограждала её от впечатлений и влияния, которые могли бы вызвать у неё эмоциональное по-

трясение и пробудить в ней природную чувственность. Приобщение Веры Николаевны к тексту гётевского Фауста как бы пробуждает её от эмоционального забытья, и она становится похожа на свою итальянскую бабушку, навевая соотношение с главной героиней знаменитого романа аббата Прево. И. Тургенев также разделял мнение, что это произведение принадлежит к шедеврам мировой литературы и даже работал над его переводом на русский язык.

Литература семнадцатого столетия изображала личность, находящуюся во внутренней борьбе между чувством всепоглощающей страсти и чувством общественного долга или общепринятым понятием о чести. В романе аббата Прево образ Манон Леско репрезентует чувство любви и страсти, абсолютно свободное от каких-либо политических, нравственных или философских категорий. Героиня воплощает представление о легкомысленной и беспечной грешнице, которая обладает непобедимой силой очарования и способностью радоваться и упиваться каждым днём или далее минутами своего земного бытия.

Тургеневский нарратив также соотносится с «Божественной комедией» Данте. Павел Александрович вновь встретил Веру Николаевну спустя почти десятилетия, как и Данте свою Беатриче [4].

В Аду Данте узнаёт трагичную историю Франчески, которая приняла смерть от своего мужа за преступную любовь к его младшему брату. Такая же ситуация возникает у Веры, её мужа и Павла Александровича, то есть возникает треугольник, в котором происходит сближение замужней Веры и Павла Александровича, приводящее героиню к трагическому финалу.

Занимаясь саморефлексией, Павел Александрович признается самому себе, что в его тридцать семь лет к нему пришло настоящее чувство. В то время, когда ты решил, что настало время жить размеренно, с некой пользой и занимаясь нужным другим людям делом, любовь обрушилась на его голову, как внезапный удар. Она стала тяжёлым испытанием, ибо для тургеневского героя – это везде некий жизненный выбор между эгоистическим желанием и необходимостью следовать долгу.

Ни Павел Александрович, ни Вера Николаевна не могут противиться вспыхнувшей между ними страсти, но она переворачивает сознание героини, яростно опровергает все прописные и, казалось, прежде незыблемые истины, которыми она руководилась раньше. Всё, во что она верила, рухнуло в одночасье, и это в итоге надломило её психику и привело к физической гибели. Жить без чувств и любви тургеневская героиня с детства умела, а жить, переполненная чувством любви, не смогла. Критик Д. Писарев, современник И. Тургенева, писал по этому поводу, что глаза, привыкшие к полной темноте, не выдержали яркого света.

Культурная память героя раскрывается в процессе интроспекции и проецирования прошлого на сегодняшний день. В этом смысле можно говорить об автобиографичности сюжета, так как в эти годы сам писатель задумывался о неустроенности собственной личной жизни и отсутствии семейного гнезда. Эти мысли сопровождались сомнениями в своём литературном даре и побуждали размышлять о бесцельности земного существования.

Главный герой «Фаусте» Павел Александрович воплощает типичные черты русского интеллигента, ставшего «лишним человеком» в русской действительности 30-40-х годов XIX столетия. Возвращение в родное гнездо после девятилетних скитаний соединяет в его культурной памяти прошлое и настоящее. Он эмоционально и духовно воскресает среди звуков и красок родной земли и родной природы. Глаз улавливает зелёный и нежный цвет листвы, и он чувствует тонкий запах воздуха, в котором слышится воркование горлинок и голос зябликов.

Сам И. Тургенев в письме к Валентине Деласcер от 5 июня 1865 года признавался в близости описания родового поместья в «Фаусте» и собственного Спасского. В душе тургеневского героя восстанавливается душевный покой и приходит внутреннее осознание нетленности всего прекрасного. Павел Александрович размышляет о смысле жизни через те устойчивые образы – символы, которые сохранили в его сознание благодаря родной почве, образованию и воспитанию, то есть культурной памяти.

В своём доме тургеневской герой находит заплесневелый от времени томик «Фауста» Гёте. В «Посвящении» автор говорит, что хотел бы вернуться к замыслам и местам своей юности и признавая неизбежность бега времени, дать им новую жизнь, новое переосмысление с высоты прожитых лет, когда «насущное отходит в даль, а давность // Приблизившись, приобретает сущность» [2, Т.3, С. 13].

Переосмысление прошлого даёт силы почувствовать настоящее, ощупать свою моральную готовность к новым чувствам и проживаниям.

Смерть Веры потрясла Павла Александровича, и он не мог отогнать мысли о трагической судьбе этой женщины. В итоге он глубоко раскаивается в том, что вторгся в размеренное существование супружеской пары, пробудил те чувства, которые стали причиной фатального финала. Жизнь, заключает тургеневский герой, вовсе не забава и не наслаждение, а готовность к долгу и самоотречению.

Такая концепция соотношения личного счастья и нравственного долга созвучна авторской идеи пушкинского романа «Евгений Онегин». С этим романом также благодаря Павлу Александровичу познакомилась и Вера. В тургеневское повествование включена прямая цитата из этого романа, когда герой размышляет о прошлом и настоящем. В пушкинском цитировании, где «другие умы – другие сны» ощутимо смирение героя перед навсегда ушедшей молодостью и наступившей порой зрелости, в которой нет места высокопарным романтическим метаниям.

Центральный контрапункт тургеневской повести (отречься, отречься) заявлен автором в её названии. «Фауст» Гёте входит в художественную ткань литературного текста И. Тургенева, становится частью культурной памяти героев, посредством кото-

рой они начинают воспринимать и себя, и окружающий мир. Эти фаустовские реминисценции мотивируют движение сюжета, существуют в сознании тургеневских персонажей, разрешают художественный конфликт и определяют решение философской концепции о вероятности достижения человеческого счастья. В одно пространство культурной памяти, которая строится на цепи ассоциативных связей, объединяются тексты Гёте, Пушкина, Данте и аббата Прево, которые являются средством воссоздания психологии и духовного мира персонажей И. Тургенева и входит в содержание культурной памяти самого писателя

Мировоззрение И. Тургенева изначально диалектично. Образ лишнего человека в тургеневских повестях 1850-х годов расширяется и усложняется. Вечные архетипы, порожденные эстетикой сентиментализма и романтизма и живущие в далёкую эпоху античности, а также философское видение природы и человека в наследии Гегеля и Шопенгауэра, дают писателю возможность раскрыть всю гамму духовных исканий и эмоциональных переживаний его героев и самому присутствовать в философских дискуссиях на уровне репрезентации авторской позиции.

Самосознание тургеневских героев отнюдь не тождественно авторскому, и авторский голос является выражением некого сверхсознания, которое доносит читателю основную идею литературного текста путём репрезентации всевозможных ассоциаций и реминисценций, которые проясняют образ и жизненную позицию предъявленных на суд читателя художественных характеров.

Литература

1. Недзвецкий В.А. История русского романа XIX века. – М., 2011. – 153 с.
2. Тургенев И.С. Полное собрание сочинений и писем в 30-х томах. — М., 1990.
3. Кристева Ю. Знамения на пути к успеху // Интенциональность и текстуальность. Философская мысль Франции XX века – Томск, 1998 – С. 289-296.
4. Данте Алигьери. Новая жизнь. Божественная комедия. — М., 1967. — 640с.

PHYSICS AND MATHEMATICS

PHYSICAL FEASIBILITY OF TIME TRAVELS[17]

Antonov A.
PhD, HonDSc, H.Prof.Sci
Independent researcher, Kiev, Ukraine

ABSTRACT

The article argues that the version of the special theory of relativity (SRT), which is generally recognised and studied in all physics textbooks, is incorrect. And numerous proofs are given to it. SRT on the one hand and all radio engineering, electrical engineering and computer technology on the other hand mutually refute each other. SRT is also refuted by the existence of resonance and shock oscillations. I.e. if SRT were true, then neither computers, nor mobile phones and smartphones, nor television, nor GPS trackers, nor pianos and other musical instruments should exist, nor even tsunamis should not exist and swings on children's playgrounds should not swing after a push from parents. Consequently, to refute SRT it was not necessary to invent some very expensive experiments on Tevatron and Large Hadron Collider. And it was necessary simply to look around and to understand that the generally recognised version of SRT is refuted by numerous all known and therefore irrefutable natural and created by people processes. And, hence, SRT should be corrected.

Therefore the author has created the corrected version of SRT, from which relativistic formulas and new scientific knowledge received after creation of incorrect version of SRT it followed that in the nature there is not only our visible universe, but besides it there are many other mutually invisible universes and antiverse. And besides existing in universes of matter, space and time, in antiverses there exist antimatter, anti-space and anti-time. And the existence of anti-time makes travelling in space possible not only in space but also in time. And the article explains how it can be done now.

Keywords: imaginary numbers; special theory of relativity, invisible universes and anti-universes, hidden Multiverse, portals, anomal zones.

1. Introduction

The 20th century in physics turned out to be rich in new interesting scientific ideas. But many of them, even called theories, have not yet received experimental confirmation. For example, one of the most prominent and currently studied in all physics textbooks is the special theory of relativity (SRT) [1]-[3], which was nominated 66 times for the Nobel Prize, nevertheless, due to the lack of experimental confirmation, it has not received it.

And from the very beginning, the generally accepted version of SRT was criticised by Oliver Heaviside, Nikola Tesla, Nobel Prize winner Albert Abraham Michelson, Nobel Prize winner Wilhelm Frederick Ostwald, Nobel Prize winner Joseph John Thomson, Nobel Prize winner Svante August Arrhenius, Nobel Prize winner Philipp Eduard Anton von Lenard, Nobel Prize winner Alvar Gulstrand, Nobel Prize winner Wilhelm Carl Werner Otto Fritz Wien, Nobel Prize winner Walter Hermann Nernst, Nobel Prize winner Ernest Rutherford, Nobel Prize winner Johannes Stark, Nobel Prize winner Frederick Soddy, Nobel Prize winner Percy Williams Bridgman, Nobel Prize winner Edwin Mattison Macmillan, Nobel Prize winner Hideki Yukawa, Nobel Prize winner Hannes Olof Jösta Alven and many other distinguished scientists.

And in the XXI century this wrong version of STO was even by the above-mentioned arguments experimentally refuted [4]-[37] in the most indisputable way. However being unable to object, the authors of existing physics textbooks simply ignored these refutations and the incorrect version of SRT still continues to be taught even in the most prestigious universities in all countries.

All modern science is in a similar state. In the 21st century Jean de Climont in his books [34]-[37] writes about 9671 scientists who refuted the currently recognised scientific truths in all sciences. But the trouble is not that one or another infidelity has been discovered in the modern sciences. The author of the concept of 'open society' Sir Karl Raimund Popper, a member of the Royal Society of London, wrote [38]: *"...the struggle of opinions in scientific theories is inevitable and is a necessary condition for the development of science"*. From which he made, at first glance paradoxical, but in fact correct conclusion that the most valuable results of scientific research are precisely the refutations of generally recognised theories, because they allow them to develop. And this is inevitable. There is no doubt that all scientific knowledge in a thousand years, much less in a million or a billion years, will be quite different. Therefore, we should not naively assume that we have already learnt everything and hinder the research of colleagues who propose new ideas.

2. The version of the special theory of relativity taught in all physics textbooks is incorrect

So what are the refutations of the generally recognised version of SRT obtained during the last century? They are the following:

- the relativistic formulas obtained in this SRT are incorrect;
- the relativistic formulas received in this SRT are incorrectly explained with use of incorrect principle of non-exceeding of speed of light;

[17] This is reprint of the article “Antonov A.A. 2025. Time travels for people on Earth are already possible. European Journal of Applied Sciences, Services for Science and Education. UK. 13(1). 163-180. DOI:10.14738/aivp.131.18239”.

- from relativistic formulas of this SRT wrong conclusions about physical unreality of imaginary numbers and existence in the nature of our only visible universe are made.

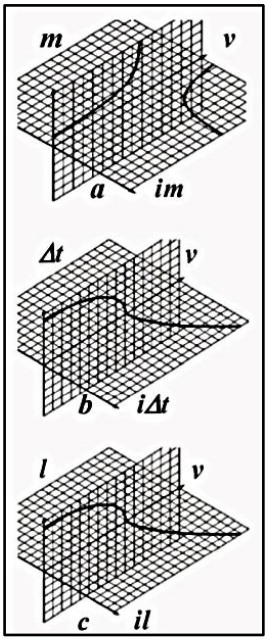

Fig. 1. Graphs of functions $m(v)$, $\Delta t(v)$ *and* $l(v)$ *corresponding to the existing versions of the STR in the subluminal* $v < c$ *and superluminal* $v > c$ *ranges*

And these conclusions are available for experimental verification. Indeed, the relativistic formulae

$$m(v) = m_0 / \sqrt{1 - (\frac{v}{c})]^2} \quad (1)$$

$$\Delta t(v) = \Delta t_0 \sqrt{1 - (\frac{v}{c})^2} \quad (2)$$

$$l(v) = l_0 \sqrt{1 - (\frac{v}{c})]^2} \quad (3)$$

where m_0 is the rest mass of a moving body;

m - relativistic mass of a moving body;

Δt_0 - rest time of a moving body;

Δt - relativistic time of a moving body;

l_0 - rest length of a moving body;

l - relativistic length of a moving body;

v - the velocity of the moving body;

c - speed of light;

are explainable (see Fig. 1a,b,c) only in the range of pre-light velocities $v<c$, in which the values m, and l take values measured by real numbers. And in the range of superluminal velocities $v>c$ these quantities m, and l already take values measured by imaginary numbers discovered 500 years ago [39],[40], but still unexplained. After all, what is, for example, 10 grams, 20 seconds and 30 metres, everyone can explain, but what is $10i$ grams, $20i$ seconds and $30i$ metres, where $i = \sqrt{-1}$, is not explained in any textbook. Moreover, the graph in Fig. 1a in the range of velocities $v>c$ corresponds to a physically unstable process, which cannot exist in nature at all.

And since such a theory, the formulas of which even its creators could not explain, would be of no use to anyone, a postulate called the principle of not exceeding the speed of light was introduced into it. From this postulate it followed that imaginary numbers are physically unreal. Therefore, it was concluded that there was no need to explain them.

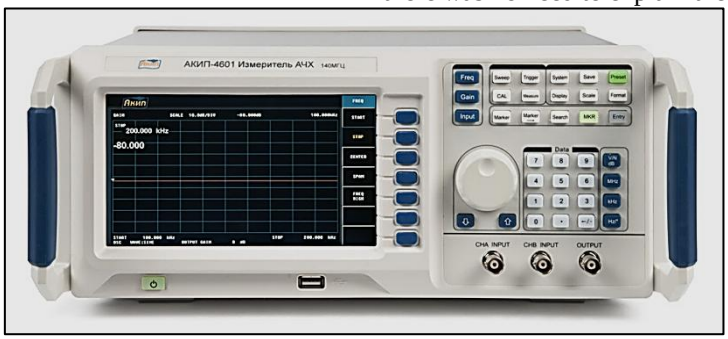

Fig. 2. In any radio engineering laboratory there are devices called frequency characteristic meters, which by their very existence prove the physical reality of imaginary and complex frequencies, and consequently, of any imaginary and complex numbers.

But there are other sciences besides physics. And in the theory of linear electric circuits used in radio engineering, electrical engineering and computer technology, according to Ohm's law as interpreted by Charles Proteus Steinmetz [41], there are imaginary resistances of capacitors and inductors (also called inductance coils), which are measured by devices available in any radio engineering laboratory (Fig. 2). This proves [42]-[53] that imaginary numbers are physically real[18] and the principle of non-exceeding the speed of light is incorrect. And therefore relativistic formulas (1)-(3) are incorrect[19].

3. Corrected version of the special theory of relativity

But even from the uncorrected relativistic formulas (1)-(3) follows an important conclusion, which the authors of SRT have overlooked and by their principle of non-exceeding of the speed of light have made this conclusion impossible – the velocity ***v*** in these formulas is an additional, besides length, width and height, spatial dimension.

Therefore in the corrected version of SRT the corrected relativistic formulas [54[-[61] are received

$$m(q,r,s)=\frac{m_0 i_1^q i_2^r i_3^s}{\sqrt{1-[v/c-(q+r+s)]^2}} \quad (4)$$

$$\Delta t(q,r,s)=\Delta t_0 i_1^q i_2^r i_3^s \sqrt{1-[v/c-(q+r+s)]^2} \quad (5)$$

$$l(q,r,s)=l_0 i_1^q i_2^r i_3^s \sqrt{1-[v/c-(q+r+s)]^2} \quad (6)$$

where $\boldsymbol{q(v)=\lfloor v_q/c \rfloor}$ – is the "floor" function of discrete mathematics from the argument ***v/c***, which is the fourth spatial dimension (Fig. 3);

$\boldsymbol{r(v)=\lfloor v_r/c \rfloor}$ – is the "floor" function of discrete maths from the argument ***v/c***, being the fifth spatial dimension (Fig. 3);

$\boldsymbol{s(v)=\lfloor v_s/c \rfloor}$ – is the "floor" function of discrete maths from the argument ***v/c***, being the sixth spatial dimension (Fig. 3);

$\boldsymbol{v_q, v_r\, v_s}$ – projections of the velocity vector ***v*** on orthogonal coordinates ***q, r, s*** (see Fig. 4).

