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Study of Strategies for Sustainable Production and Consumption in the Economic Conditions of Ukraine

Abstract. Modern requirements for companies and consumers include the stability of financial performance amid increasing environmental attractiveness. Companies need to cover such seemingly diverse interests as profitability for owners, concern for staff, interest for partners and consumers, and actions for environmental protection. It is essential to consider the growing role of conscious consumption, which is a direct regulator of production activity. Today, this is especially important for Ukraine, considering its transition to sustainability and the implementation of sustainable development goals in the sphere of sustainable production and consumption. The aim is to formulate a strategy and recommendations for combining sustainable initiatives in production and consumption in the context of European integration processes in Ukraine. The research object is sustainability in production and consumption. The article proposes a strategy combining sustainable production and consumption into one cluster. It will allow sustainable initiatives are focused on systemic changes and essential areas of production and consumption. The work used the method "Sustainable value of the business". This method includes detailed reporting on the sustainable development of production with relevant ratings and indices. It's recommended for use in decision-making, investment management for business development, comparative analysis, and communication with stakeholders; it also provides a comprehensive view of the company's impact on six standardized parameters. The result is a proposal to create an algorithm to combine sustainable production and consumption into one cluster. It will allow sustainable initiatives to focus on systemic changes in crucial production and consumption areas – energy, transport, housing, agriculture, and food. The practical value of the approach is in a strategy that includes measures stimulating environmental and socio-economic policy of production. It will allow moving from relative disunity of actions to technological standards. The proposed approach can be implemented in recommendations for improving programs on changing behavior from a gradual transition from individual consumers to broader initiatives to change the entire system – production and consumption

Keywords: environmental accounting and reporting, sustainability, sustainable activity, environmental aspects, conscious consumption

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INTRODUCTION

Today, the efforts are aimed at analyzing current environmental problems and their correlation with the most sustainable levels of social development. Thereby, it was recognized multisystem approach that combines measures: to study the anthropogenic impact, assess trade-offs between environmental protection and human activity; improve computational methods; assess maximum sustainable levels of the ecological footprint; comparative analysis of resource use efficiency. Ultimately, transformational changes emerge in the global economy to reduce humankind's impact on the environment to a sustainable level. At the same time, investors, clients, regulators, and the media are increasingly paying attention to the companies' efforts in sustainable development.

For instance, the research [1] identifies the regulation of taxes, subsidies, and support for social communications,

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education, and public procurement as the main goals for policies that promote sustainable production and consumption at the present moment. However, there is a need to link sustainable consumption initiatives with policies aimed at making production more sustainable on national and international levels. In addition, it is necessary to enlist the help of consumers in incentivizing producers to sustainable production and achieve sustainable development goals. Weber and coauthors note that experiential marketing tools help accomplish these goals. In particular, they allow sustainable enterprises to promote their products to local and remote consumers [2].

Meanwhile, researchers [1-3] note that not all consumers understand their rights and responsibilities or have insufficient knowledge about the impact of using the goods and services on the environment and, all the more, on producers. Thus, there is a need to form a sustainable worldview among consumers. It is necessary to educate consumers on the basics of conscious consumption. In works [3; 4], the authors state that companies themselves can take the initiative in raising consumer awareness by offering information about the environmental and social meaning of consumption and its results. In this case, companies help consumers make conscious decisions [4].

E. Assadourian, S. Sakarya, et al. [4; 5] argue that socio-cultural, worldview, mental, and other factors influence the environmental choice of consumers. Consequently, it is necessary to change consumers' attitudes to the formation of the need itself. As a result, consumers' conscious choices of ecological or less harmful products for the environment are more probable. Scientists also insist on the significant impact of companies on sustainable development goals achievement. However, complexities in the production and sale of products and services and logistics organizations decrease the efficiency of companies' work [5]. In the research [6], H. Leleu focuses on the mandatory support of these activities by the central and local government, without which it will be impossible to achieve significant changes in the "conscious production – conscious consumption" system. Effective initiatives on sustainable production and conscious environment use can only be realized by the collaborative actions of producers and consumers. Such cooperation may stimulate consumers and producers to make their activities more conscious [7]. In this regard, some authors propose to implement the information that influences behavior change and structural measures to promote sustainability in the eco-activities of producers and consumers through education. Namely, education contributes to sustainable worldview formation and, as a result, sustainable consumption [8].

According to the above, the aim is to create a strategy and recommendations for the unification of sustainable initiatives in the field of production and consumption in the context of European integration processes in Ukraine. The novelty of the research is in the strategy of sustainable production and consumption development. The method allows controlling the "sustainable production-consumption" system for both in production and the sale of products.

THEORETICAL FRAMEWORK

Any production has a variety of environmental, social, economic, and other impacts, which can be both positive and negative. Minimizing the negative consequences of aggregate influences is called sustainability. Sustainability can be high or low. Today, it can be measured the value of products, technologies, and production due to sustainability mechanisms. In addition, sustainability allows us to predict the result of introducing new technologies or products to assess ones on the market. Such an assessment will provide new opportunities for both the output and the business in attracting investments, new partners, and consumers. For now, conscious consumers are the control link determining greening business and production profitability and expedience.

Companies can demonstrate sustainability by presenting the benefits of products compared to similar products through their own or partner information and education programs. It shouldn't be forgotten about the indirect benefits of sustainable indicators that can be "activated" with the help of other independent organizations. For example, the Ministry of Health of Ukraine can support the manufacturer by confirming the health benefits of the eco-friendly properties of a product or technology, etc. It is also possible to turn to the ideas of a sustainable compromise. In this case, the dilemma of comparing the value of the application results of a specific technological process in different conditions is solved. For instance:

– compare the funds invested in reducing emissions with the cost-effectiveness of the results for human health;

– to compare the efficiency of using eco-friendly packaging of goods with not eco-friendly ones in terms of the cost of their disposal and recycling.

Sustainability is suitable for companies of various scales. However, if the end link of the product is the other company, then the companies control values by themselves. And only after that, the consumer supervises deals because of the mandatory mechanisms of the production process transparency inherent in a sustainable business. Investors can use sustainability to compare companies from different industries, setting cut-off values of environmental indicators for themselves. According to this, investors will develop sustainable investment strategies. Sustainability indicators can be a part of tax adjustments to encourage sustainable industries as their business model already includes environmental and health costs. Promoting such a policy will undoubtedly affect the European integration processes in Ukraine. Moreover, the EU is implementing an Action Plan on environmental technologies, for which sustainable consumption and production are a priority [9].

Thus, this aspect should become the basis for future studies bearing in mind the European integration processes in Ukraine.

Perhaps, the first step towards sustainability is the refusal of individual responsibility; and the recognition of collective responsibility for sustainability issues. In other words, there is a shared responsibility for environmental problems and joint actions to eliminate them and prevent the emergence of new ones [10]. Today, almost no ecological issues can be considered concerning to one company or industry. Long-term development and economic growth depend not only on producing and consuming goods and services but also on the eco-friendliness of all production components. It requires more efficient and eco-safety management of the entire production process, including the production cycle, consumption, and disposal [11].

The reporting practice in sustainable development began in 1989 with the first report on the social and environmental assessment of the current ecological situation [12].

Following the first debate on the human right to a pollution-free, healthy and sustainable environment in the 1990s at the UN Human Rights Council, it has become common to call on companies to report their impact on human health and the natural environment [13]. Since 1999, these activities have resulted in sustainable development reports provided by many large companies [14].

With the creation of the first reporting mechanism to ensure that companies adhere to the principles of responsible environmental behavior, in 2000, the independent international organization Global Reporting Initiative began to publish its recommendations for reporting on sustainable development [15].

Today, many large European companies offer and implement corporate sustainability responsibility reports in compliance with environmental, social, and corporate performance standards. Independent companies publish ratings and indices of the stability of enterprises and keep records of their corporate responsibility [16]. For instance, EU rules on non-financial reporting currently apply to large companies with more than 500 employees. In doing so, approximately 11,700 large companies and groups throughout the EU are covered, roughly 96% of European companies [17].

The Institute for Governance and Accountability (G&A), the leading environmental, social, and corporate governance organization in the United States, has released sustainability study results for 2021. The study recorded continued growth in sustainability reporting for the S&P 500 (companies with the largest capitalization). Thus, corporate sustainability reporting is used as a best practice in 92% of the largest public companies in the United States [18].

Corporate responsibility reporting is carried out according to several standards selected by companies [19]. They include:

– reporting forms of the Global Reporting Initiative (GRI, since 1997);

– integrated reporting standards of the International Integrated Reporting Council (IIRC, since 2010);

– standards of the Sustainability Accounting Standards Board (SASB since 2011).