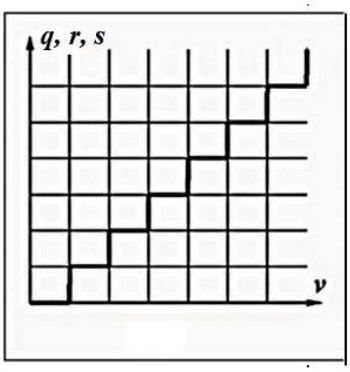

Fig 3. Graphs of functions q(v), r(v), s(v) illustrating the meaning of the "floor" function of discrete mathematics

From them it follows that we live in a Multiverse [62]-[77],which is six-dimensional – three dimensions ***x, y, z*** has each universe and three more dimensions ***q, r. s*** are coordinates of universes in the Multiverse (Fig. 4) – and is described by quaternions $\boldsymbol{f_{q,r,s}(x,y,z)+i_1 q+i_2 r+i_3 s}$, the number of which is equal to the number of universes in the Multiverse. This is exactly what Lisa Randall predicted: *"We could be living in a three-dimensional pocket of higher dimensional space."*

$$i_1^2=i_2^2=i_3^2=-1 \quad (7)$$

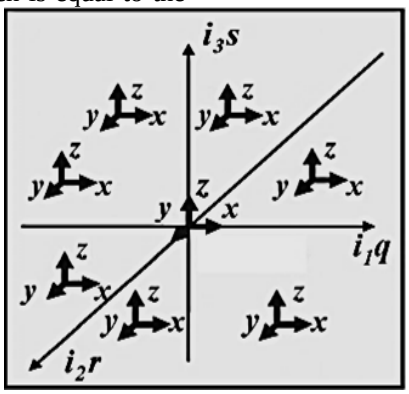

*Fig. 4. Six-dimensional space of the hidden Multiverse, where **q, r, s** are the coordinates of invisible parallel universes, and **x, y, z** are the coordinates of the matter content in each parallel universe*

[18] Since you can only measure what actually physically exists.

[19] Since the derivation of correct relativistic formulas due to absence in the 20th century of necessary experimental and theoretical knowledge simply was not completed.

$$i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1 \quad (8)$$

$$i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1 \quad (9)$$

In the mathematics of hypercomplex numbers, the function $i_1^q\ i_2^r\ i_3^s$ can be calculated only for integer values[20] ***q, r, s,*** but can take both positive and negative values, as well as both real and imaginary values. But we have already proven that imaginary numbers are physically real. Therefore, we must also explain them. Therefore, let us now consider the values of the quantities $m(v)$, $\Delta t(v)$ and $l(v)$, and in the range of velocities $\boldsymbol{v > c}$ for successive values of the argument ***q + r + s*** equal to ***0, 1, 2, 3, 4, 5,*** … Then for our visible universe with coordinates ***q = 0, r = 0, s = 0,*** i.e. located at we get $i_1^q\ i_2^r\ i_3^s$ = **–1.** This situation also corresponds to an invisible universe, since it is located beyond the event horizon. We will call it a tardyon[21] antiuniverse. For the value ***q + r + s=3*** in the velocity range $\boldsymbol{v > c}$ we get $i_1^q\ i_2^r\ i_3^s$ = **–** ***i.*** This situation corresponds to an invisible universe, since it is also located beyond the event horizon. We will call it a tachyon[22] antiuniverse. For the value ***q + r + s=4*** in the velocity range $\boldsymbol{v > c}$ we get $i_1^q\ i_2^r\ i_3^s$ = +1. This situation corresponds to an invisible tardyon universe (but a different one), since it is also located beyond the event horizon. For the value ***q + r +***

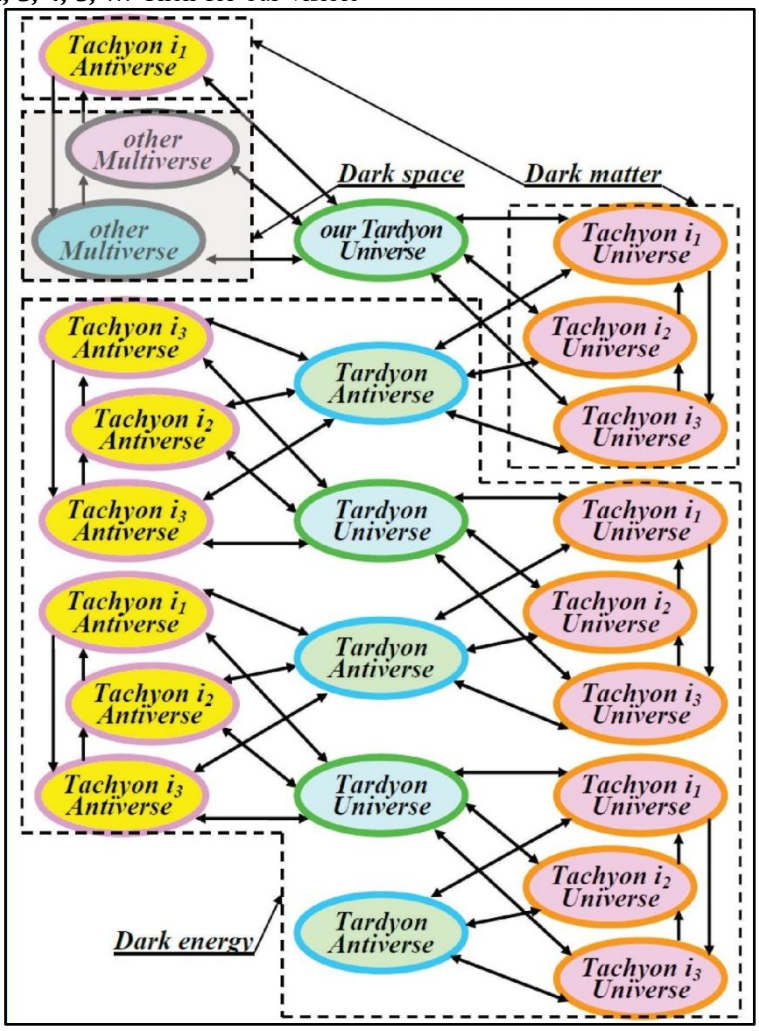

Fig. 5. Possible version of the quaternion structure of the hidden Multiverse

+ s=5 in the velocity range $\boldsymbol{v > c}$ we get $i_1^q\ i_2^r\ i_3^s$ = +*i*. This situation corresponds to an invisible tachyon universe (but a different one), since it is also located beyond the event horizon. Thus, all universes are mutually invisible. Therefore, we will call our Multiverse hidden. And to make sure that invisible universes and antiuniverses neighbouring our visible universe exist, one can try to see them [79]-[84] from portals, the entrances to which are probably more than two hundred thousand so-called anomalous zones [85]-[88] existing

[20] And for non-integer values of the argument the author obtained [78] the formula $i^q = \cos(q\pi/2) + i\sin(q\pi/2)$. It, in particular, will be needed in mathematical processing of experimental data of geophysical investigations of portals

[21] The term tardyon-universe was proposed by Isaac Asimov in short story “Take a match”.

[22] The term tachyon-universe was proposed by Isaac Asimov in short story “Take a match”.

on Earth. People avoid visiting them - and rightly so – as the portals are invisible labyrinths, once in which it is almost impossible to get out of them. These portals are analogous to a corridor in your flat, from which you can look into the next room and see something in it. And to make sure that you really see something about the neighbouring universe in the portal, you should look at the starry sky through a telescope and see that the constellations on it are at least a little bit different from those outside the portals.

In other words, it is necessary to do an experiment similar to the famous experiment of Sir Arthur Stanley Eddington in 1919 [89] by which he confirmed the prediction of the general theory of relativity about the deflection of light rays in the Sun's gravitational field.

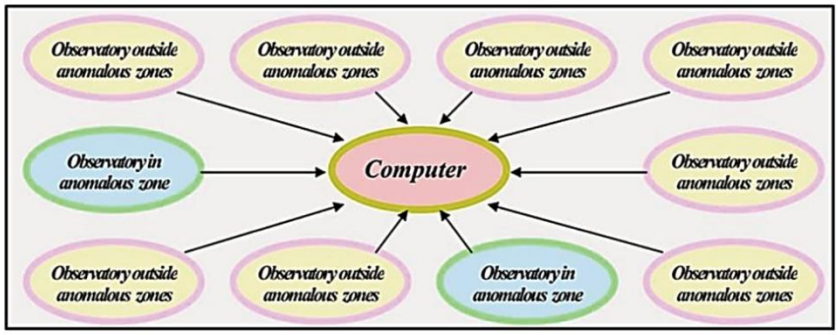

Fig. 6. Scheme of an astronomical experiment to detect invisible universes

And we're in luck. Since there are many anomalous zones on Earth, some of them may already host astronomical observatories, through whose telescope one can see these traces of the invisible out-of-portal neighbouring universe or antiuniverse. Such, for example, is the Main Astronomical Observatory of the National Academy of Sciences of Ukraine, which is located in the Goloseevsky forest 12 km from the centre of the capital of Ukraine, Kiev. But since in the anomalous zone, i.e. at the very edge of the portal, the differences of the constellations observed by neighbouring observatories located in anomalous zone and outside the anomalous zone are very small and may be not visible to the naked eye, it is necessary to compare the observations of these observatories on the computer (Fig.6). And if these differences turn out to be too small, the telescope will have to be moved deeper into the portal. After all, Sir Arthur Stanley Eddington moved the telescope much further away – from England to the island of Principe in the Atlantic Ocean in order to perform his famous experiment.

4. Time travels

As is easy to notice, in Fig. 5 half of the universes of the hidden Multiverse are called antiuniverses in order to draw the readers' attention to the fact that they are cosmic antipodes of other universes. For them, the quantities $m(v)$, $\Delta t(v)$, $l(v)$ in formulas (4)-(6) differ only in sign. That is, the concepts of matter, time and space in the universes correspond to the concepts of antimatter, anti-time and anti-space in the antiuniverses [90]-[93]. But, as on Earth, inhabitants-antipode in space do not notice this difference, since the same physical, chemical, biological and other natural scientific laws operate in the universes and antiuniverses.

And when observed from Earth, in all universes and anti-universes, as they move away from our visible universe, not only the distance increases, but also time (like in time zones on Earth). Moreover, in universes it becomes greater than on Earth, and in anti-universes it becomes less than on Earth. And this circumstance makes time travel really possible both in the past and in the future.

Here are a couple of quotes that explain the current state of understanding of this problem. *"Time is the most frequently used word in the English language and the third most frequently used word in Russian. It is in every other language, too, because synchronizing actions in time is just as important as coordinating them in space. Without knowing the exact time, it is impossible to organize your life and plan it in advance. If in ancient times you could rely on natural cycles and an internal sense of time, then in our days you need to constantly have a watch or a phone with you. Time is the most important of the abstract concepts that we pronounce every day. Every thinking person has thought about the problem of time at least once in his life, and a huge amount of philosophical and scientific literature has been written on this topic. Nevertheless, no one can say for sure what time is."* [94]

Here is what Stephen William Hawking writes about this: "In everyday life, there is a huge difference between moving forward and backward in time. Imagine that a cup of water falls from a table and breaks into pieces. If you film this fall, then when you watch the film, it will immediately become clear whether the film is running forward or backward. If it is running backward, then we will see how the fragments lying on the floor suddenly come together and, having formed a whole cup, jump onto the table. And you will be able to say that the film was running backward, because in everyday life this does not happen. Otherwise, the faience factories would have to be closed" [95].

This phenomenon, known as the arrow of time, is one of the most amazing problems in physics. And the name "arrow of time" was proposed by the British physicist Sir Arthur Stanley Eddington at the beginning of the 20th century [96]. And all our life experience, it would seem, confirms this opinion.

The corrected version of the STR, in which the new concept of 'anti-time' has appeared, allows this life experience to be corrected. Indeed, if we assume that one day travel through the vastness of the hidden Multiverse will become possible for people on Earth, then time travel [97] will also become possible, both in the past and in the future. Let us show this.

But first, let us explain what we need to learn to do for this. And the main thing we need to learn is to master portals [98], [99], i.e. understand what they are and learn to navigate in them. Just as people once learned to navigate with a compass in the boundless expanses of the seas and oceans. Or even in the forest, in the desert, in the mountains, in any unfamiliar area. Even in labyrinths. So, a portal is an unfamiliar area that has become an invisible labyrinth for people. Portals are transitions from one universe to another, which turn these universes into communicating vessels. Therefore, at the entrance and exit of portals, according to the law of communicating vessels, the habitat should be almost the same – the same air, the same water, the same vegetation and animals[23]. Only the area is unfamiliar. But in order not to get lost in the portals and find the way back, you can use, as in mythology, the 'thread of Ariadne'. Or, in order not to risk ourselves, we can send unmanned vehicles to explore the portals, which people have now learned to make very well. It is also not difficult to create something like a radio compass, taking into account that as you dive into the portals, the electromagnetic field intensity from earthly radio stations should decrease. And on the way back, it should increase. Having got through the portal to some other planet, in order to move further in the hidden Multiverse, you will need to use unmanned aerial vehicles to search for anomalous zones on it, which are entrances to portals that lead to other neighboring universes. And so on. But all these problems are quite solvable.

And now we will show that the concept of the 'arrow of time' in the corrected version of STR is already partially refutable, since although we will not restore the cup mentioned by Hawking, we will be able to move into the past and future time. For this, we will use Fig. 7 and 8. In them, the positive branch of the vertical coordinate axis corresponds to time ***t***, measured in tardyon (including our visible tardyon) universes by positive real numbers, and its negative branch corresponds to negative time ***t*** in tardyon antiuniverses. Similarly, the positive branch of the horizontal coordinate axis corresponds to positive imaginary time[24] ***it***, measured in tachyon universes by positive imaginary numbers, and its negative branch corresponds to negative time it in tachyon antiuniverses. On the vertical axis of real time ***t*** and on the horizontal axis of imaginary time ***it***, thick black arrows show our comparatively long-term activity in tardyon and tachyon universes and anti-universes. And thin красными и синими стрелками показаны red and blue arrows show transitions through portals (staying in which is short-lived) between neighboring universes and antiuniverses.

Then we will consider the simplest options for traveling to the future and the past, since they would be very useful to us. Indeed, traveling to the future would allow us to refuse to continue all types of our unsuccessful activities and make them much more effective. But after such a search for the most effective option for activity, it will be necessary to return to the original state in order to start doing something differently and to do this. Traveling to the past would also be useful if, despite the search for an acceptable option for subsequent activity, it still turned out to be bad. Then it would be necessary, again having returned to the past, to somehow correct it. Therefore, having received the opportunity to travel through time, people could make their lives much more successful and happier. And since such searches for happiness are often a rather intimate activity, it would obviously be useful to begin them with the transition from our tardyon universe through the necessary portal to one of the neighboring tachyon universes or antiuniverses, since our activity in them is not visible from our tardyon universe due to the fact that time in them flows in mutually perpendicular directions[25]. And we will have to move to the tachyon universe if we are interested in something in the future. And we will have to move to the tachyon antiuniverse if we need to do something in the past.

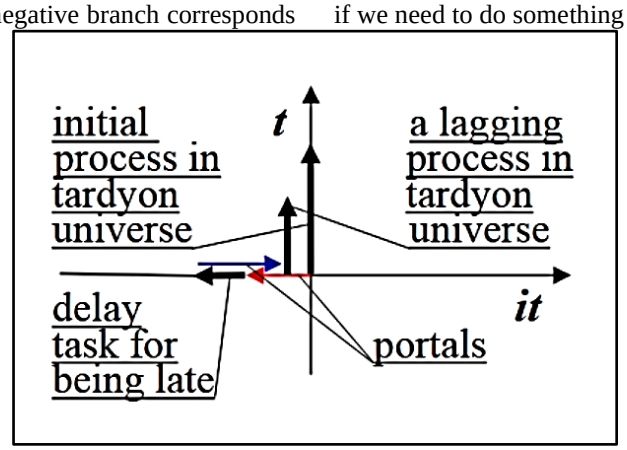

Fig. 7. Possible route of travel to the past time

And Fig. 7 shows one of such simplest routes of travelling to the past time by successive travelling through portals through universes and antiuniverses of the hidden Multiverse. As it can be seen, this journey

[23] And if at least one portal on Earth ended in open space, then there would have been no air, no water, no anything else on Earth, like on the Moon or Mars.

[24] Despite the fact that the physical reality of imaginary numbers is denied in the generally accepted version of SRT, the term 'imaginary time' is used in modern physics. For example, in [95] Hawking writes: "Attempts to unify gravity with quantum mechanics have led to the concept of imaginary time".

[25] On the essence of imaginary time, Hawking holds the same opinion: "Imaginary time is a new dimension at right angles to ordinary real time" [95].

starts from the origin of coordinates, where in our visible tardyon universe there are conditionally two groups of researchers who spend the same biological time on the same duration of activity. And one of these groups of researchers through the portal (shown by the thin red arrow), moves to the tachyon antiuniverses and stays in it for some time (corresponding to the required lag time on the axis of imaginary time it, shown by the thick black arrow). All this time it is invisible from our tardyon universe, since imaginary time it is perpendicular to real time ***t***. Then it returns to our tardyon universe through the same or another portal (shown by the thin blue arrow) and completes the same work in the same time as the second group of scientists remaining in the tardyon universe. The duration of the activities of both groups in our tardyon universe is shown by thick black arrows of different lengths, which would both have to be on the actual time axis ***t***. But to make the figure more understandable, we have conventionally placed the short thick arrow next to the long thick arrow. And as a result, both groups of researchers, having spent the same amount of time on their identical activity, will nevertheless finish it in our tardyon universe at different times. Thus, the effect of delay was obtained due to the travel into the past time of one group of scientists relative to the other. Naturally, the same result can be obtained using other routes of travel through the Multiverse.

Fig. 8 shows another version of the time travel route, which differs from that shown in Fig. 7 in that this travel is carried out into the future. As in the previous case, it begins with the movement of the first group of researchers from the origin of coordinates, but in the opposite direction - through the portal shown by the thin red arrow into one of the (see Fig. 5) neighboring tachyon universes i_1. Then this group of researchers spends some time, corresponding to a given interval of advance time, in the tachyon universe i_1 and through another portal (shown by the thin blue arrow) moves to the next tachyon universe i_2. in the same dimension *v*. And from it through the third portal (shown by the thin red arrow) moves to the third tachyon universe i_3 in the same dimension ***v***.

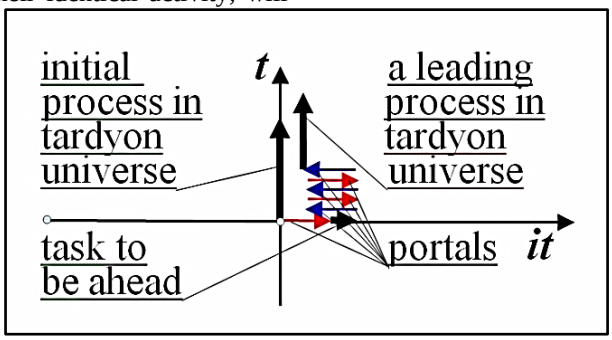

Fig. 8. Possible route of travel to the future time

And finally, from this third tachyon universe i_3. with a triple time advance (obtained due to successive visits to three tachyon universes) returns to our tardyon universe via the portal shown by the thin blue arrow. But with some lead over the second group of researchers, who were in our tardyonta universe all the time. And therefore, when both groups, having spent their equal biological time on their activity, finish it, it will turn out that they finish it at different times. And such a result can be interpreted as follows: the group of researchers who traveled through the hidden Multiverse, was ahead in time of the group of researchers who did not leave our tardyon universe, i.e., they traveled into the future. The same effect, naturally, can be obtained using other time travel routes.