The standards are divided into environmental, social, and economic categories; they depend on the industry field and include quantitative and, in some cases, qualitative indicators; they are used for reporting and are targeted at providers of financial capital. These reporting standards are comparable among themselves, but they are often not commensurate with the internal activity of the enterprise. Usually, the suitable standard choice presents difficulties for enterprises with mandatory reporting [20-22].

Along with reporting, ratings and sustainability indices have been used to measure business sustainability since 1990 [23]. They include assessments of all risks and data on economic, environmental, and social indicators (Table 1-2).

Table 1. Indicators of sustainability indices

Sustainability index	Indicators
Dow Jones Sustainability Indices (DJSI) [24]	It represents 10% of the 2,500 largest global sustainability leaders identified by S&P Global in the Corporate Sustainability Assessment (CSA). It takes into account long-term economic, environmental, and social criteria
FTSE4Good (Emerging; ASEAN 5; IBEX; Developed Minimum Variance; Bursa Malaysi; Taiwan ESG) [25]	It measures the results of environmental, social, and governance (ESG) activities of companies. It's used to create and evaluate sustainable investment products
Euronext Vigeo Eiris [26]	Companies with top-ranked as measured by ESG
STOXX ESG-X; ESG от Sustainalytics [27]	European companies that use an eco-responsible policy. It helps reduce reputational and idiosyncratic risks. The software allows companies to focus on essential ESG indicators enabling efficiency and focus on resource use
Thomson Reuters / S-Network [28]	Companies with socially responsible investment and corporate responsibility
Kirchhoff Consult Good [29]	Sustainable Development Communication
Corporate Knights [30]	Research and financial information products to promote a sustainable economic system that includes social, economic, environmental costs and benefits
MSCI KLD 400 [31]	Information for investors on comparing social and environmental factors for investment

Table 2. Sustainability rating indicators

Sustainability Rating	Indicators
Annual List A CDP [32]	List of 300 companies that achieved maximum sustainability in their operations.
Carbon Risk Rating [33]	Rating of companies for investors based on the analysis of risks associated with CO_2 emissions
Newsweek Green Ranking [34]	It measures the environmental performance of 500 large well-known companies. Eight key indicators of efficiency are used for analysis
Corporate Human Rights Benchmark [35]	It analyses the corporate behavior of the largest companies in the field of human rights

Table 2, Continued

Sustainability Rating	Indicators
Workforce Disclosure Initiative (WDI) [36]	They accumulate data on the methods of working with personnel. They contribute to developing practical proposals for solving personnel problems and improving the social climate in production
Bloomberg Gender-Equality Index (GEI) [37]	Access to social data and strategy in the area of gender equality policy
Thomson Reuters Diversity and Inclusion [38]	It analyses data on the racial and ethnic diversity of employees in the largest companies around the world. Equality in education and justice

Since the early 1990s, the essential method for assessing a business's sustainability was to consider a company's sustainable development [39]. Currently, there are various methods of accounting for sustainability. They compile traditional financial statements supplemented by external factors that positively or negatively affect aspects of production activity, from profitability or loss ratio to social and environmental impact on the environment, economy, and society [40].

Unfortunately, methods for assessing sustainability do not differ in the universality of criteria for estimating an external effect considering industrial sectors and the diversity of regions [41]. However, sustainability accounting methods are often criticized for their complex adaptation to modern technologies or new products. If sustainable accounting can be relatively easy to use for large companies, its usage in setting priorities for enterprise development is challenging.

MATERIALS AND METHODS

Existing approaches to sustainable valuation of production and consumption have certain disadvantages. Often there is an inconsistency between the proposed sustainable initiatives and the manufacturer. There is also a low speed of response to the needs of stakeholders from the end consumers. The lack of information about the entire company's business and specific technological cycles and investment decisions creates some problems in applying sustainable approaches. It is necessary to note the issue of the lack of universality in reporting standards in the field of sustainable production, which creates difficulties in their comparison and, accordingly, problems in the qualitative assessment of production and final products. The applying ESG (Environmental, Social and Corporate Governance) indicators provide information about the effectiveness of various environmental, social, and economic factors but do not allow comparison of these factors and are not indicators of impact. Sustainable production development at the current stage of eco-economic relations requires new approaches to reveal all the prospects for controlling positive and negative corporate effects.

The European Commission is trying to solve this issue through the Sustainable Foods Initiative, among the essential elements of which are mandatory disclosure requirements for sustainability-related activities, specific ecodesign rules for sustainable products, and EU-specific rules for sustainable public procurement [42].

Together with the Boston Consulting Group, Merck has developed a new production valuation method called "Sustainable Business Value" [43]. The proposed methodology makes it possible to assess, among other things, the social impact of business on the economy, the environment, and society as a whole.

Based on these methods, the direction of similar studies and calculations for Ukraine was formed under the integration of the Ukrainian economy into the European one. It picked out the importance of the relationship between sustainable production and consumption, which ultimately provided a comprehensive analysis of six standardized economic sustainability indicators. This standardization allows for a wide range of comparisons from different products and services to entire companies.

RESULTS AND DISCUSSION

Today, business sustainability assessment does not cover all environmental, social, and economic factors that affect positive and negative impacts of production. There are also problems with a lack of coherence between eco-initiatives and production structures. In turn, these problems affect the promotion and implementation of specific environmental technologies and investment decisions. There is no universality in the reporting standards for the sustainable development of enterprises. There is no information on sustainable consumption. Sustainability indicators provide information on environmental, social, and economic policies but cannot compare and contrast these factors [44].

There is a need to develop a method for assessing sustainability in business. The procedure should be understandable, universal, uniform, and flexible and analyze as many indicators as possible. It will allow realizing the comparisons covering all production and consumption aspects. It is necessary to provide a holistic view of the enterprise's activity and consumption issues to adjust their impact on the economy and all stakeholders in the sustainable operation of the enterprise: partner companies, investors, suppliers, employees, customers, and consumers; without overlooking the environment and social aspects.

Many studies have claimed interdisciplinary approaches but have not accounting the interrelationships in the "producer-consumer" system. However, it is such a system that is capable of self-control. Sustainable production is in demand only by sustainable consumption; therefore, sustainable consumption exists where there is sustainable production. All other efforts in sustainability are not able to significantly affect environmental performance. Usually, the reports present studies that address the problem of sustainability in production [11; 14; 40] or the social issue of a conscious sustainable consumers' choice [13; 19; 23]. Based on the method "Sustainable value of the business" and theoretical methods such as abstraction, critical analysis, and synthesis, a "Sustainable production and consumption strategy" was proposed. The strategy allows controlling the system of "sustainable production-consumption" both during production and during the sale of products. This approach is compatible with the requirements of the greening of production and the socio-environmental activities of modern humans.

The sustainability of production can be determined by indicators – a set of rates and assessments along the entire chain of creating a company's value. Rates of a company's sustainability also include the impact of its technological processes, products, and services. It provides a multi-vector perspective of their impact (Fig. 1). It is important to note that the sustainability of production and consumption is based on climate neutrality and inclusive growth.

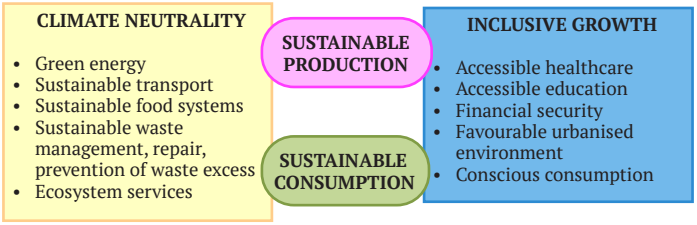

Figure 1. Basic sustainability indicators

The first group of indicators is related to production and consumption climate neutrality. Climate change threatens ecosystems and biodiversity and affects the distribution of freshwater resources, the functioning of urban areas, and the number and extent of extreme weather events. It severely affects agricultural production, human well-being, socio-economic activity, green growth, and sustainable development.

The green energy indicator denies burning any fuel type. It is valued at the price of electricity produced, greenhouse gas emissions at all stages of the technological cycle, availability of renewable sources, energy conversion efficiency, land and water requirements, and social impacts. The cost of electricity, greenhouse gas emissions, and power generation efficiency vary widely for each facility, mainly due to differences in process technology and geographic latitude. The social impacts of green energy projects are assessed by individual effects, including health, conservation of the natural environment, etc. According to this, wind energy is the most sustainable. Next comes small hydropower and photovoltaic energy. Geothermal energy is in last place [45].