5. Conclusions

So, in the article by the analysis of numerous existing in the nature and created by people processes it is experimentally proved and theoretically explained that the version of SRT studied in all

So, in the article by the analysis of numerous existing in the nature and created by people processes it is experimentally proved and theoretically explained that the version of SRT studied in all textbooks of physics is incorrect, as in it:

- relativistic formulae obtained by its authors are incorrect and incorrectly explained;
- the postulated principle of non-exceeding of the speed of light, used by the authors of this version of SRT because of inability to explain and correct the relativistic formulas received by them, is incorrect;
- the conclusions about physical unreality of imaginary numbers and about existence in the nature of our visible universe, in which everything existing is measured only by real numbers, made from the received by them incorrect relativistic formulas, are incorrect.

Therefore physicists, forced according to the incorrect version of SRT to search for explanations of all physical problems in our only visible universe, could not explain much. They could not explain dark matter and dark energy, they could not discover dark space, they could not solve the problem of baryonic asymmetry and many other problems. For the same reason physicists still cannot explain the physical phenomenon of time and why it is unidirectional. They even created a special term for this concept 'time arrow'. But they are not sure that this term is irrefutable.

And the article refutes this term. For this purpose the corrected version of SRT was used, in which:

- the physical reality of imaginary numbers is experimentally proven and theoretically explained;
- by the experimentally proved principle of physical reality of imaginary numbers the principle of non-exceeding the speed of light was refuted and thus it was proved that the speed ***v*** gives rise to three additional spatial dimensions;

- it was found out that there exists in Nature a six-dimensional Multiverse containing about twenty mutually invisible three-dimensional universes and antiuniverses, whose position in the Multiverse space is determined by three additional dimensions.

It is explained that antimatter in the Multiverse is located in the antiuniverses, which are antipodes of other universes. In the same antiuniverses there are an anti-time, which is opposite to time of other universes. Examples of use of this anti-time are given, allowing already now to move both in the past and in the future time. And the existence of anti-time corrects the understanding of the phenomenon 'arrow of time'.

But anomalous zones in different countries on Earth may have different service advantages and disadvantages. Therefore, different countries may use different portals and different time travelling routes using them. And it will allow to get more valuable information about portals. Astro-geophysical researches of portals [99]-[115] made as a result of such time-travelling in our hidden Multiverse will allow to create time machines imitating on the Earth stay of people in portals. And this will significantly increase the effectiveness of scientific research and the corresponding accelerated intellectual and economic development of our entire human civilisation.

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References

1. Einstein A. (1920). Relativity: The Special and General Theory. H. Holt and Company. NY.

2. Bohm D. (2006). The Special Theory of Relativity. Routledge, Abingdon on Thames.

3. Penrose R. (2010). The Nature of Space and Time. Princeton University Press. Princeton.

4. Antonov A.A. (2021). The special theory of relativity stated in physics text-books is incorrect. 77th International Scientific Conference of the Eurasian Scientific Association. "Theoretical and practical issues of modern science". Moscow. ESA. 11-15. (In Russian)

5. Antonov A. A. (2021). Version of the special theory of relativity that is studied in all physics textbooks is incorrect. Österreichisches Multiscience Journal (Insbruck, Austria). 43(1). 17-22. http://osterr-science.com

6. Antonov A. A. (2021). Generally accepted version of the special theory of relativity contained in physics textbooks is incorrect. The scientific heritage. (Budapest, Hungary). 73(2). 39-43. DOI: 19.24412/9215-0365-2021-73-2-39-43

7. Antonov A. A. (2021). Special theory of relativity, which is studied in physics text-books, is incorrect. German International Journal of Modern Science. 16, 49-53. DOI: 10.24412/2701-8369-2021-16-49-53

8. Antonov A. A. (2021). Special theory of relativity, which is studied in all physics textbooks, is incorrect. Danish Scientific Journal. 51(1). 31-35. http://www.danish-journal.com

9. Antonov A. A. (2021). Special theory of relativity taught in all physics text-books is incorrect. Annali d'Italia. 22(1). 39-44. https://www.anditalia.com/

10. Antonov A. A. (2021). Special theory of relativity presented in physics text-books is wrong. Norwegian Journal of development of the International Science 68(1). 3-7. DOI: 10.24412/3453-9875-2021-68-3-7.

11. Antonov A. A. (2021). In all physics textbooks an erroneous version of special theory of relativity is given. International independent scientific journal. 31.34-39. http://www.iis-journal.com

12. Antonov A. A. (2021). Special theory of relativity taught in physics textbooks is wrong. Journal of science. Lyon. 23. 47-52. https://www.joslyon.com/

13. Antonov A. A. (2021). All physics textbooks study incorrect special theory of relativity. Sciences of Europe. (Praha, Czech Republic) 79(1). 30-35. DOI: 10/24412/3162-2364-2021-79-30-35

14. Antonov A. A. (2021). The version of STR stated in physics textbooks is incorrect because it denies the existence of radio engineering. 82nd International Scientific Conference of the Eurasian Scientific Association "Scientific result in theory and practice". Moscow. ESA. 11-15. (In Russian) https://esa-conference.ru/sborniki/?y=2021

15. Antonov A. A. (2022). The version of STR presented in physics textbooks is incorrect, since it follows from it that radio engineering should not exist. European Journal of Applied Sciences. Services for Science and Education. UK. 10(1). 440-445. DOI://doi.org/10.14738/aivp.101.2022

16. Antonov A. A. (2022). The existence of radio engineering refutes the physics text-books version of STR. The scientific heritage. (Budapest, Hungary). 83(1). 19-22. DOI: 10.24412/9215-0365-2022-83-1-19-22

17. Antonov A.A. (2022). The fundamental Ohm's law in radio engineering as interpreted by Steinmetz, which proves the physical reality on imaginary capacitive and inductive reactances, refuted the version of the STR presented in physics textbooks even before its creation. German International Journal of Modern Science. 26. 50-53. DOI: 10.24412/2701-8369-2022-26-50-63

18. Antonov A.A. (2022). The version of STR stated in physics textbooks is refuted by the existence of radio engineering. Danish Scientific Journal. 56. 56-59. http://www.danish-jour-nal.com

19. Antonov A.A. (2022). The version of STR presented in physics textbooks is in correct because it denies the possibility of the existence of Ohm's law as intepreted by Steinmetz and, consequently, the existence of radio engineering. Annali d'Italia. 28(1), 43-47. https://www.anditalia.com/

20. Antonov A.A. (2022). The version of STR stated in physics textbooks is re-futed by the existence of radio engineering. Norwegian Journal of development of the International Science. 78(1). 63-67. DOI: 10.24412/3453-9875-2022-78-63-66.

21. Antonov A.A. (2022). If the physics textbook version of STR were true, then Ohm's law should not exist in nature, and therefore all radio engineering would not exist. International independent scientific journal. 36. 16-19. http://www.iis-journal.com

22. Antonov A.A. (2022). If the version of STR in physics textbooks were true, then there would be no radar, no television, no radio navigation, no telecommunication and many other things. Journal of science. Lyon. 28. 76-79. https://www.joslyon.com/

23. Antonov A.A. (2022). The version of STR set out in physics textbooks is in-correct because it states that Ohm's law as interpreted by Steinmetz does not really exist, and therefore radio engineering does not exist either. Sciences of Europe (Praha, Czech Republic). 87(1). 54-57. DOI: 10.24412/3162-2364-2022-1-54-57

24. Antonov A.A. (2022). Why the physics textbooks teach an incorrect version of the special theory of relativity which denies the existence of radio- and electrical engineering. III international scientific conference "Challenges and problems of modern science". London. Great Britain. 78-86. https://doi/org/10.528/zenodo.7486814

25. Antonov A. A. (2023). Why is the incorrect version of the special theory of relativity being studied in physics textbooks, refuted the existence of radio- and electrical engineering even before its creation? The scientific heritage. (Budapest, Hungary). 105. 83-89. DOI: 10.5281/zenodo.7560145

26. Antonov A.A. (2023). Why is an incorrect version of the special theory of relativity that denies the possibility of the existence radio and electrical engineering being studied in physics textbooks? German International Journal of Modern Science. 48. 23-29. DOI: https://doi.org/10.5281/zenodo.7541137

27. Antonov A.A. (2023). Who needs the incorrect version of special relativity taught in physics textbooks despite all its experimental refutations? Annali d'Italia. 39, 64-70. DOI: 10.5281/zenodo.7568916

28. Antonov A.A. (2023). Why is incorrect version of the special theory of relativity that denies the possibility of the existence of radio and electrical engineering being studied in textbooks of physics? Norwegian Journal of development of the International Science. 100. 27-33. https://doi.org/10.5281/zenodo.7528512

29. Antonov A.A. (2023). Why is incorrect version of the special theory of relativity, refuted by the existence of radio and electrical engineering, is still studies in all university physics textbooks? Danish Scientific Journal. 69. 66-72. https://doi.org/10.5281/zenodo.7692053

30. Antonov A.A. (2023). Why is incorrect version of the special relativity still being studied in physics textbooks, which denies Ohm's law for alternating current used worldwide by millions of radio- and electrical engineers? International independent scientific journal. 46. 38-44. https://doi.org/10.5281/zenodo.7525751.

31. Antonov A.A. (2023). Why is the generally accepted version of STR, which denies the possibility of the existence of radio engineering and electrical engineering, tsunamis and bell ringing, the physical phenomenon of resonance and Ohm's physical law for alternating current, music created by the piano and even swing swings on the playground, nevertheless is still considered correct and studied in physics textbooks? Sciences of Europe (Praha, Czech Republic). 112. 44-50. DOI: 10.5281/zenodo.7708515

32. Antonov A.A. (2023). Why is the incorrect version of the special theory of relativity still being studied in physics textbooks, despite all its experimental refutations. European Journal of Applied Sciences. Services for Science and Education. UK. 11(2). 61-71. DOI: https://doi.org/10.14738/aivp.112.14128

33 Antonov A.A. (2023). Why the incorrect version of the special theory of relativity, which denies the possibility of the existence of radio engineering and electrical engineering, has not yet been refuted. Journal of science. Lyon. 40. 19-25. https://doi.org/10.5281/zenodo.7704392

34. Jean de Climont. (2009), (2010), (2016), (2020), (2023). The Failure of Pure Science. Editions d'Assailly.

35. Jean de Climont. (2017). The alternative theories. Editions d Assailly.

36. Jean de Climont. (2019), (2020), (2023). The Worldwide List of Alternative Theories and Critic. Editions d'Assailly.

37. Jean de Climont. (2023). Einstein and Maxwell speculation. Editions d'Assailly.

38. Popper K.R. 2002. Conjectures and Refutations. The Growth of Scientific Knowledge. Routledge. London.

39. Weinstein E.W. (2005). The CRC Concise Encyclopedia of Mathematics. 3-rd ed. CRS Press. Roca Raton. FL.

40. Beckmann P. (1976). A history of π. 3rd edition. St. Martin Press. NY.

41. Steinmetz C. P. (2010). Theory and Calculation of Electric Circuit. Nabu Press.

42. Antonov A. A. (2008). Physical Reality of Resonance on Complex Frequencies. European Journal of Scientific Research. 21(4). 627-641. http://www.eurojournals.com/ejsr.htm

43. Antonov A. A. (2009). Resonance on Real and Complex Frequencies. European Journal of Scientific Research. 28(2). 193-204. http://www.eurojournals.com/ejsr.htm

44. Antonov A. A. (2010). New Interpretation of Resonance. International Journal of Pure and Applied Sciences and Technology. 1(2). 1-12. http://doi.org/10.17686/sced_rusnauka_2010-888

45. Antonov A. A. (2010). Oscillation processes as a tool of physics cognition. American Journal of Scientific and Industrial Research. 1(2). 342-349. doi:10.5251/ajsir.2010.1.2.342.349

46. Antonov A. A. (2010). Solution of algebraic quadratic equations taking into account transitional processes in oscillation systems. General Mathematics Notes. 1(9). 11-16. http://doi.org/10.17686/sced_rusnauka_2010-887

47. Antonov A. A. (2013). Physical Reality of Complex Numbers. International Journal of Management, IT and Engineering. 3(4). 219-230. http://doi.org/10.17686/sced_rusnauka_2013-898

48. Antonov A. A. (2014). Correction of the special theory of relativity: physical reality and nature of imaginary and complex numbers. American Journal of Scientific and Indus-trial Research. 5(2). 40-52. doi:10.5251/ajsir.2014.5.2.40.52

49. Antonov A. A. (2015). Physical reality of complex numbers is proved by research of resonance. General Mathematics Notes. 31(2). 34-53. http://www.emis.de/journals/GMN/yahoo_site_admin/asets/docs/4_GMN9212-V31N2.129701.pdf

50. Antonov A.A. (2015). Principle of physical reality of imaginary and complex numbers in modern cosmology: the nature of dark matter and dark energy. Journal of the Russian physico-chemical society. 87(1). 328-355. (In Russian) http://doi.org/10.17686/sced_rusnauka_2015-1119

51. Antonov A. A. (2016). Physical Reality and Nature of Imaginary, Complex and Hypercomplex Numbers. General Mathematics Notes. 35(2). 40-63. http://www.geman.in/yahoo_site_admin/assets/docs/4_GMN-10932-V35N2.31895146.pdf

52. Antonov A. A. (2017). The physical reality and essence of imaginary numbers. Norwegian Journal of development of the International Science. 6. 50-63. http://www.njd-iscience.com

53. Antonov A. A. (2018). Physical Reality and Essence of Imaginary Numbers in Astrophysics: Dark Matter, Dark Energy, Dark Space. Natural Science. 10(1). 11-30. doi:10.4236/ns.2018.101002

54. Antonov A.A. (2023). The Corrected Version of the Special Theory of Relativity. European Journal of Applied Sciences. Services for Science and Education. UK. 11(5). 68-83. DOI:10.14738/aivp.115.15474

55. Antonov A. A. (2023). Corrected special theory of relativity. Journal of science. Lyon. 48. 27-36. https://doi.org/10.5281/zenodo.10277156

56. Antonov A. A. (2023). Corrected special theory of relativity. Annali d'Italia. 49, 25-35. DOI: 10.5281/zenodo.10214679

57. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. The scientific heritage. (Budapest, Hungary). 123. 72-81,

58. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. Norwegian Journal of development of the International Science. 118. 40-49. https://doi.org/10.5281/zenodo.10009500

59. Antonov A. A. (2023). Alternative Version of the Special Theory of Relativity. Sciences of Europe. (Praha, Czech Republic). 128. 62-71.

60. Antonov A. A. (2023). Special Theory of Relativity. German International Journal of Modern Science. 67. 64-73. DOI: 10.5281/ zenodo.10966458

61. Antonov A. A. (2023). Corrected Version of the Special Theory of Relativity. Danish Scientific Journal. 77. 88-97. https://doi.org/10.5281/zenodo.10054677

62. Antonov A. A. (2011), Structure of the Multiverse. British Journal of Science. 2(2). 51-60. http://doi.org/10.17686/sced_rusnauka_2011892

63. Antonov A. A. (2012). Multiverse. Time Travels. International Journal of Pure and Applied Sciences and Technology. 12(2). 43-56. http://doi.org/10.17686/sced_rusnauka_2012-896

64. Antonov A.A. (2012). Discovery of the real Multiverse. Encyclopaedia of Russian thought, Papers to the Russian Physical Society. 16(3). 3-20. (In Russian)

http://doi.org/10.17686/sced_rusnauka_2012-1115

65. Antonov A.A. (2013). Cognition of the Multiverse as a factor in accelerating the development of human civilisation. Journal of Russian physical thought. 1-12, 6-77. (In Russian) http://doi.org/10.17686/sced_rusnauka_2011-1117

66. Antonov A. A. (2015). Hidden Multiverse. International Journal of Advanced Research in Physical Science. 2(1). 25-32.

67. Antonov A.A. (2015). The astrophysical phenomenon of dark matter and dark energy proves the existence of the hidden Multiverse. American Journal of Modern Physics. 4(4). 180-188. doi: 10.11648/j.jamp.20150404.14

68. Antonov A. A. (2015). Why dark matter and dark energy are invisible? Optics. 4(6), 43-47. doi: 10.11648/j.optics.20150406.12

69. Antonov A. A. (2015). Hidden Multiverse: explanation of dark matter and dark energy phenomena. International Journal of Physics. 3(2). 84-87. doi:10.12691/ijp-3-2-6

70. Antonov A. A. (2015). Principles and structure of the real Multiverse: explanation of dark matter and dark energy phenomena. American Journal of Modern Physics. 4(1). 1-9. doi:10.11648/j.ajmp.20150401.11

71. Antonov A. A. (2015). Explanation of dark matter and dark energy phenomena. Jour nal of Science Frontier Research: A Physics and Space Science. 15(1). 33-38. http://doi.org/10.17686/sced_rusnauka_2015-902

72. Antonov A. A. (2015). Review of publications by A. A. Antonov on the problem of explaining the fenomenon of dark matter and dark energy. Journal of the Russian physico-chemical society. 87(3). 63-76. (In Russian)

73. Antonov A. A. (2016). Explaining the Phenomenon of Dark Matter and Dark Energy by Existence of the Hidden Multiverse. Frontiers of Astronomy, Astrophysics and Cosmology. 2(1). 1-9. doi: 10.12691/faac-2-1-1

74. Antonov A. A. (2016). What Physical World do We Live in? Journal of Modern Physics. 7(14). 1933-1943

75. Antonov A. A. (2016). Hypothesis of the Hidden Multiverse: Explains Dark Matter and Dark Energy. Journal of Modern Physics. 7(10), 1228-1246. doi: 10.4236/jmp.2016.710111

76. Antonov A. A. (2017). Nature of dark matter and dark energy. Journal of Modern Physics. 8(4). 567-582. doi: 10.4236/jmp.2017.84038

77. Antonov A. A. (2017). Hypothesis of the hidden Multiverse explains the phenomenon of dark matter and dark energy. Applied Physics Research. 9(2). 30-41. doi: https://doi.org/10.5539/apr.v9n2p30

78. Antonov A. A. (2024). Mathematical Sciences: From the Experimentally Proved Principle of the Physical Reality of Imaginary Numbers it Follows that the Invisible Afterlife World, Mentioned in All Religions, Really Exists. European Journal of Applied Sciences, 12(5). 119-145. DOI:10.14738/aivp.125.17569.