The importance of the "transport sustainability" indicator is caused by the fact that it is the primary source of pollution in urban areas and greenhouse gas emissions and creates significant problems due to congestion, noise, and accidents. In addition, transport is vital to the national and international economy and generates substantial profits for individual companies and private individuals; for instance, it influences employment, prices, and economic growth [46]. Today, the following categories are additionally classified as transport sustainability: proximity to public transport, accessibility of opportunities, and characteristics of an urbanized area. In other words: how long do people spend in transport, how many jobs are available within one route, and how compact is the settlement organized [47]. Undoubtedly, transport sustainability plays an essential role in achieving integrated sustainability.

Sustainable food systems are the world's largest employer. They form an essential part of the national gross domestic product (GDP), provide food security, solve health problems associated with malnutrition or obesity and affect the well-being of the natural environment. Most of the United Nations Sustainable Development Goals (SDGs) for the period up to 2030 are related to the efficiency of global food systems [48]. At the same time, the global food system is the largest consumer of freshwater, is responsible for a third of total greenhouse gas emissions, and covers about half of the earth's surface. Sustainable food systems will bring humanity closer to the norms of healthy nutrition, and agricultural production will be sustainable and climate-neutral [49].

An economy linked to sustainability allows us to preserve the value of resources by minimizing waste generation, turning them into resources that can be reused in production processes. Sustainable waste management is a critical issue for most countries concerning climate change and greenhouse gas emissions. [50]. To solve it, it is necessary to massively implement the reuse of materials, their processing and repair, and the prevention of excess waste. Moreover, prevention is the essential step in this chain of events. For this, it is necessary to consider the environmental perspective and economic and social indicators. These include value conservation, weight change, and durability [51]. The basis of all activities is the responsibility of the manufacturer and the consumer.

The concept of ecosystem services shows a steadily growing appeal to managers. Ecosystem services are used as indicators in human-economy-environment systems and represent variables that combine several elements into a single whole. They are chosen to support specific management goals with cumulative value, explaining qualities, quantities, states, or interactions that are difficult to estimate. Ecosystem services are sets of indicators, including descriptive and evaluative aspects [52]. The assessment of ecosystems and their services is a crucial action to achieve climate, agriculture, regional planning, and other purposes.

The second group of indicators is related to inclusive growth. Inclusive growth means human development and combines economic, social, and environmental dimensions, making it difficult to measure and monitor. No single indicator is enough to track progress, and there is hardly a standardized, one-size-fits-all solution. Thus, countries can choose different measurement approaches and indicators depending on their priorities and capabilities. Today the world has achieved substantial reductions in poverty, but many countries face growing disparities in income and access to services between the rich and the poor. This situation poses a threat to sustainable growth. Inclusive growth is increasingly on the development agenda at the national and international levels. These indicators show the relationship between production, consumption, economy, and environment. It is possible to form a strategy for sustainable production and consumption in Ukraine, taking into account mentioned indicators (Fig. 2).

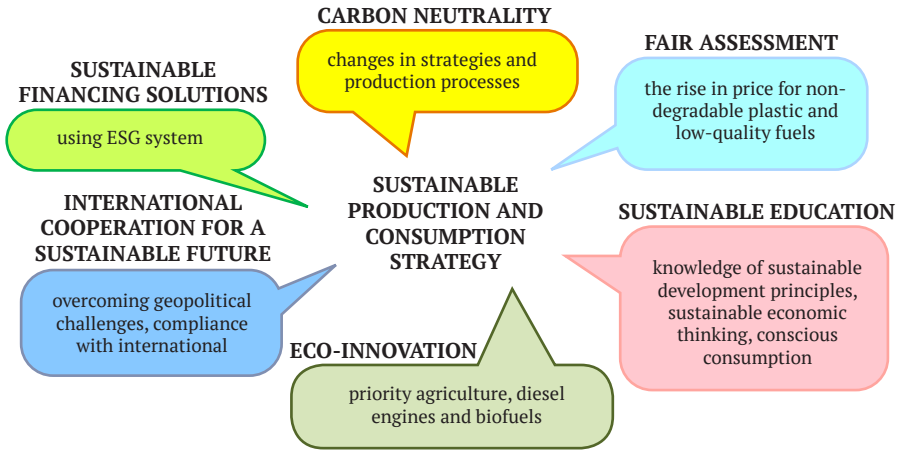

Figure 2. Strategy for sustainable production and consumption in Ukraine

Ukraine's ecological and economic situation and the fulfillment of commitments on SDG 12 [53] were analyzed. As a result, it was supposed that a strategy for sustainable production and consumption gets to include six directions. These are carbon neutrality, sustainable decisions in the financing, increasing the share of eco-innovation, fair assessment of non-eco-friendly goods and resources, the introduction of sustainable education, and international cooperation in environmental policy.