79. Antonov A. A. (2020). How to See Invisible Universes. Journal of Modern Physics. 11(05), 593-607. DOI: 10.4236/jmp.2020.115039

80. Antonov A. A. (2020). Can invisible universes be seen? International independent scientific journal. 21(2). 51-60. http://www.iis-journal.com

81. Antonov A. A. (2020), How to discover invisible universes. Norwegian Journal of development of the International Science. 42(1). 36-48. http://www.njd-iscience.com

82. Antonov A. A. (2020). Universes Being Invisible on Earth outside the Portals Are Visible in Portals.

Natural Science. 12(8). 569-587. https://doi.org/10.4236/ns.2020.128044

83. Antonov A. A. (2020). Invisible universes can be seen in anomalous zones. Danish Scientific Journal. 43(1). 9-24. http://www.danish-journal.com

84. Antonov A. A. (2021). Invisible universes can be seen in anomalous zones. International independent scientific journal. 23(1). 28-44.

85. Chernobrov, V. (2000). Encyclopedia of mysterious places of the Earth. Veche Publishing House. Moscow. (In Russian)

86. Chernobrov, V. (2004). Encyclopedia of mysterious places of Russia. Veche Publishing House. Moscow. (In Russian)

87. Chernobrov, V. (2007). Encyclopedia of mysterious places of Earth and space. Veche Publishing House. Moscow. (In Russian)

88. Chernobrov, V. (2009). Encyclopedia of mysterious places of Moscow and Moscow region. Helios ARV. Moscow. (In Russian)

89. Dyson F.W, Eddington A.S., Davidson C. (1929). A determination of the deflection of light by the sun's gravitational field, from observations made at the total eclipse of May 29, 1919. Philosophical transactions of the Royal Society A. 220. 291-333. https://doi.org/10.1098/rsta.1920.0009

90. Frazer G. (2004). Antimatter: The Ultimate Mirror. Cambridge University Press, Cambridge, UK.

91. Santilli R. M. (2006). Isodual Theory of Antimatter: With Applications to Antigravity, Grand Unification and Cosmology. Springer. Dordrecht. Netherlands.

92. Alain M., Le Brun V. (2012). Matter, Dark Matter, and Anti-Matter: In Search of the Hidden Universe. Springer-Verlag. NY.

93. Antonov A.A. (2016). Dark matter, dark energy and antimatter are located in the hidden Multiverse. PONTE. 72(8). 288-300.

94. Dionis Dimetor. The arrow of time, Loschmidt's demon and quantum. thermodynamics Why is time irreversible? https://habr.com/ru/articles/785014/

95. Hawking S.W. (1988). Brief History of Time: From the Big Bang to Black Holes. Bantam Dell Publishing Group. UK.

96. Eddington, A. S. (1928). Nature of the Physical World. Cambridge University Press, London.

97. Chernobrov, V. (1999). Secrets of Time. Helios ARV. Moscow. (In Russian)

98. Antonov A. A. (2012), Earth, portals, parallel universes. American Journal of Scientific and Industrial Research. 3(6). 464-473. doi:10.5251/ajsir.2012.3.6.464.473

99. Antonov A. A. (13 January 2016). How Portals of the Invisible Multiverse Operate. Science PG Frontiers. http://www.sciencepublishinggroup.com/news/sciencepgfrontiersinfo?articleid=7

100. Antonov A.A Geophysical exploration of portals will provide new knowledge about space. Proceedings of the III International Scientific Conference. Philadelphia. USA. “The modern vector of the development of science”. Philadelphia, USA. 2023. 85-101. https://doi.org/10.5281/zenodo.7709801

101. Antonov A.A. 2023. Geophysical researches of portals will allow to discover invisible universes and to explore them. European Journal of Applied Sciences. Services for Sciences and education. UK. 11(2). 370-391. DOI: 10.14738/aivp.112.14323.

102. Antonov A.A. 2023. The necessity of geophysical researches of portals. The scientific heritage. (Budapest, Hungary). 110. 77-90. DOI: 10.5281/zenodo.7804563

103. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of invisible universes and to explore them. German International Journal of Modern Science. 53. 64-78. DOI: 10.5281/zenodo.7796151

104. Antonov A.A. 2023. The relevance of geophysical researches of portals. Danish Scientific Journal. 70. 75-89. https://doi.org/10.5281/zenodo.778944

105. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of hidden Multiverse and to research it. Annali d’Italia. 42. 71-85. DOI: 10.5281/zenodo.7865307

106. Antonov A.A. 2023. Why geophysical researches of portals are necessary. Norwegian Journal of development of the International Science. 105. 83-96. https://doi.org/10.5281/zenodo.7779019

107. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of hidden Multiverse and to research it. International independent scientific journal. 49. 23-37.

108. Antonov A.A. 2023. Geophysical researches of portals will allow to discover invisible universes. Journal of science. Lyon. 41. 26-38.

109. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of hidden Multiverse and to research it. Sciences of Europe. 114. 76-90

110. Antonov A. A. 2024. Astrophysical portals are a source of new knowledge. German International Journal of Modern Science 95. 34- 44. DOI: 10.5281/zenodo.14609615

111. Antonov A. A. 2024. Scientific value of researches of astrophysical portals. 82. 41-51.

112. Antonov A. A. 2024. The relevance of research on astrophysical portals. Znanstvena misel journal. 98. 35-45

113. Antonov A. A. 2024. Scientific value of researches of astrophysical portals. Sciences of Europe (Praha, Czech Republic).153. 93-106.

114. Antonov A. A. 2024. The existence of astrophysical portals refutes the version of SRT studied in textbooks. Annali d’Italia. 63. 9-19. DOI: 10.5281/zenodo.14726250

115. Antonov A. A. 2025. Physical Sciences: Astrophysical Portals are a Source of New Knowledge. European Journal of Applied Sciences, Services for Science and Education. UK 13(1). 23-39. DOI:10.14738/aivp.131.18112.

SOCIAL SCIENCES

EXPLORING THE PATH AND POLICY RESPONSES TO CHINA'S GREEN ECONOMY TRANSITION UNDER THE 'DUAL CARBON' GOAL

Wang Qian,
Wang xiaowan
Belarusian State University
Minsk, Belarus

ABSTRACT

Against the background of global climate change, China has put forward a 'dual carbon' target, which presents an urgent requirement and a great opportunity for China's green economy transformation. In this paper, we use the STIRPAT model, system dynamics simulation and other methods to analyse the drivers of carbon emissions, explore the path of green economy transformation, and propose corresponding policy responses by combining the provincial panel data of China from 2000 to 2024. The study finds that energy intensity and industrial structure are the core constraints on carbon emissions, green technology progress policies have lagging effects, and carbon market pilots are effective. Based on this, a differentiated policy toolkit is formulated to promote green economy transformation and provide reference for achieving the 'dual carbon' goal.

Keywords: dual carbon policy, green economy, carbon emissions.

I. Introduction

1.1 Background and significance of the study

International context: From an international perspective, global warming is becoming an increasingly serious problem that threatens the survival and development of mankind. According to the International Energy Agency (IEA), global CO_2 emissions will reach about 37 billion tonnes in 2024, and the high level of emissions will continue to aggravate the deterioration of the global climate, such as the rise in sea level and the increase in extreme weather events. Against this backdrop, many countries around the world have put forward carbon neutrality targets and are actively promoting the development of a green economy to address the challenges of climate change.

Domestic Context: In China, the proposal of 'carbon neutral' and 'carbon peaking' targets has demonstrated the country's commitment to green development. The Peak Carbon Action Plan by 2030 sets out a series of specific targets, including a 25% share of non-fossil energy consumption by 2030. However, China's economic development is still facing many challenges. The proportion of energy-intensive industries in industrial value added will still reach 27.8% in 2024, the energy structure dominated by coal and other fossil energy sources has not yet been fundamentally changed, and economic growth has not yet been completely decoupled from carbon emissions, which will impede China's green economy in the long term and sustainable development.

Significance of the study: The study of China's green economy transition path and policy responses under the 'dual-carbon' goal is of great theoretical and practical significance. At the theoretical level, it can help enrich and improve the theory of green economy transition, explore in depth how the 'dual-carbon' target affects economic transition, and inject new connotation into the theory of sustainable economic development. At the practical level, it can provide a reference basis for the government to formulate scientific and reasonable green economic policies and for enterprises to choose the right path of green development, so as to promote China's economy to realise green transformation as soon as possible and move towards a new stage of high-quality development.

1.2 Literature review

Research on Carbon Emission Factors: The classic environmental Kuznets curve (Grossman, 1995) points out that there is an inverted U-shaped relationship between economic growth and environmental pollution, i.e., as the economy develops, the quality of the environment deteriorates first and then improves. Wang Feng et al. (2021) used the CGE model to study the impact of macroeconomic changes on carbon emissions; Sun Chuanwang et al. (2022) used the LMDI decomposition method to analyse the dynamic changes in the contribution of carbon emissions from various sectors, which enriched the research method of carbon emission factors.

Research on Green Economy Transition Path : Scholars have explored the green economy transition path from different angles. Some studies emphasise that technological innovation is the key, such as promoting the greening of the economy by means of research and development of clean energy technologies and improvement of energy efficiency, while others focus on industrial structural adjustment, advocating the reduction of the proportion of high-pollution and high-energy-consuming industries and the development of green emerging industries.

Policy Response Research : Based on the characteristics of carbon emissions and green economy transformation, many scholars have studied the corresponding policy response. Some argue that environmental regulation should be strengthened to force enterprises to reduce emissions by formulating strict emission standards and reward and punishment measures; others advocate perfecting the green financial system to provide financial support for the development of green economy. However, fewer existing studies have systematically combined the 'dual-carbon' goal with a comprehensive and in-depth exploration of the path of

green economy transformation and policy responses, and this paper complements and expands on this aspect.

2 Identification of carbon emission drivers

2.1 STIRPAT model construction

Model formula: In this paper, the improved STIRPAT model is chosen to analyse the carbon emission drivers, and the model formula is:

$$LnI = a + bLnP + cLnA + dLnT + eLnS + \epsilon$$

Among them:

(I): represents the carbon intensity in tonnes per 10,000 yuan of GDP, which measures the carbon emissions per unit of economic output.

(P): represents the population size in billions, reflecting the potential impact of population size on carbon emissions.

(A): is the per capita GDP in ten thousand yuan, reflecting the role of the level of economic development on carbon emissions.

(T): represents technological progress, measured in green patents granted per million people, showing the impact of technological innovation on carbon emissions.

(S): is the industrial structure, measured by the proportion of value added of the secondary industry (%), observing the driving effect of changes in industrial structure on carbon emissions.

2.2 Data description and processing

The data were obtained from the National Bureau of Statistics, the Ministry of Ecology and Environment, and China Science and Technology Statistical Yearbook and other authoritative organisations. The time span is 2000 - 2024, covering 31 provinces, autonomous regions and municipalities directly under the central government in China. To ensure the accuracy and comparability of the data, some missing data were supplemented by linear interpolation, and the relevant data were logarithmised to reduce the effect of heteroscedasticity.

2.3 Analysis of empirical results

The STIRPAT model was estimated by regression using a panel data fixed effects model. The results show that energy intensity and industrial structure are the core constraints on carbon emissions, with a combined contribution of 62.3 per cent. Specifically, for every 1% increase in energy intensity, carbon emission intensity rises by about 0.32%; and for every 1% increase in the proportion of value-added of the secondary industry, carbon emission intensity rises by about 0.21%. This indicates that low energy use efficiency and irrational industrial structure are important reasons for high carbon emissions. At the same time, although the coefficient of innovation-driven green technology progress is negative, there is a statistically significant 6 - 8 year policy lag effect, indicating that it takes a certain amount of time for green technology to accumulate from research and development to application and to produce obvious emission reduction effects.

3 Policy simulation modelling

3.1 System Dynamics Modelling

System dynamics can comprehensively consider the complex feedback relationship between multiple subsystems of economy, society and environment, and dynamically simulate the effect of policy implementation. The constructed system dynamics model of green transition includes energy subsystem, economic subsystem, environmental subsystem, etc. The energy subsystem mainly describes the process of energy production, consumption and conversion. The energy subsystem mainly describes the process of energy production, consumption and conversion; the economic subsystem covers economic activities such as industrial development, investment and consumption; and the environmental subsystem focuses on carbon emissions, pollutant emissions and their environmental impacts.

There are interrelated feedback loops between the subsystems. For example, the increase in energy consumption leads to an increase in carbon emissions, the increase in carbon emissions triggers the strengthening of environmental regulation, environmental regulation prompts enterprises to increase investment in the research and development of green technology, green technology advances to improve the efficiency of energy use, and thus reduce energy consumption and carbon emissions, forming a complex closed loop.

3.2 Scenario Design

In order to comprehensively assess the impact of different policy combinations on the green economy transition and the realisation of the ‘dual-carbon’ goal, the following three scenarios are set up:

Baseline Scenario: Keeping the existing policies unchanged, the projections are made according to the current economic development and energy consumption trends, which serve as the basis for comparison with the other scenarios. In the baseline scenario, economic growth relies mainly on traditional industries, energy structure adjustment is slow, carbon emissions continue to rise and are expected to peak around 2030, but the peak level is high, which may make it more difficult to achieve the carbon neutrality target.

Enhanced policy scenarios: Increase policy implementation, including raising the carbon price to RMB 200 per tonne to guide enterprises to reduce carbon emissions; raise the share of green investment in total investment to 15 per cent to encourage green industry development and technological innovation; and strengthen environmental regulations to strictly control pollutant and carbon emissions. Through these enhanced measures, the economy will be promoted to transition to a green and low-carbon economy.

Technological innovation scenario: Assuming major breakthroughs in clean energy technologies, such as a 40 per cent reduction in the cost of solar photovoltaics, a significant increase in the efficiency of wind power generation, and substantial progress in energy storage technologies. Technological innovation will reduce the cost of clean energy use and improve the stability of energy supply, thus accelerating the transition of energy structure to clean energy and effectively reducing carbon emissions.

3.3 Analysis of Scenario Simulation Results

Carbon emission peak and magnitude

Indicator	Baseline scenario	Enhanced Policy Scenarios	Technology Innovation Scenarios
Year of peak carbon emissions	2029	2026	2027
Peak magnitude (billion tonnes)	1.27 billion tonnes	1.13 billion tonnes	1.17 billion tonnes

From the table, it can be seen that the enhanced policy scenario has the earliest year of peak carbon emissions and the smallest peak magnitude, indicating that the enhanced policy has the most significant effect on the control of carbon emissions; the technological innovation scenario can also advance the peak year and reduce the peak magnitude to a certain extent, but the effect is not as obvious as that of the enhanced policy scenario.

The cost of carbon neutrality in the baseline scenario accounts for 4.5 per cent of GDP; in the enhanced policy scenario, the cost is reduced to 3.8 per cent, indicating that policy promotion can effectively improve the efficiency of emission reduction and reduce the cost of carbon neutrality; and in the technological innovation scenario, the cost of carbon neutrality is 3.6 per cent, indicating that technological innovation also has a positive effect on reducing the cost of emission reduction.

4 Policy toolkit design

4.1 Differentiated regional strategies

China has a vast territory, and the level of economic development, resource endowment and industrial structure of different regions vary greatly, so it is necessary to implement differentiated regional strategies to promote green economic transformation.

Eastern region: Eastern region has developed economy, high technology level and innovation ability, and focuses on the development of carbon finance industry. 2024, the carbon trading volume of some eastern provinces has reached more than 25 billion yuan, which has a good foundation for the development of carbon finance. It can further improve the carbon market trading mechanism, enrich carbon financial products, such as carbon futures, carbon options, etc.; accelerate the establishment of carbon asset management companies and other professional organisations to provide enterprises with one-stop carbon asset management services; and actively carry out international carbon financial cooperation to enhance the discourse and pricing power in the international carbon market, attract the inflow of global green funds, and help the eastern region take the lead in realising a green and low-carbon transformation.

Central region: The central region has a strong industrial base, and its industrial structure is dominated by manufacturing. It should focus on promoting green upgrading of industries, increasing investment in technological transformation of traditional manufacturing industries, and encouraging enterprises to adopt advanced cleaner production technologies and energy-saving and emission reduction equipment. For example, in the iron and steel, chemical and other industries to promote the application of waste heat and pressure recycling, intelligent control systems and other technologies to improve the efficiency of energy use, reduce energy consumption per unit of product and carbon emissions. At the same time, actively undertake the transfer of green industries in the eastern region, cultivate and grow green emerging industries such as energy saving and environmental protection, new energy vehicles, etc., to form new points of economic growth, and achieve the synergistic development of the optimisation of industrial structure and the green economy.

Western region: The western region is rich in resources and has huge potential for renewable energy development. It should give full play to its resource advantages, vigorously develop clean energy industries, accelerate the construction of large-scale wind power and photovoltaic bases, and promote the development of diversified clean energy sources such as hydropower and solar thermal power generation. Strengthen the construction of energy transmission corridors, improve the ability of clean energy transmission, and turn resource advantages into economic advantages. In addition, focus on ecological environmental protection and restoration, strictly abide by the ecological red line while developing the economy, encourage local residents to participate in ecological protection through means such as ecological compensation mechanism, and realise the benign interaction between economic development and ecological environment improvement.

4.2 Industrial policy mix

For the characteristics of different industries, formulate differentiated industrial policies to promote the optimisation and upgrading of industrial structure and the development of green economy.

Energy-consuming industries: For energy-consuming industries such as iron and steel, cement and building materials, implement strict capacity control policies and resolutely curb new excess capacity. We will raise the threshold for entry into the industry and set higher requirements for energy consumption, environmental protection and other indicators for new projects, so as to force enterprises to eliminate outdated production capacity and adopt advanced production processes and equipment. Establish a sound system of energy consumption quota standards, strengthen the monitoring and assessment of energy consumption by enterprises, and implement punitive tariffs, water prices and other measures for enterprises exceeding the quota standards, so as to prompt enterprises to increase their efforts in energy conservation and emission reduction. At the same time, enterprises are encouraged to carry out technological innovation and green transformation, and are supported to research and develop and apply new energy-saving and emission-reduction technologies and processes through tax incentives, financial subsidies and other policies.

Green emerging industries: Increase support for green emerging industries such as energy conservation and environmental protection, new energy, new materials and new energy vehicles. Set up special industrial development funds to provide financial support for en-

terprises, encourage enterprises to increase R&D investment, break through key core technologies and improve industrial competitiveness. Give tax breaks and preferential land policies to green emerging industry enterprises to reduce the operating costs of enterprises. Strengthen the construction of industrial parks, improve supporting facilities, guide the development of green emerging industries agglomeration, the formation of industrial cluster effect, and promote the industry to become bigger and stronger. In addition, through government procurement, green consumption subsidies and other policies, cultivate the green consumption market and boost the demand for green emerging industry products.

Service industry: Vigorously develop green finance, green logistics, green tourism and other green service industries. In terms of green finance, financial institutions are encouraged to develop green credit, green bonds, green insurance and other financial products to provide diversified financing channels for the development of green economy. It will strengthen green financial supervision, improve the green financial standard system, and ensure the effective allocation of financial resources to green industries. In green logistics, promote the application of new energy logistics vehicles, optimise logistics and distribution networks, improve logistics efficiency, and reduce energy consumption and carbon emissions in the logistics process. In green tourism, strengthen ecological environmental protection in tourist attractions, develop green tourism products, guide tourists to travel green and travel civilised, and promote the sustainable development of tourism.

4.3 Technology Innovation Support Policies

Technological innovation is the core driving force to promote the transformation of the green economy, and a series of policies need to be formulated to support the research and development and application of green technology.

Increase investment in R&D: The government will continue to increase financial investment in green technology R&D, set up a special R&D fund, and focus on supporting technology R&D in key areas such as clean and efficient use of energy, carbon capture and sequestration, new energy technologies, and recycling of resources. Encourage enterprises to increase investment in R&D, and implement tax incentives such as additional deduction for enterprise R&D expenses, so as to improve the enthusiasm of enterprise R&D. Guiding social capital to invest in green technology R&D, attracting private capital to participate in green technology innovation through the establishment of industrial investment funds and venture capital funds, and forming a diversified R&D investment mechanism.

Cultivation and introduction of talents: Strengthen the construction of green technology-related disciplines, set up majors in new energy, energy conservation and environmental protection, and environmental science in colleges and vocational schools, and cultivate professionals adapted to the needs of green economy development. Establish an industry-university-research co-operation mechanism, encourage universities, scientific research institutions and enterprises to jointly carry out talent training and technology research and development, and improve the relevance and practicality of talent training. Formulate preferential policies to attract outstanding green technology talents and innovation teams from home and abroad to work in China, and provide talent guarantee for green technology innovation.

Technology promotion and application: Establish a platform for the transformation of green technology achievements, strengthen the docking between supply and demand of green technology, and promote the rapid transformation and application of green technology achievements. Provide financial subsidies, loan interest subsidies and other policy support to enterprises adopting green technologies, so as to reduce the cost of applying new technologies. Formulate a green technology promotion catalogue and regularly release information on advanced and applicable green technologies and products, so as to guide enterprises to actively adopt green technologies for production and operation. Strengthen the protection of intellectual property rights, encourage enterprises to innovate independently, safeguard the legitimate rights and interests of enterprises innovating in green technologies, and create a favourable environment for technological innovation.

References

1. Grossman G M, Krueger A B. Economic Growth and the Environment [J]. Quarterly Journal of Economics, 1995, 110 (2): 353-377.

2. Wang Feng, Feng Genfu, Wu Hongshun. Impact of economic restructuring on carbon emissions in China [J]. Economic Research, 2021, 56 (10): 127-143.

3. Sun Chuanwang, Liu Xiying, Lin Boqiang. Structural decomposition of industrial CO_2 emissions and dynamic characteristics of industry contribution in China [J]. Management World, 2022, 38 (3): 79-91.

4. Chen Shiyi. Energy Consumption, Carbon Dioxide Emission and Sustainable Development of Chinese Industry [J]. Economic Research, 2010, 45 (2): 21-33.

5. Zhou Shouhua, Tao Kunyu, Liu Cheng. Study on the Path of Green Finance to Help Achieve the Carbon Peak Carbon Neutral Goal [J]. Financial Research, 2021, (5): 1-20.

6. Qi Shaozhou, Lin Dizhi, Cui Jingbo. Spatial correlation of interprovincial carbon emissions in China and its influencing factors - based on social network analysis [J]. Economic Research, 2014, 49 (6): 142-154.

7. He JK, Liu B. Carbon emission intensity analysis as a measure of greenhouse gas emissions [J]. Journal of Tsinghua University (Natural Science Edition), 2004, 44 (6): 740-743.

8. Tu Zhengge, Chen Renjun. Total Factor Energy Efficiency in China's Industrial Sectors - A Study Based on Sub-industry Panel Data [J]. World Economy, 2009, 32 (8): 29-43.

9. Wang K, Zou Ji, Wang Can. Analysis of factors affecting carbon emissions from energy consumption in China based on STIRPAT model [J]. China Population, Resources and Environment, 2010, 20 (12): 1-6.

10. YANG Jun, SHAO Hanhua, ZHOU Xiaohua. Energy consumption, economic growth and carbon

emission in China [J]. Research on Quantitative and Technical Economics, 2010, 27 (11): 26-37.

11. Yu Yongze, Pan Yan. Industrial structure, technological progress and CO_2 emission intensity in China [J]. Finance and Trade Economics, 2014, 35 (6): 129-140.

12. Zhang K, Wang DF. Industrial carbon emission performance and influencing factors in China - An empirical analysis based on spatial panel Durbin model [J]. China Industrial Economy, 2014, (11): 70-82.

13. Jingyan Fu, Lisa Li. An empirical study of environmental regulation, factor endowment and international competitiveness of industries -- Based on panel data of Chinese manufacturing industry [J]. Management World, 2010, (10): 87-98.

14. Jiang Ke, Zhong Changbiao. The Impact of Industrial Structure Upgrading on Carbon Emissions in China -- An Empirical Analysis Based on Spatial Measurement [J]. Finance and Trade Economics, 2015, 36 (10): 124-137.

15. Zhao A, Wu Chunyou. An empirical study on the relationship between energy consumption, carbon emission and economic growth in China -- Based on LMDI decomposition method and VAR model [J]. Research Management, 2016, 37 (1): 134-142.

16. Lin Boqiang, Liu Xiying. Carbon emissions in China's urbanisation stage: influencing factors and emission reduction strategies [J]. Economic Research, 2010, 45 (8): 66-78.

17. Yuan Huaxi, Li Liping, Yang Haoran. Research on the Impact of Green Finance on China's Green Economic Growth -- Empirical Analysis Based on Spatial Durbin Model [J]. Financial Research, 2020, (10): 142-160.

18. Wang Family, Cao Qingfeng. Study on the convergence of regional energy efficiency and economic growth in China [J]. Research on Quantitative Economics and Technical Economics, 2012, 29 (11): 3-20.

19. Zhang Youguo. Impact of economic restructuring on carbon emissions in China [J]. Economic Research, 2010, 45 (11): 120-134.

20. Su Yifang, Hu Ridong. Study on the dynamic evolution of China's carbon emissions and the factors affecting them - An empirical analysis based on interprovincial panel data from 1995-2009 [J]. Research on Quantitative and Technical Economics, 2012, 29 (12): 19-32.

21. Song DY, Lu ZB. Decomposition of factors affecting carbon emission and its cyclical fluctuation in China [J]. China Population, Resources and Environment, 2009, 19 (4): 15-21.

22. Li Kingland, Qi Shaozhou. Trade openness, economic growth and carbon dioxide emissions in China [J]. Economic Research, 2011, 46 (11): 60-72.

23. Peng Shujun, Zhang Wencheng. Fluctuation characteristics and influencing factors of China's carbon emission intensity - An empirical analysis based on inter-provincial panel data from 1995-2009 [J]. China Industrial Economy, 2012, (1): 55-64.

24. Xu Guangyue, Song Deyong. An empirical study on the environmental Kuznets curve of carbon emissions in China - based on provincial panel data [J]. China Industrial Economy, 2010, (5): 37-47.

25. Zhang Cheng, Lu Yang, Guo Lu, Yu Tongshen. Environmental regulation intensity and production technology progress [J]. Economic Research, 2011, 46 (2): 113-124.

RESEARCH ASSESSMENT ON THE LEGAL FRAMEWORK OF THE EU DRAFT ANTI-ECONOMIC COERCION IN THE PERSPECTIVE OF INTERNATIONAL LAW

Ye YiWen,
Wang SuMeng
Belarus State Economic University Republic of Belarus
Minsk

ABSTRACT

This paper analyses in depth the legal framework of the EU draft law against economic coercion from the perspective of international law. Through theoretical analyses, it clarifies the relationship between economic coercion and the principles of international law, and explains the position of the draft in the international legal system. Combined with the theoretical conferences, legal developments and international current affairs in the past two years, this paper explores the problems of the draft in terms of implementation scope, compatibility with existing international law and enforcement mechanism, and puts forward strategies and suggestions for coping with them and looks forward to the future, so as to provide references for the research and development of the international economic legal order.

Keywords: European Union Draft on Anti-Economic Coercion; International Law; Legal Framework; Economic Order.

1 Introduction

In the deep development of the globalised economy, the interdependence and competition of the economies of all countries are fierce, and economic coercion has become an issue of great concern in international economic relations. The European Union (EU) has launched a draft anti-economic coercion law in an attempt to build a legal defence against economic coercion, which has attracted widespread attention in the international economic and legal fields. Studying the legal framework of the draft from the perspective of international law helps to accurately grasp its connotation, impact and development direction, and is of great significance to the maintenance of the stability and fairness of the international economic order [1].

2 Theoretical analysis

2.1 International Law Definition of Economic Coercion

There is no uniform and clear definition of economic coercion in international law. Traditional international law focuses on political and military coercion, and with economic globalisation, the influence of economic coercion is becoming more and more prominent [2]. Generally speaking, economic coercion can be understood as a country or an international organisation exerting pressure on another country through economic means, such as trade restrictions, investment bans, financial sanctions, etc., to force it to change its economic or political decision-making, and such behaviour violates the basic principles of international law, such as sovereign equality and non-interference in internal affairs. In international practice, the determination of economic coercion is complex and requires a comprehensive consideration of the legality of the means, the legitimacy of the end and the degree of impact on the sovereignty and economic order of other countries.

2.2 Relationship between the draft and the basic principles of international law

The EU draft against economic coercion should follow the basic principles of international law. The principle of sovereign equality requires that the draft, in the course of its implementation, should not infringe upon the sovereignty of other countries and should not unilaterally impose its will on other countries. The principle of non-interference in internal affairs restricts the draft from interfering in the formulation of economic policies and the management of economic affairs within other countries in the name of anti-economic coercion [3]. The principle of fairness and mutual benefit prompts the draft to ensure the fair status of all parties in international economic relations when dealing with economic coercion, so as to achieve mutual benefit and win-win situation, rather than becoming a tool for the EU to seek unilateral interests. However, in the actual formulation and potential implementation of the draft, the draft may conflict with these basic principles of international law due to excessive consideration of self-interest, which is an issue that needs to be focused on in the study.

2.3 Positioning of the draft in the international legal system

The draft is a legal document of the EU at the regional level, and is at the point of interaction between regional and international law in the international legal system. On the one hand, the formulation of the draft is based on the EU's own economic interests and security needs, and is an extension of the EU's internal legal order; on the other hand, its implementation is bound to have an impact on international economic relations and the rules of international law. At the level of the international legal system, the draft needs to operate on the premise of conforming to the basic principles and rules of international law, and when the provisions of the draft conflict with international law, international law should have priority application. However, since the international legal system lacked a strong and unified executive body, the draft might have difficulty in coordinating with international law in practice.

3 Current issues

3.1 Ambiguity in the scope of implementation of the draft

There are ambiguities in the definition of the scope of implementation of the EU draft law against economic coercion. The enumeration of ‘economic coercion’ is not exhaustive and the criteria are not clear enough, resulting in a lack of clear basis for judging

whether a certain economic behaviour constitutes coercion. For example, the draft does not clearly delineate the boundaries between trade measures and normal trade policy adjustments, which makes it possible for some countries' normal trade protection measures to be wrongly identified as acts of economic coercion. In terms of the scope of subjects, the draft also defines the countries, enterprises and international organisations involved in a rather general manner, which is prone to disputes, which may lead to excessive abuse of the draft in the course of its implementation or an undue narrowing of the scope of application.

At the International Law Colloquium 2024, many experts and scholars conducted in-depth discussions on the EU Regulation on Anti-Economic Coercion (the subsequent development results of the draft), and many points of view pointed out that such a vague definition will bring great trouble in the practical application, which may lead to conflict with the existing rules of international law, break the balance of international trade law based on the multilateral framework of the WTO rules and other multilateral frameworks, and make the international economic and trade order face new Uncertainty [4].

3.2 Compatibility with existing rules of international law

From the perspective of international law, there are questions about the compatibility of the draft with existing rules of international law. In the field of international trade law, certain trade restrictive measures in the draft may conflict with the rules of the World Trade Organisation (WTO), which emphasise free trade and fair competition, while the anti-economic coercive measures in the draft may, to a certain extent, undermine the balance of the multilateral trading system. In terms of international investment law, the draft's restrictive measures on investment may violate the provisions on investment protection and promotion in bilateral or multilateral investment agreements, affecting the stability and development of international investment. In addition, the draft will lead to chaos in the international legal order if it is inconsistent with the existing international law dispute settlement channels in terms of dispute settlement mechanisms [5].

The Anti-Economic Coercion Regulation introduced by the EU at the end of 2023 has many problems from the perspective of international law. Its definition of ‘economic coercion’ is not in line with the current situation where there is no precise definition in international law, and it unilaterally determines that third countries take or threaten to take measures affecting trade or investment of the EU and its Member States in an attempt to prevent or induce the EU and its Member States to cease, modify or intervene in the EU and its Member States' trade or investment activities by means of a specific act. The ‘legitimate sovereign choice’ of the EU and its member states as ‘economic coercion’ greatly expands the EU's room for interpretation of ‘economic coercion’, which may be used to intervene in the normal economic and trade behaviour of third countries without justification[6]. In January 2025, the EU passed a bill banning forced labor, claiming that it does not target any country, but from the specific provisions, many details are strictly limited, obviously targeting developing countries such as China's industrial chain, for example, in the field of new energy vehicles, not only the brand of the vehicle must not have any suspicion of forced labor, and even all the parts of the vehicle must not have a similar problem, or else the product will be returned to the EU market. Compulsory return, which is contrary to the fair rules of international trade [7].

3.3 Potential Conflicts in Enforcement Mechanisms

The enforcement mechanism of the draft may conflict with the relevant mechanisms of other countries and international organisations. When the EU implements the draft, it may adopt unilateral economic sanctions, which is contrary to the multilateralism solution advocated by the United Nations and other international organisations [8]. For example, when the EU implements economic sanctions against a certain country in response to the so-called economic coercion, if other countries or international organisations hold different views, it may trigger international confrontation over sanctions and undermine the stability of the international economic order. Moreover, the lack of an effective coordination mechanism with other countries and international organisations in the implementation mechanism of the draft is likely to lead to different legal judgments and outcomes in the same economic incident.

In the context of the Russian-Ukrainian conflict, the EU has continued to impose sanctions on Russia, with the number of rounds of sanctions reaching fifteen since the escalation of the crisis situation in Ukraine in February 2022 [9]. This not only puts pressure on the Russian economy, but also damages the EU's own economy and affects global economic stability and energy market supply. In this context, the implementation of the EU's Anti-Economic Coercion Regulation is more likely to further intensify economic confrontation in international relations, leading to a more complex and volatile international landscape [10].

4 Coping Strategies and Suggestions

4.1 Coping strategies at the international level

At the international level, countries should strengthen cooperation within the framework of international organisations and jointly improve international economic rules. For example, under the framework of WTO, members can discuss the identification criteria and countermeasures of economic coercion and formulate unified rules to avoid countries acting on their own. The United Nations should also play a greater role in supervising and mediating economic coercion and promoting the stability of the international economic order through the establishment of special institutions or platforms. International organisations should strengthen their attention to and assessment of the EU's anti-economic coercion draft (and subsequent relevant regulations), and make timely recommendations and interventions when the draft may have a negative impact on the international economic order.

4.2 Suggestions for response at the national level

Countries potentially affected by the draft should actively use diplomatic means to communicate and consult with the EU. Through bilateral or multilateral

dialogue, they should express their concerns and strive for fair treatment in the implementation of the draft. At the same time, these countries should strengthen the construction of their own economic strength, reduce their dependence on the EU market and improve their ability to cope with economic coercion. At the legal level, countries should strengthen the interface between domestic legislation and international law, and improve their own legal system against economic coercion, so that they have laws to follow when facing unfair economic pressure.

Take China-EU relations as an example, in the 'Xinjiang cotton incident', the EU defines the patriotic behaviour of people spontaneously boycotting clothing brands such as H&M and Adidas as 'economic coercion' by the Chinese state; in the Lithuanian Taiwan issue, the EU tries to make use of the so-called 'economic coercion'. On the issue of Lithuania's involvement in Taiwan, the EU tried to use the so-called concept of 'economic coercion' to stand up for Lithuania and discredit China's countermeasures. China should continue to make its position clear through diplomatic channels, and at the same time accelerate the construction of domestic and international double-cycle, reduce its dependence on the EU market, and improve the relevant legal system to cope with the EU's unreasonable initiatives.