Thus, there is a clear link between production, consumption, sustainability, and financial performance [54]. Therefore, it is offered economic indicators of business sustainability for Ukraine, taking into account the principles of the European Economic Community.

These indicators include:

1. Economic value. It covers individual income (company profit), social income (taxes), and non-direct income (increasing labor productivity and reducing general production costs).

2. Customer value. It contains the positive advantages of the product or its ratio (for instance, the ratio of price and quality, practical and aesthetic satisfaction).

3. Ethical value. It covers marketing, industry standards, and business transparency.

4. Environmental value. It defines energy efficiency, resource-saving, and the possibility of recycling or waste disposal.

5. Social value. It includes decent working conditions (microclimatic, environmental, medical, educational, etc.), the well-being of employees, and a positive impact on society as a whole.

6. Management value. It covers team morale, employee motivation practices, and fair corporate policies.

For example, while expanding sustainable activity, a company introduced changes in the process and quality of nutrition. The sustainable food program guarantees quality and good nutrition at affordable prices, considering its environmental impact [55; 56].

The organization of high-grade, sustainable nutrition at the enterprise is a part of a comprehensive program to improve employee health, accounting for the current requirements for sustainable development of personality and production (Fig. 3).

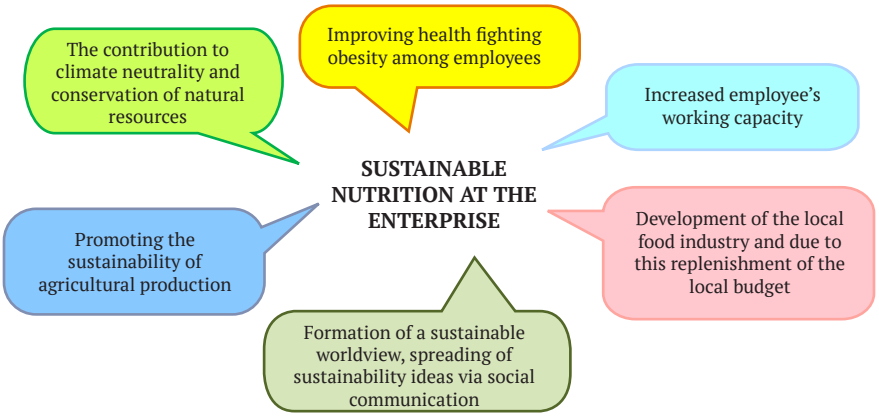

Figure 3. Economic indicators of enterprise sustainability as a result of the introduction of nutrition-ergonomic indicators

In this example, the economic parameters of sustainable development are the following:

1. Economic value is achieved through indirect income (increased labor productivity, reduced production costs, reduced sick leave payments, etc.).

2. Customer value. If the product is manufactured at

the enterprise with sustainable programs for employees, it is more attractive to purchase, and the enterprise is more interesting for investors.

3. Ethical value. A human spends most of the time at work. Consequently, the workplace is ideal for implementing effective health and well-being measures that will help reduce the financial losses associated with reduced productivity.

4. Environmental value. Using locally sourced food helps stimulate the region's economy and supports local producers. Also, this contributes to reducing greenhouse gas emissions because of transporting food.

5. Social value. The company contributes to its employees' sustainable behavioral and social strategies by influencing their awareness, providing information support, etc. Both individuals and groups of people can participate in such events.

6. Management value. Changes in enterprise policy can include simplified access to healthy food (for example, by changing food offerings in public nutrition places). The enterprise may offer additional services to employees, such as health insurance, benefits for health club members, etc.

Often, the estimation of enterprise sustainability is difficult to understand for potential investors. Therefore, a financial justification is required to incorporate sustainability into the company's strategy. The economic rationale shows the impact of various enterprise variables on mitigating adverse environmental effects from product releases and identifies levers to maximize sustainability. In doing this, the enterprise must understand which way shareholders will use such estimation as an opportunity for their actions or a condition for their activities.