4.3 Countermeasures at the enterprise level

Enterprises, as the main body of international economic activities, should strengthen the research on the EU's draft anti-economic coercion (and related regulations), and do a good job of risk assessment and response plan in advance. In international trade and investment, enterprises should pay attention to the design of contract terms and increase the provisions to cope with legal risks. For example, the treatment of force majeure and trade policy changes should be clearly defined in trade contracts to avoid economic losses caused by the implementation of the draft. Enterprises should also actively expand diversified markets, reduce dependence on a single market, and reduce the market risk caused by the implementation of the EU draft.

5 Outlook and Conclusion

5.1 Prospective Analysis of the Draft

The future of the EU draft anti-economic coercion is full of uncertainties. On the positive side, if the draft can be continuously improved in the process of implementation, clearly define the scope of implementation, effectively coordinate with the existing rules of international law, and establish a reasonable enforcement mechanism, it will help safeguard the EU's economic security and interests, and at the same time, it may also provide useful reference for the international community to deal with economic coercion. However, if the draft fails to address existing problems, its implementation may trigger tensions in international economic relations, leading to intensified trade and investment disputes and destabilising the international economic order. With the changes in the global economic landscape and the continuous evolution of international economic rules, the draft also needs to continuously adapt to new situations.

5.2 Research Conclusion

This paper studies and evaluates the legal framework of the EU's draft anti-economic coercion from the perspective of international law, and finds that there are many problems with the draft in terms of its theoretical basis, current implementation and other aspects. Theoretically, although based on the need to respond to economic coercion, the degree of fit with the basic principles of international law needs to be strengthened. In the current situation, the ambiguous scope of implementation, insufficient compatibility with existing rules of international law, and potential conflicts in the implementation mechanism stand out, which have been further highlighted by relevant theoretical conferences, legal developments and international current affairs in the past two years. By proposing coping strategies and suggestions at the international, national and corporate levels, the draft aims to provide ideas for solving these problems. The outlook for the draft suggests that its development depends on its ability to effectively address existing problems and adapt to changes in the international economic situation. The study of the draft is of great significance for understanding the development trend of the international economic legal order and maintaining a fair and stable international economic environment, and also provides a reference for subsequent relevant research and international economic practice.

References

1. Huo Zhengxin. The International Law Implications of the Anti-Foreign Sanctions Act, in Social Science Digest, No. 10, 2021.

2. Gong Hongliu. On the WTO Compliance of Implementing 'Countermeasures' in the U.S.-China Trade War: China's Response to the U.S. 301 Measures as an Example,' Issue 1, 2019.

3. Liu Ying and Liu Zhengyang, 'The Limitations of the Application of the 301 Clause Outside the WTO System--Analyzing the Violation of International Law by the Unilateral Sanctions of the United States', Vol. 3, No. 3, 2019.

4. He Renping. Clarification of the Functional Position of Competition Law and Trade Remedy Law - Taking EU White Paper on Foreign Subsidies as the Core, in Journal of International Economic Law, Vol. 4, 2021.

5. Liao Fan. From 'prosperity' to norms: Reflection and prospect of China's international economic law research[J]. Politics and Law Forum,2018,36(05):106-118.

6. Wang Tieya. International law [M]. Law Press,1995.

7. Yin L. The identification of circumvention in the EU anti-circumvention legislation[J]. Jurist,2004(06):133-139.

8. He Zhipeng. On the Chinese programme of international economic rule of law[J]. Chinese social science,2017(06):124-145.

9. Shen Sibao, Wang Bingqian. Legal Risk Prevention in the Implementation of 'Going Out' Strategy of Chinese Enterprises[J]. Jurist,2012(03):1-11.

10. Pang Zhongying. International political economy [M]. Higher Education Press, 2008.

TECHNICAL SCIENCES

ПРОБЛЕМЫ КИБЕРБЕЗОПАСНОСТИ В ЭПОХУ ОБЛАЧНЫХ ВЫЧИСЛЕНИЙ, РИСКИ И ИХ РЕШЕНИЯ

Имашев А.А.
Университет Барри

CYBERSECURITY CHALLENGES IN THE ERA OF CLOUD COMPUTING, RISKS AND ITS SOLUTIONS

Imashev A.
Barry University

АННОТАЦИЯ

В этой статье рассматриваются проблемы кибербезопасности, возникающие в эпоху облачных вычислений, с упором на присущие им риски и современные решения, доступные для смягчения этих угроз. Поскольку организации все чаще используют облачные сервисы для хранения данных, хостинга приложений и интеграции бизнес-процессов, они сталкиваются с повышенными рисками, включая утечки данных, атаки программ-вымогателей, внутренние угрозы и уязвимости со стороны сторонних поставщиков услуг. Исследование критически анализирует меняющийся ландшафт угроз и подчеркивает важность надежных мер безопасности, таких как сквозное шифрование, многофакторная аутентификация и системы непрерывного мониторинга. Кроме того, в статье рассматривается роль новых технологий, включая искусственный интеллект (ИИ) и машинное обучение, в обнаружении и реагировании на киберугрозы в режиме реального времени. Результаты подчеркивают, что, хотя облачные вычисления предлагают значительную масштабируемость и экономическую выгоду, обеспечение целостности и конфиденциальности данных остается первостепенной задачей. В заключение приводятся стратегические рекомендации для организаций по внедрению интегрированных фреймворков безопасности, сочетающих технологические инновации, передовой опыт управления рисками и соблюдение нормативных стандартов для создания устойчивых облачных инфраструктур.

ABSTRACT

This article examines the cybersecurity challenges that arise in the era of cloud computing, focusing on the inherent risks and contemporary solutions available to mitigate these threats. As organizations increasingly adopt cloud services for data storage, application hosting, and business process integration, they face heightened risks including data breaches, ransomware attacks, insider threats, and vulnerabilities from third-party service providers. The study critically analyzes the evolving threat landscape and highlights the importance of robust security measures such as end-to-end encryption, multi-factor authentication, and continuous monitoring systems. Additionally, the article explores the role of emerging technologies, including artificial intelligence (AI) and machine learning, in detecting and responding to cyber threats in real time. The findings underscore that while cloud computing offers significant scalability and cost benefits, ensuring data integrity and privacy remains a paramount concern. The paper concludes with strategic recommendations for organizations to adopt integrated security frameworks that combine technological innovations, best practices in risk management, and adherence to regulatory standards to build resilient cloud infrastructures.

Ключевые слова: проблемы кибербезопасности, организации. надежная безопасность, искусственный интеллект.

Keywords: cybersecurity challenges, organizations. robust security, artificial intelligence.

Introduction

Cloud computing has revolutionized the way organizations store, manage, and process data. Its scalability, flexibility, and cost-effectiveness have made it a cornerstone of modern IT infrastructure. However, as businesses increasingly rely on cloud services, they face a host of cybersecurity challenges that threaten data integrity, business continuity, and consumer trust.

Data breaches remain one of the most significant threats in the cloud computing environment. Cloud storage systems often host sensitive and valuable data, making them attractive targets for cybercriminals. In a breach, unauthorized users gain access to confidential information, which can result in severe financial and reputational damage. According to Kshetri (2018), data breaches in cloud environments have led to losses amounting to billions of dollars globally. The multi-tenant nature of cloud services can sometimes facilitate lateral movement for attackers, allowing them to compromise additional systems once a single breach occurs.

Insider threats pose another critical risk. Unlike external attackers, insiders—whether employees or contractors—often have legitimate access to sensitive data and systems. This access can be misused either maliciously or inadvertently. Insider threats are particularly difficult to detect because they originate from trusted sources within the organization. As noted by Greitzer and Frincke (2010), the potential for harm

from insider actions in cloud environments is significant, especially when combined with inadequate monitoring and poor access controls.

Ransomware attacks have grown in frequency and sophistication, targeting cloud-based systems alongside traditional IT infrastructures. Attackers often deploy ransomware to encrypt critical data and demand payment for its release. Cloud environments, with their vast repositories of data, become lucrative targets. In addition, malware designed to exploit cloud-specific vulnerabilities can spread rapidly, disrupting services and causing extensive operational downtime (Chandramouli & Behrens, 2020). These attacks not only cause immediate financial losses due to ransom payments but also result in long-term costs associated with system restoration and reputational damage.

Vulnerabilities in Cloud Architectures and Third-Party Integrations

The architecture of cloud computing systems introduces unique vulnerabilities. Public clouds, in particular, operate on a multi-tenant model where resources are shared among numerous customers. This model can lead to risks if proper isolation mechanisms are not implemented. For example, side-channel attacks, where an attacker gains information by monitoring shared hardware resources, have been documented as potential risks in multi-tenant cloud environments (Ristenpart et al., 2009). Additionally, misconfigurations in cloud storage and computing services are a common source of vulnerabilities. Research indicates that a significant percentage of cloud security incidents stem from improper configuration of storage buckets, access controls, or network settings (Mell & Grance, 2011).

Modern cloud environments often involve multiple third-party integrations, including Software as a Service (SaaS) applications, cloud-based analytics, and external APIs. Each integration introduces additional risk factors, as vulnerabilities in third-party systems can compromise the entire cloud ecosystem. A breach in a trusted third-party provider can cascade, affecting all clients that rely on its services. Furthermore, third-party integrations can complicate security monitoring and incident response, as data flows between multiple systems with varying security standards (Subashini & Kavitha, 2011).

Cybersecurity incidents in cloud environments can severely disrupt business operations. When data breaches or ransomware attacks occur, they can lead to prolonged system downtime and loss of access to critical data. This disruption affects not only internal processes but also customer-facing services, potentially eroding customer trust and leading to revenue losses. According to a report by IBM (2020), the average cost of a data breach in cloud environments has been rising, with companies experiencing significant financial impacts due to business interruption. The inability to quickly recover from such incidents can undermine an organization's competitive edge and long-term viability.

Data integrity is a cornerstone of effective business operations. In cloud environments, maintaining the accuracy, consistency, and reliability of data is paramount. Cybersecurity challenges such as unauthorized access, data tampering, and malware can compromise data integrity. This, in turn, affects decision-making, operational efficiency, and regulatory compliance. For instance, manipulated data can lead to erroneous business insights and poor strategic decisions, while compromised data may result in legal liabilities and loss of customer trust. Ensuring robust data integrity requires advanced security measures, continuous monitoring, and a well-defined incident response strategy (Rittinghouse & Ransome, 2017).

The era of cloud computing has brought about transformative benefits for businesses, yet it also presents substantial cybersecurity challenges. Data breaches, insider threats, and ransomware attacks pose significant risks, exacerbated by vulnerabilities inherent in cloud architectures and third-party integrations. These cybersecurity challenges have far-reaching implications for business continuity and data integrity, affecting operational efficiency and stakeholder trust. Organizations must therefore adopt a multifaceted approach to cloud security, which includes robust access controls, continuous monitoring, and comprehensive risk management strategies. As the cloud continues to evolve, addressing these challenges will be crucial for ensuring that businesses can fully leverage the benefits of digital transformation while maintaining resilience against cyber threats.

Solutions and Mitigation Strategies for Cloud Security Risks

As cloud computing becomes integral to business operations, cybersecurity risks have grown in parallel. Cyber threats such as data breaches, unauthorized access, and ransomware attacks pose significant challenges to organizations using cloud services. Addressing these risks requires a comprehensive set of solutions that encompasses both technical and managerial measures.

Encryption is one of the most critical technical solutions for securing data in the cloud. By converting data into unreadable ciphertext, encryption protects sensitive information from unauthorized access even if data breaches occur. Both data-at-rest and data-in-transit must be encrypted using strong algorithms such as AES-256 (Advanced Encryption Standard) to ensure robust security (Mell & Grance, 2011). Alongside encryption, tokenization and data masking techniques are used to further reduce the risk of exposure by substituting sensitive data elements with non-sensitive equivalents.

Multi-factor authentication (MFA) significantly strengthens user verification processes by requiring two or more independent credentials—such as passwords, biometrics, or security tokens—before granting access to cloud systems. MFA mitigates the risk of unauthorized access, particularly in cases where credentials are compromised. Additionally, robust access control measures, including role-based access control (RBAC) and least privilege principles, ensure that users have only the necessary access rights to perform their functions (Subashini & Kavitha, 2011). These controls reduce the risk of insider threats and limit the damage caused by compromised accounts.

Regular security audits and continuous compliance monitoring are essential managerial strategies for

maintaining cloud security. Periodic audits help identify vulnerabilities, misconfigurations, and non-compliance with internal policies or regulatory standards. Organizations can use automated tools to continuously monitor cloud environments for anomalies and ensure that security protocols are being followed. By maintaining up-to-date security certifications such as ISO/IEC 27001 and ensuring compliance with frameworks like the NIST Cybersecurity Framework, companies can provide assurance to stakeholders about their commitment to protecting data (Mell & Grance, 2011).

A well-defined incident response plan is critical to mitigating the impact of security breaches in cloud environments. This involves developing a comprehensive strategy for detecting, responding to, and recovering from cyber incidents. Regularly updating and testing incident response plans ensures that organizations can quickly contain breaches and minimize downtime. Disaster recovery plans that include data backups, redundant systems, and clear communication protocols are also essential to ensure business continuity in the event of a significant security incident (Rittinghouse & Ransome, 2017).

Artificial intelligence (AI) is increasingly being integrated into cloud security strategies. AI-powered threat detection systems can analyze vast amounts of network data in real time, identifying patterns that may indicate a cyber attack. Machine learning algorithms are particularly effective in detecting anomalies that could signal ransomware, phishing, or zero-day exploits. By continuously learning from new data, these systems become more adept at predicting and preventing security breaches (Kshetri, 2018). For example, IBM's QRadar Advisor with Watson uses AI to correlate data across multiple sources, thereby accelerating threat detection and response times.

In addition to threat detection, AI can facilitate automated incident response. Automated systems can trigger pre-defined responses to specific threats, such as isolating affected servers, revoking compromised credentials, and alerting security teams. This rapid response capability is crucial in cloud environments, where the speed of an attack can determine the extent of data loss and operational disruption. By integrating AI-driven incident response tools with Security Information and Event Management (SIEM) systems, organizations can ensure that their response mechanisms are both proactive and adaptive (Chandramouli & Behrens, 2020).

Best Practices and Regulatory Frameworks

Adhering to industry best practices is fundamental to maintaining secure cloud environments. Key practices include:

- Implementing Zero Trust Architecture: Organizations should assume that both internal and external networks are inherently insecure and verify every access request rigorously.
- Regular Patching and Updates: Ensuring that all systems, applications, and devices are regularly updated to protect against known vulnerabilities.
- Comprehensive Employee Training: Continuous training programs can help staff recognize and respond to security threats effectively.
- Data Backup and Recovery Protocols: Regularly backing up data and testing recovery processes minimize the impact of any data breaches or ransomware attacks.

Governments and international organizations have established regulations to safeguard data in cloud environments. Notable regulatory frameworks include:

- General Data Protection Regulation (GDPR): Enforces strict data privacy and security standards in the European Union, impacting any company that handles EU citizens' data (European Commission, 2018).
- California Consumer Privacy Act (CCPA): Imposes similar requirements on companies operating in or serving customers in California.
- NIST Cybersecurity Framework: Provides guidelines for managing and reducing cybersecurity risk for organizations using cloud services (NIST, 2018).

Compliance with these frameworks not only ensures legal adherence but also enhances consumer trust and overall data security. Organizations must regularly update their policies to remain aligned with evolving regulations and emerging security threats.

Conclusion

The era of cloud computing brings numerous cybersecurity challenges that require both technical and managerial solutions. Encryption, multi-factor authentication, regular audits, and robust incident response strategies form the core of technical defenses. At the same time, the adoption of AI-driven threat detection and automated incident response systems enhances the resilience of cloud infrastructures. Adhering to best practices and regulatory frameworks further safeguards data integrity and ensures compliance with global standards. By implementing these solutions, organizations can effectively mitigate cloud security risks, maintain business continuity, and protect sensitive data in an increasingly digital and interconnected world.

References

1. Chandramouli, R., & Behrens, R. (2020). Machine Learning for Cybersecurity: A Comprehensive Guide. Wiley
2. European Commission. (2018). General Data Protection Regulation (GDPR). Retrieved from https://ec.europa.eu/info/law/law-topic/data-protection_en
3. Greitzer, F. L., & Frincke, D. A. (2010). Combining traditional cyber security audit data with psychosocial data: Towards predictive modeling for insider threat mitigation. Insider Threats in Cyber Security, 85-113.
4. IBM. (2020). Cost of a Data Breach Report 2020. Retrieved from https://www.ibm.com/security/data-breach
5. Kshetri, N. (2018). 1 The emerging role of big data in key development issues: Opportunities, challenges, and concerns. In Big Data for Development (pp. 3-15). Springer.
6. Mell, P., & Grance, T. (2011). The NIST Definition of Cloud Computing. National Institute of Standards and Technology Special Publication 800-145.

7. NIST. (2018). Framework for Improving Critical Infrastructure Cybersecurity. National Institute of Standards and Technology.

8. Ristenpart, T., Tromer, E., Shacham, H., & Savage, S. (2009). Hey, you, get off of my cloud: Exploring information leakage in third-party compute clouds. In Proceedings of the 16th ACM conference on Computer and communications security (pp. 199-212). ACM

9. Rittinghouse, J. W., & Ransome, J. F. (2017). Cloud Computing: Implementation, Management, and Security. CRC Press.

10. Subashini, S., & Kavitha, V. (2011). A survey on security issues in service delivery models of cloud computing. Journal of Network and Computer Applications, 34(1), 1-11.

КОМПЛЕКСНАЯ РЕЛЕЙНАЯ ЗАЩИТА ЭЛЕКТРОСЕТЕЙ 6-35 кВ

Дмитриченко В.И.,
Алматинский университет энергетики и связи им. Г. Даукеева, доцент
Кадылбеков С.К.,
Алматинский университет энергетики и связи им. Г. Даукеева
Траисов Р.С.,
Алматинский университет энергетики и связи им. Г. Даукеева
Жайсанов А.
Алматинский университет энергетики и связи им. Г. Даукеева

COMPLEX RELAY PROTECTION OF ELECTRICAL NETWORKS 6-35 kV

Dmitrichenko V.,
Almaty university of power engineering and telecommunications named after G. Daukeev, associate professor
Kadylbekov S.,
Almaty university of power engineering and telecommunications named after G. Daukeev
Traisov R.,
Almaty university of power engineering and telecommunications named after G. Daukeev
Zhaisanov A.
Almaty university of power engineering and telecommunications named after G. Daukeev

АННОТАЦИЯ

В предлагаемой статье рассматриваются направления совершенствования комплексной релейной защиты электрических сетей 6-35 кВ. Особое внимание уделяется решениям проблем, связанных с однофазными замыканиями на землю, а также обоснованию применения комплекс известных алгоритмов и видов релейной защиты для повышения надежности электроснабжения.

ABSTRACT

This article discusses directions for improving the integrated relay protection of 6-35 kV electrical networks. Particular attention is paid to solving problems associated with single-phase ground faults, as well as justifying the use of a set of well-known algorithms and types of relay protection to improve the reliability of power supply.

Ключевые слова: однофазные замыкания на землю, перенапряжение, блок-схема, напряжение, релейная защита, электрические сети.

Keywords: single-phase earth faults, overvoltage, block diagram, voltage, relay protection, electrical networks.

Мировая потребность в электроэнергии неуклонно растет, что обостряет вопросы надежности и бесперебойности электроснабжения. Для повышения устойчивости работы электрических сетей и снижения аварийности ученые и инженеры разрабатывают различные решения. В данной статье рассматривается один из возможных способов повышения надежности распределительных сетей напряжением 6–35 кВ, включающий ограничение и регистрацию перенапряжений, а также защиту от однофазных замыканий на землю (ОЗЗ).

Следует отметить рост количества аварий на линиях, среди которых основную часть составляют ОЗЗ и перенапряжения, которые часто приводят к таким замыканиям.

Практика показывает, что при возникновении ОЗЗ линии, как правило, продолжают работу без отключения, поэтому такие события не классифицируются как аварийные. Однако в последние годы это отношение пересматривается. Например, с 2018 года Республика Беларусь начала придавать таким ситуациям статус аварийного события. Такой подход позволяет продлить срок службы кабелей с устаревшей изоляцией, высоковольтных электродвигателей и современных кабелей с изоляцией из сшитого полиэтилена [1,2].

В связи с этим актуальной задачей становится сокращение времени на поиск поврежденного кабеля при возникновении замыканий на землю и его своевременное отключение [5].

На многих подстанциях региональных энергокомпаний установлено современное оборудование, включая шкафы релейной защиты от ОЗЗ, которые, однако, часто не используются из-за ряда недостатков.

Таким образом, важнейшей проблемой распределительных сетей 6–35 кВ является эффективное ограничение перенапряжений, а также быстрое выявление и отключение участков с ОЗЗ.

Анализ существующих решений для защиты от перенапряжений и ОЗЗ показывает наличие се-

рьезных недостатков, особенно для сетей с кабелями устаревшего типа, высоковольтными электродвигателями и современными кабелями из сшитого полиэтилена [3,4].

Цель работы — разработка комплексной системы защиты распределительных сетей 6–35 кВ от перенапряжений и однофазных замыканий на землю.

Релейные защиты от ОЗЗ основаны на наиболее распространенных и проверенных алгоритмах [1,2].

1. Алгоритм на основе максимального действующего значения основной гармоники тока нулевой последовательности применяется в сетях с изолированной нейтралью. Однако его использование ограничено, особенно при небольшом количестве отходящих фидеров.

2. Алгоритм, основанный на переходном процессе ОЗЗ, определяет знак мгновенной мощности нулевой последовательности в начальной фазе переходного процесса. Он позволяет фиксировать кратковременные самоустраняющиеся пробои изоляции, но требование фиксации сигналов в течение всего 0,5–2,0 мс снижает его надежность. В практике данный метод используется редко.

3. Алгоритм по направлению мощности нулевой последовательности считается наиболее логичным и эффективным, поскольку источник нулевой последовательности находится непосредственно в точке ОЗЗ. Однако его применение затруднено из-за значительных угловых погрешностей и различий в характеристиках трансформаторов тока нулевой последовательности, особенно при малых токах и в условиях ОЗЗ [3,5].

4. Алгоритм, основанный на сумме высших гармоник тока нулевой последовательности, показывает хорошие результаты в централизованных устройствах относительного измерения для разветвленных сетей с большим количеством ферромагнитного оборудования (трансформаторов, дугогасящих реакторов и т.п.). Однако в индивидуальных устройствах абсолютного измерения сложно установить надежную уставку по гармоникам из-за нестабильности их состава и уровня, что снижает эффективность метода.

5. Алгоритм по величине гармоник наложенного тока обеспечивает высокую селективность в компенсированных сетях, но требует наличия специального источника наложенного тока. Его использование целесообразно только в сетях, где такой источник уже существует, например, для управления дугогасящими реакторами. В сложных и разветвленных сетях метод имеет ограниченное применение [4].

Анализ перечисленных алгоритмов показывает наличие значительных недостатков, которые ограничивают их использование в современных условиях.

Для решения поставленной задачи предлагается новая схема релейной защиты с применением алгоритма на основе RC-гасителя (рисунок 1) [6].

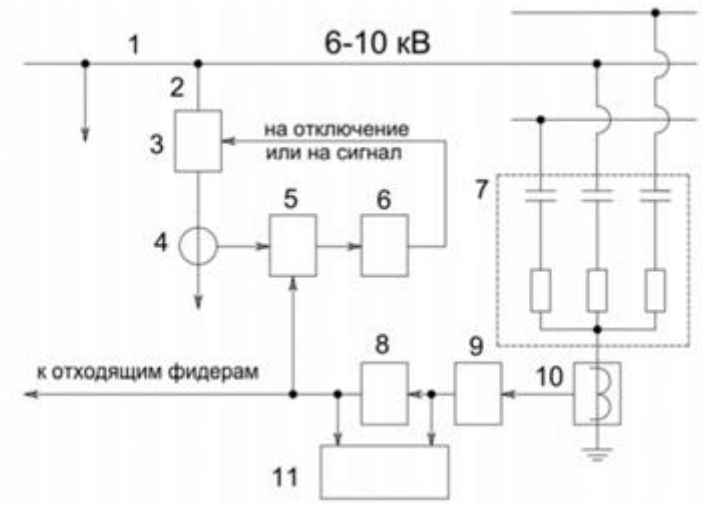

Рисунок 1 – Блок-схема направленной релейной защиты от однофазных замыканий на землю в электрических сетях.

Предложенное устройство защиты от ОЗЗ в электрических сетях включает следующие компоненты:
1 — электросеть, 2 — отходящий фидер, 3 — выключатель, 4 — датчик тока нулевой последовательности, 5 — фазоопределяющий модуль, 6 — исполнительное реле, 7 — RC-гаситель, 8 — реле напряжения, 9 — согласующий блок, 10 — трансформатор тока, 11 — регистратор сигналов.

Сравнение устройства с известными системами позволяет выделить следующие особенности:

1. Применение RC-гасителя 7 в роли опорного сигнала вектора тока нулевой последовательности Io, вместо вектора напряжения нулевой последовательности Uo, основано на его полном подобии с неповрежденными отходящими фидерами сети 1. Ток в датчике тока RC-гасителя 7 совпадает по фазе с токами в датчиках тока неповрежденных фидеров и имеет противоположное направление (угол 180^0) по отношению к току в поврежденном фидере. Тогда как вектор тока поврежденного фидера имеет угол 90^0 по отношению к вектору напряжения $3U^0$ измерительного трансформатора напряжения, что

значительно повышает надежность релейной защиты от ОЗЗ.

2. В отличие от стандартных релейных защит, предлагаемое устройство выполняет дополнительную функцию ограничения и регистрации коммутационных перенапряжений. RC-гаситель 7 ограничивает перенапряжения даже малой величины и шунтирует опасные высшие гармоники. Это делает защиту более надежной по сравнению с устройствами на основе нелинейных ограничителей перенапряжений (ОПН), которые срабатывают на более высоких уровнях перенапряжений.

3. Включение регистратора сигналов 11 позволяет фиксировать моменты возникновения и ограничения коммутационных перенапряжений. Данные регистрации помогают при последующем анализе выявлять источники перенапряжений и принимать меры для их предотвращения, что способствует повышению надежности работы электросети.

4. Повышенная электробезопасность достигается благодаря трансформатору тока 10, который обеспечивает гальваническую развязку между высоковольтной электросетью 1 с подключенным RC-гасителем 7 и остальными низковольтными компонентами устройства.

Для работы устройства могут применяться серийные RC-гасители, трансформаторы тока нулевой последовательности ТЗЛ и ТЗР, а также стандартные элементы релейных защит и системы регистрации сигналов [5].

Таким образом, основными преимуществами устройства являются простота конструкции, относительная доступность и расширенные функциональные возможности. Оно обеспечивает эффективную защиту от перенапряжений и ОЗЗ в электрических сетях напряжением 6–10 кВ, кроме сетей с компенсированным режимом нейтрали, а также способствует повышению безопасности и надежности работы электросетей.

Кроме того, для решения задач защиты от ОЗЗ предлагается релейная защита, реализующая новый алгоритм выделения постоянной составляющей в токе нулевой последовательности.

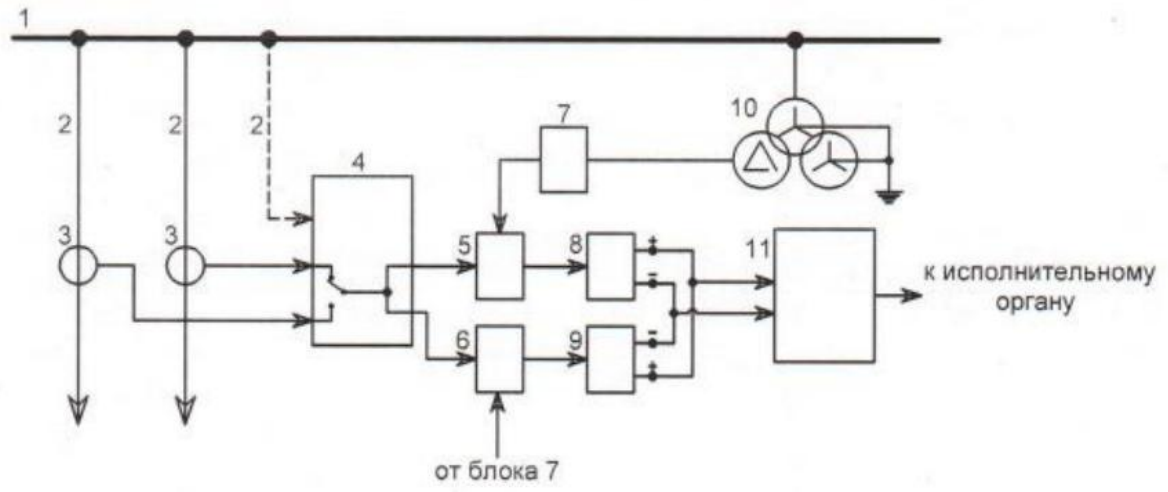

Рисунок – 2. Блок-схема устройства

На фигуре 1 представлена блок-схема предлагаемого комбинированного устройства для определения поврежденного фидера при однофазных замыканиях на землю в электрических сетях, где:

1 – электросеть, 2 – отходящие фидеры, 3 – трансформаторы тока нулевой последовательности (ТТНП) отходящих фидеров, 4 – переключатель, 5 – разделительный трансформатор, 6 – блок выделения постоянной составляющей тока, 7 – блок запуска, 8 – блок выделения высших гармоник тока, 9 – выпрямитель, 10 – измерительный трансформатор напряжения (ТН), 11 – измерительный орган

Комбинированное устройство для определения поврежденного фидера при ОЗЗ в электрических сетях, содержит ТТНП отходящих фидеров 3 электросети 1, связанных переключателем 4, который соединен выходом с входом блока выделения постоянной составляющей тока 6, а также с входом разделительного трансформатора 5. При этом разделительный трансформатор 5 выходом соединен с входом блока выделения высших гармоник 8, а выход блока выделения постоянной составляющей тока 6 соединен с выпрямителем 9. Кроме того, блок запуска 7 подключен своим входом с измерительным трансформатором напряжения 10, а выходами соединен с разделительным трансформатором 5 и блоком выделения постоянной составляющей тока 6 [6].

Принцип работы устройства РЗА.

В нормальном режиме работы электросети 1 без ОЗЗ (фигура 1) отходящие фидеры 2 обеспечивают электроснабжение потребителей, а ТТНП 3 отходящих фидеров и измерительный ТН 10 находятся под напряжением и формируют для блока запуска 7 соответствующие сигналы о нормальном состоянии электросети 1 без ОЗЗ. Разделительный трансформатор 5, блок выделения постоянной составляющей тока 6, блок выделения высших гармоник тока 8, выпрямитель 9 и измерительный орган

11 находятся в исходном состоянии (в готовности функционировать)

При возникновении в электросети 1 ОЗЗ измерительный ТН 10 фиксирует факт замыкания, включает в работу блок запуска 7 и начинается процедура определения поврежденного фидера. Сигналы от ТТНП 3 и других фидеров через переключатель 4 поочередно подключаются посредством разделительного трансформатора 5 к входу блока выделения высших гармоник тока 8, в котором формируются сигналы суммарных значений высших гармоник тока поочередно от разных фидеров и затем также поочередно подаются на вход измерительного органа 11.

Параллельно и синхронно с этим процессом подается сигнал от переключателя 4 на вход блока выделения постоянной составляющей тока 6 и далее через выпрямитель 9 соединяется, суммируясь с выходным сигналом блока выделения высших гармоник тока 8. Затем в измерительном органе 11 по наибольшему значению суммарного сигнала определяется поврежденный фидер соответствующей функцией релейной защиты.

Введение разделительного трансформатора 5 необходимо для гальванической развязки между двумя параллельными цепочками устройства. Одна в составе разделительного трансформатора 5 и блока выделения высших гармоник тока 8, а вторая в составе блока выделения постоянной составляющей тока 6 и выпрямителя 9. Обе цепочки включены между выходом переключателя 4 и входом в измерительный орган 11. Этим устраняется их взаимное влияние, обеспечивая эффективное функционирование устройства. Вместе с тем введение в устройство выпрямителя 9 диктуется следующим.

Основными источниками несимметричного переменного ТНП являются ОЗЗ, сопровождающиеся дуговыми разрядами в месте повреждения (перемежающаяся, затем прерывистая дуги) при любых режимах нейтрали электросети, а также нелинейные характеристики индуктивностей в электросети (дугогасящие реакторы, нейтралеобразующие и силовые трансформаторы), апериодический характер переходных процессов при возникновении ОЗЗ и др. При этом несимметричный переменный ТНП появляется в ТТНП 3 только поврежденного фидера с момента появления и до установившегося состояния ОЗЗ [7].

Указанные процессы происходят во всей электросети и весьма неоднородны, а их динамика непредсказуема. Поэтому выделение постоянной составляющей из ТНП с однозначной полярностью на выходе из блока выделения постоянной составляющей тока 6 не представляется возможным. А поскольку на выходе блока выделения высших гармоник тока 8 конструктивно выполняется четкая полярность сигнала, то для параллельного соединения выходов этих блоков 6 и 8 необходим выпрямитель 9, посредством которого выходы названных блоков и соединяются параллельно.

Сравнительный анализ предлагаемого устройства с прототипом показывает, что в случае ОЗЗ выделенные из ТТНП 3 отходящих фидеров раздельно постоянная составляющая тока и сумма высших гармоник тока, в отличие от прототипа, суммируются, создавая, таким образом, комбинированный сигнал более высокого уровня. Затем этот сигнал поступает к исполнительному органу 11, обеспечивая более высокую чувствительность защиты от ОЗЗ.

Кроме того, значения указанных токов различны в зависимости от стадий процесса ОЗЗ в месте повреждения (вначале перемежающаяся дуга, затем прерывистая с переходом в установившийся режим с металлическим замыканием или через переходное сопротивление). Такие различия в ТНП определяют дополнительное условие учитывать и фактор момента времени от возникновения ОЗЗ, особенно для замыканий через переходное сопротивление с ослабленными параметрами токов и напряжений. При этом более эффективно суммирование раздельных сигналов с формированием усиленного комбинированного, а не малозначимого их раздельного использования. Это позволит определять поврежденный фидер с ОЗЗ в электросетях с любым режимом заземления нейтрали, в том числе при замыканиях через переходное сопротивление, и значительно расширить область применения защит.

Представленный анализ подтверждает повышение чувствительности и селективности комбинированного устройства для определения поврежденного фидера, расширение области применения предлагаемого изобретения, а также на новизну и значительные преимущества предлагаемого устройства по сравнению с прототипом [6].

Заключение.

Проведены исследования по повышению надежности и обеспечению бесперебойного электроснабжения за счет ограничения перенапряжений и совершенствования релейной защиты является важным шагом для снижения аварийности в распределительных электрических сетях.

На основе анализа алгоритмов релейной защиты от однофазных замыканий на землю разработаны новые комплексные решения, направленные на устранение двух наиболее распространенных проблем в электросетях: ограничение и регистрация перенапряжений, а также обеспечение эффективной релейной защиты от однофазных замыканий на землю.

Литература

1. Шабад М.А. Защита от однофазных замыканий на землю в сетях 6-35 кВ. - М.: НТФ Энергопрогресс, 2007. — 64 с.

2. Евдокунин Г.А., Титенков С.С. Внутренние ПН в сетях 6—35 кВ. — СПб.: Терция, 2004. — 188с.

3. Сарин Л.И., Ильиных М.В., Ширковец А.И., Подьячев В.И., Шалин А.И. Резистивное заземление нейтрали в сетях 6-35 кВ с СПЭ-кабелями. //Новости электротехники, 2008, №2, с. 23-34.

4. Телегин А.В., Ширковец А.И. Проблематика замыканий на землю и режим заземления нейтрали в сетях среднего напряжения стран Европы и Америки //Релейная защита и автоматизация. 2012. №3. с. 30-39.

5. Шуин В.А., Гусенков А.В. Защиты от замыканий на землю в электрических сетях6-10 кВ. //Приложение к журналу «Энергетик», выпуск 11(35). – М.: НТФ «Энергопрогресс», 2012.

6. Патент РК на изобретение №34854 KZ, H02H 3/00. Комбинированное устройство для определения поврежденного фидера при однофазных замыканиях на землю в электрических сетях. /Дмитриченко В.И., Омирзаков Н.Т.; опубл. 22.01.2021, бюлл. №3. (https://gosreestr.kazpatent.kz)

7. Лихачев Ф.А. Замыкания на землю в сетях с изолированной нейтралью и с компенсацией емкостных токов. – М.: «Энергия», 1971. – с. 48-49; Саенко Ю.Л., Попов А.С. Влияние характера горения дуги на повреждаемость трансформаторов напряжения контроля изоляции//Вестник Приазовского Государственного Университета – Мариуполь, 2011. – Вып.21. – С. 101-106.

ЕНЕРГОЗБЕРІГАЮЧІ ІОТ-МЕРЕЖІ: АДАПТИВНИЙ АЛГОРИТМ НА ОСНОВІ REINFORCEMENT LEARNING

Сіпко О.М.
Київський національний університет імені Тараса Шевченка, доцент
Київ, Україна

ENERGY-EFFICIENT IoT NETWORKS: AN ADAPTIVE ALGORITHM BASED ON REINFORCEMENT LEARNING

Sipko O.
Taras Shevchenko Kyiv National University, associate professor,
Kyiv, Ukraine

АНОТАЦІЯ

У цій статті розглядається новий підхід до оптимізації енергоспоживання у бездротових сенсорних мережах IoT. Пропонується адаптивний алгоритм маршрутизації на основі навчання з підкріпленням [1, с.128], що дозволяє мінімізувати витрати енергії, подовжити термін служби мережі та покращити якість передачі даних. Було проведено моделювання алгоритму в середовищі NS-3 та порівняння його ефективності з класичними методами (LEACH, PEGASIS) [2, с.12]. Результати підтверджують переваги запропонованого підходу для динамічних IoT-мереж.

ABSTRACT

This paper presents a novel approach to optimizing energy consumption in wireless sensor networks within the Internet of Things (IoT) ecosystem. An adaptive routing algorithm based on Reinforcement Learning [1, p.128] is proposed, enabling the minimization of energy costs, extension of network lifetime, and improvement of data transmission quality. The algorithm was modeled using the NS-3 simulation environment and compared with classical methods such as LEACH and PEGASIS [2, p.12]. The results confirm the advantages of the proposed approach for dynamic IoT networks.

Ключові слова: інтернет речей, енергозбереження, бездротові сенсорні мережі, Reinforcement Learning, Q-learning.

Keywords: IoT, energy efficiency, wireless sensor networks, Reinforcement Learning, Q-learning.

Інтернет речей є ключовою технологією для багатьох сфер, включаючи розумні міста, медицину, промисловість та екологічний моніторинг. Завдяки розвитку сенсорних технологій, комунікаційних протоколів та розподілених обчислень, IoT відкриває можливості для автоматизації, ефективного управління ресурсами та підвищення якості життя. Однак бездротові сенсорні мережі (WSN), які є основою IoT, обмежені в енергетичних ресурсах [3, с. 97].

Одним із критичних викликів у розгортанні масштабованих IoT-мереж є ефективне управління енергоспоживанням для подовження часу роботи мережі. Традиційні методи маршрутизації, такі як LEACH або PEGASIS, засновані на статичних або напівстатичних підходах, які не завжди враховують динамічні зміни у топології мережі та рівнях енергоспоживання [4, с.78]. Наприклад, вузли можуть виходити з ладу або змінювати свої позиції, що ускладнює підтримку оптимального маршруту.

Сучасні дослідження вказують на ефективність машинного навчання, зокрема навчання з підкріпленням (Reinforcement Learning, RL), для адаптації процесів маршрутизації у динамічних середовищах [5, с. 484]. RL дозволяє мережевим вузлам самостійно приймати рішення, орієнтуючись на локальну інформацію про середовище та історичні дані передачі. Використання алгоритму Q-learning дає змогу оптимізувати вибір маршрутів передачі даних, зменшуючи енергетичні втрати та підвищуючи ефективність комунікації.

У цій роботі я пропоную адаптивний алгоритм маршрутизації на основі RL для бездротових сенсорних мереж IoT. Основними завданнями дослідження є:

- Аналіз існуючих енергозберігаючих методів маршрутизації в IoT-мережах;
- Розробка адаптивного алгоритму маршрутизації на основі Q-learning;
- Проведення симуляційних експериментів у середовищі NS-3;
- Оцінка ефективності запропонованого методу у порівнянні з традиційними підходами (LEACH, PEGASIS).

Отримані результати можуть бути застосовані для оптимізації роботи IoT-систем у різних сферах, включаючи екологічний моніторинг, розумні будівлі, логістику та сільське господарство. Запропонований метод демонструє перспективність використання RL для підвищення автономності та ефективності IoT-мереж.

Навчання з підкріпленням (Reinforcement Learning, RL) є підходом у машинному навчанні, який базується на концепції навчання через взаємодію з середовищем. Агент, який є учасником цієї системи, вчиться приймати рішення та виконувати дії, отримуючи за це зворотний зв’язок у ви-

гляді винагород або покарань. Мета агента – максимізувати свою загальну винагороду, що накопичується протягом тривалого часу, і таким чином адаптувати свою стратегію для досягнення найкращого результату.

У цьому процесі важливу роль відіграє взаємодія між агентом і середовищем. Агент вибирає певну дію, яка може змінити його поточний стан у середовищі. Після того, як агент виконує дію, середовище надає йому винагороду або покарання, що дає зворотний зв'язок про корисність виконаної дії. Агент намагається навчитися, як вибирати дії, які призводять до максимального позитивного ефекту в довгостроковій перспективі. Цей процес може бути дуже схожий на навчання через проби і помилки, де кожен вибір або дія має свої наслідки.

Основні компоненти RL:

- Агент – сенсорний вузол IoT.
- Середовище – топологія мережі та стан енергоспоживання.
- Стан (state) – залишковий рівень енергії вузлів, затримки в мережі.
- Дія (action) – вибір наступного вузла для передачі даних.
- Функція винагороди (reward function) – залежить від рівня енергоспоживання та якості зв'язку.

Агент, перебуваючи в певному стані, вибирає дію, яку він вважає найкращою на основі наявної інформації. Цей процес триває в кількох ітераціях, і в кожній з них агент отримує зворотний зв'язок, який допомагає йому коригувати свою стратегію. З часом агент удосконалює свою політику, тобто стратегію вибору дій у відповідь на зміни стану середовища.

Моделі навчання можуть бути різними. Одні методи не використовують чіткої моделі середовища (моделі без моделі), а просто покладаються на досвід агента, щоб вивчити оптимальні стратегії. Інші методи можуть побудувати модель середовища і використовувати її для планування своїх дій (моделі з моделлю). Це дозволяє агенту прогнозувати наслідки своїх дій та приймати більш обґрунтовані рішення.

Застосування навчання з підкріпленням дуже різноманітне. Він використовується в таких областях, як ігри, робототехніка, самокеровані транспортні засоби та фінансові стратегії. Наприклад, в іграх агент може вивчати стратегії для досягнення перемоги, в той час як у робототехніці він може навчатися виконувати складні фізичні завдання. У випадку з автопілотами самокерованих автомобілів агент аналізує ситуації на дорозі і приймає рішення про швидкість, напрямок і маневри, щоб безпечно дістатися до мети.

Це навчання, яке вимагає постійної адаптації та вдосконалення стратегії, допомагає вирішувати складні задачі, де наслідки дій не завжди очевидні і вимагають прогнозування та оптимізації на довгий термін.

У цій роботі використано алгоритм Q-learning для оптимізації маршрутизації [6, с.279]. Q-learning – це один із найбільш відомих алгоритмів навчання з підкріпленням, який дозволяє агенту навчатися оптимальним стратегіям у середовищі без необхідності мати модель цього середовища. Він базується на ідеї використання функції Q, яка оцінює якість дій у певних станах. Агент за допомогою цього алгоритму поступово покращує свою політику, максимізуючи свою винагороду.

Основна ідея алгоритму полягає в тому, щоб оцінити, наскільки вигідною є конкретна дія в конкретному стані. Це робиться через таблицю значень, відому як Q-таблиця, де кожен елемент таблиці містить значення $Q(s, a)$, що позначає "якість" дії a в стані s. Це значення показує, якою буде очікувана винагорода, якщо агент виконає дію a в стані s, враховуючи можливі майбутні стани та їх винагороди.

Алгоритм Q-learning використовує принцип оновлення Q-значень за допомогою формули, яка враховує поточну винагороду і максимальну можливу винагороду в наступному стані.

За допомогою цього оновлення Q-learning агент поступово наближається до оптимальної політики, яка максимізує свою винагороду в довгостроковій перспективі. Що важливо, Q-learning є методом без моделі, тобто агент не потребує знання структури середовища, щоб навчатися. Він просто взаємодіє з середовищем, отримує зворотний зв'язок і адаптується до нього.

З часом агент, виконуючи багато ітерацій, набирається досвіду і здобуває оптимальну стратегію дій, яка дозволяє йому досягати найвищих можливих результатів у середовищі.

Запропонована система складається з таких основних етапів:

1. Ініціалізація мережі – розміщення сенсорних вузлів, визначення початкових енергетичних ресурсів.
2. Навчання агента – сенсорні вузли навчаються оптимальному вибору маршруту на основі Q-learning.
3. Оцінка маршруту – після кожної передачі даних оновлюється значення Q-функції.
4. Коригування маршруту – маршрути адаптуються відповідно до змін у стані мережі.

Формалізація Q-learning

Формула оновлення Q-функції:

$$Q(s,a) \leftarrow Q(s,a) + \alpha[r + \gamma \max_{\alpha' Q}(s', a') - Q(s,a)]$$, де:

- $Q(s,a)$ – значення Q-функції для стану s та дії a,
- α – коефіцієнт навчання,
- r – винагорода,
- γ – коефіцієнт дисконтування,
- $\max_{\alpha' Q}(s', a')$ – найкраща оцінка майбутнього стану [7, с.226].

Для оцінки ефективності алгоритму було використано симулятор NS-3 [8]. Основні параметри:

- Кількість вузлів: 100
- Радіус дії: 50 м
- Початкова енергія вузлів: 2 Дж
- Порівняння з LEACH, PEGASIS

Результати:

1. Енергоспоживання: RL-алгоритм забезпечує зниження витрат енергії на 25% у порівнянні з LEACH.

2. Тривалість роботи мережі: запропонований підхід дозволяє збільшити час роботи на 30%.

3. Якість зв'язку: затримки та втрати пакетів зменшуються на 15%.

Комплексне порівняння між методами навчання з підкріпленням, такими як Q-learning, та класичними підходами в області безпровідних сенсорних мереж, як-от LEACH і PEGASIS, дозволяє краще зрозуміти, чому новий підхід може мати реальні переваги. Ось кілька аспектів для порівняння:

1. Принцип роботи.

LEACH і PEGASIS – це протоколи маршрутизації для безпровідних сенсорних мереж, які використовують ієрархічний підхід для зниження енергоспоживання. LEACH використовує механізм випадкового вибору головних вузлів (кластерних голов), що знижує енергоспоживання в мережі, але не завжди адаптується до змінюваних умов середовища чи топології мережі. PEGASIS покращує LEACH, вибираючи головні вузли за допомогою генетичних алгоритмів, що дає кращі результати щодо енергоефективності, але також не враховує специфічні адаптації до динамічних змін у мережі.

Q-learning, на відміну від класичних підходів, адаптується до змін у середовищі, оскільки агент постійно взаємодіє з середовищем і коригує свої стратегії на основі отриманого зворотного зв'язку. Агент може оптимізувати маршрутизацію в мережі, вибираючи найкращі дії в реальному часі, враховуючи зміни в енергоспоживанні, навантаженні або інших факторах. Q-learning не потребує заздалегідь заданої структури чи визначених правил для вибору головних вузлів, що робить його більш гнучким і адаптивним.

2. Енергоспоживання та ефективність.

Обидва протоколи ефективно знижують енергоспоживання за рахунок ієрархічної організації мережі і періодичних виборів головних вузлів. LEACH може мати обмеження у випадку, коли топологія мережі змінюється швидко або якщо розподіл енергії вузлів нерівномірний. PEGASIS покращує LEACH, але також залежить від попереднього планування і передбачення топології мережі.

Q-learning дозволяє адаптуватися до динамічних змін у середовищі і таким чином може значно покращити енергоспоживання. Агент може оптимізувати вибір головних вузлів, маршрутизацію даних та навіть кількість переданих повідомлень в залежності від стану мережі. Врахування реального часу і зворотного зв'язку дозволяє зменшити надмірне споживання енергії в часи високого навантаження або при змінних умовах.

3. Адаптивність та масштабованість.

LEACH і PEGASIS мають обмежену адаптивність, оскільки залежатимуть від попередніх налаштувань та топології мережі. Вони не можуть ефективно реагувати на зміни в реальному часі, наприклад, при значних змінах навантаження або при додаванні нових вузлів. Масштабування таких протоколів вимагає постійної корекції і переорієнтації вузлів, що може бути складним і ресурсозатратним.

Q-learning забезпечує високий рівень адаптивності, оскільки агент може змінювати свою стратегію в залежності від поточних умов. Це дозволяє значно полегшити масштабування, оскільки агент може оптимізувати свою поведінку в умовах змінної кількості вузлів або змінної топології мережі без необхідності в ручному налаштуванні. Масштабованість зберігається, оскільки агент може застосовувати свою стратегію незалежно від кількості вузлів і їх розподілу в мережі.

4. Оптимізація маршрутів та обробка даних.

LEACH та PEGASIS фокусуються на зниженні енергоспоживання через ієрархічну маршрутизацію, однак не забезпечують динамічного оптимізування маршрутів на основі постійних змін у мережі. Вони можуть стикатися з проблемами, коли мережа має складні топології або динамічні зміни в навантаженні.

Q-learning дозволяє постійно оптимізувати маршрутизацію, адаптуючи стратегії маршрутизації до поточних умов. Це дозволяє агенту знаходити найкращі маршрути в реальному часі, враховуючи фактори, як-от енергоспоживання, збої в мережі або зміни топології. Замість попередньо заданих правил, агент використовує свій досвід і зворотний зв'язок для оптимізації маршрутів, що дає йому змогу більш ефективно обробляти дані та знижувати затрати.

5. Інтеграція з іншими технологіями.

Ці протоколи добре підходять для стандартних безпровідних сенсорних мереж, але їх інтеграція з новими технологіями, такими як IoT або складні сенсорні мережі з адаптивними компонентами, може бути обмежена.

Q-learning може бути інтегрований з іншими технологіями та пристроями, оскільки він є гнучким і може адаптуватися до нових умов. Завдяки своїй здатності працювати без попереднього моделювання середовища, він може бути застосований у різноманітних сценаріях і технологіях, включаючи складні сенсорні мережі, IoT та навіть мобільні системи.

Хоча LEACH і PEGASIS є потужними протоколами для традиційних безпровідних сенсорних мереж, Q-learning пропонує кілька важливих переваг: високий рівень адаптивності, можливість реального часу адаптуватися до змін у середовищі, кращу енергоефективність через оптимізацію маршрутів і масштабованість для великих, динамічних мереж. Ці переваги роблять Q-learning привабливим вибором для складних і змінних умов, де класичні підходи можуть бути менш ефективними.

Незважаючи на численні дослідження щодо застосування RL у мережевій маршрутизації, моя робота має кілька ключових нововведень:

1. Поєднання RL та енергозбереження у WSN.

- На відміну від традиційних RL-алгоритмів маршрутизації, які оптимізують лише шлях, запропонований алгоритм адаптується до рівня залишкової енергії вузлів.
- Це дозволяє не просто мінімізувати затримки, а й ефективно балансувати навантаження на вузли, подовжуючи термін роботи мережі.

2. Динамічна функція винагороди.

- У більшості RL-моделей винагорода залежить від затримки або пропускної здатності. Моя модель враховує залишкову енергію вузла та стан сусідніх вузлів.
- Це дозволяє вузлам вибирати маршрути з урахуванням довготривалої енергетичної стабільності мережі.

3. Порівняння з класичними підходами (LEACH, PEGASIS).

- Більшість досліджень RL для маршрутизації порівнюють методи RL лише між собою, не враховуючи класичні методи енергозбереження.
- У цій роботі проведено комплексне порівняння з класичними протоколами WSN, що демонструє реальні переваги запропонованого методу.

4. Практичне моделювання у NS-3.

- Часто RL-моделі перевіряються лише в теоретичних умовах або обмежених симуляціях. У моїй роботі проводиться детальне тестування в NS-3 для оцінки продуктивності в реальних умовах.

У цій роботі запропоновано новий підхід до маршрутизації в IoT-мережах, що базується на навчанні з підкріпленням та динамічному управлінні енергоспоживанням. На відміну від традиційних RL-методів, моя модель враховує рівень залишкової енергії вузлів та використовує адаптивну функцію винагороди. Проведене моделювання в середовищі NS-3 показало значне зменшення витрат енергії та збільшення часу роботи мережі порівняно з класичними методами (LEACH, PEGASIS). Подальші дослідження можуть включати використання Deep Q-Networks для більш складних топологій та інтеграцію з 5G.

Література

1. Sutton, R. S., & Barto, A. G. Reinforcement Learning: An Introduction // MIT Press. – 2018. – 400p.

2. Heinzelman, W. B., Chandrakasan, A. P., & Balakrishnan, H. Energy-Efficient Communication Protocol for Wireless Microsensor Networks // IEEE. – 2000. – Pp. 10-25.

3. Akyildiz, I. F., & Vuran, M. C. Wireless Sensor Networks // Wiley. – 2010. – 200 p.

4. Lindsey, S., & Raghavendra, C. S. PEGASIS: Power-Efficient GAthering in Sensor Information Systems // IEEE Aerospace Conference Proceedings. – 2002. – Pp. 78-90.

5. Silver, D., et al. Mastering the game of Go with deep neural networks and tree search // Nature. – 2017. – 529(7587). – Pp. 484-489.

6. Watkins, C. J. C. H., & Dayan, P. Q-learning // Machine Learning. – 1992. – 8(3-4). – Pp. 279-292.

7. Sutton, R. S., & Barto, A. G. Introduction to Reinforcement Learning // MIT Press. – 1998. – 322 p.

8. NS-3 Consortium. NS-3 Network Simulator. URL: https://www.nsnam.org/

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