CONCLUSIONS

Today, producers and consumers are aware of environmental problems and are worried about their consequences. Unfortunately, just worrying isn't enough today. Everyone must act at their level. It is necessary to avoid inertia and take responsibility for sustainability, rethink the company's corporate goals, and the role of business in society. Increase responsibility for sustainable development via external and internal actions that benefit people and the environment; and are profitable.

There is enthusiasm for the expected macroeconomic implications of European integration. However, the possibilities of integrating production and investing in environmental protection and sustainable environmental policy are still low. The projected increase in production will cause even more damage to the environment, while the prospects to prevent waste flows and emissions are not yet clear.

Today the concept of sustainability is widely underestimated and underutilized in business and political circles in Ukraine. Sustainability reporting, while practical, is still not necessary. Obviously, without a regulatory framework, the prospects for widespread business reporting are unlikely.

Ukraine needs to use sustainability strategies to analyze environmental policy activities in production and consumption based on the actual data. These activities will bring Ukraine closer to European integration.

It is necessary to combine sustainable production and sustainable consumption into one cluster. It will allow sustainable initiatives are focused on systemic changes and essential areas of production and consumption – energy, transport, housing, agriculture, and food. The practical value of the approach is in a strategy that includes measures stimulating environmental and socio-economic policy of production. It will allow moving from relative disunity of actions to technological standards. The proposed method can be implemented in recommendations for improving programs directed at changing behavior with the gradual transition from individual consumers to broader initiatives to change the whole system of production and consumption.

Focusing on technology (rather than entire companies) and increasing consumer awareness can help identify business opportunities, increase differentiation and create a competitive advantage.

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Дослідження стратегій сталого виробництва і споживання в економічних умовах України

Анотація. Сучасні вимоги до компаній і споживачів включають стабільність фінансових показників, на тлі збільшення екологічної привабливості. Компаніям необхідно охопити такі, на перший погляд, різнобічні інтереси, як прибутковість для власників, турботу про персонал, інтерес для партнерів і споживачів, дії з охорони навколишнього середовища. Важливо враховувати і зростаючу роль свідомого споживання, яке є прямим регулятором виробничої діяльності. Сьогодні це як ніколи актуально, у тому числі й для України, з урахуванням її переходу до сталості і виконання цілей сталого розвитку у сфері виробництва і споживання. Мета роботи – сформулювати стратегію і рекомендації щодо об'єднання сталих ініціатив у галузі виробництва і споживання у контексті євроінтеграційних процесів в Україні. Об'єктом дослідження є сталість у виробництві і споживанні. У статті запропонована стратегія, що поєднує стале виробництво і стале споживання в один кластер. Це дозволить зосередити сталі ініціативи на більш глибоких системних змінах і на ключових галузях виробництва і споживання. У роботі використана ідея методу під назвою «Стійка цінність бізнесу». Метод включає докладну звітність про сталий розвиток виробництва, з відповідними рейтингами та індексами. Метод рекомендований до використання при прийнятті рішень, управлінні інвестиціями для розвитку бізнесу, порівняльного аналізу, спілкування із зацікавленими сторонами, а також забезпечує всебічне уявлення про вплив компанії за шістьма стандартизованими параметрами. Результатом роботи є пропозиція щодо створення алгоритму об'єднання сталого виробництва і сталого споживання в один кластер. Це дозволить зосередити стійкі ініціативи на системних змінах у ключових галузях виробництва і споживання – енергетиці, транспорті, житловому будівництві, сільському господарстві, продуктах харчування. Практична цінність підходу полягає у стратегії, що включає заходи зі стимулювання екологічної і соціально-економічної політики виробництва та переходу від відносної роз'єднаності дій до технологічних стандартів. Пропонована стратегія може бути реалізована у рекомендаціях щодо удосконалення програм, спрямованих на зміну поведінки з поступовим переходом від окремих споживачів до ширших ініціатив щодо зміни всієї системи виробництва і споживання

Ключові слова: екологічний облік і звітність, сталість, стала діяльність, екологічні аспекти, свідоме споживання

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Monetary Traps of the New Macroeconomic Consensus: Problems of Stabilization Policy after COVID-19

Abstract. The relevance of the study lies in the consideration of transmission channels through which the influence of monetary policy carried out by the governments and central banks of the United States, Japan and Germany was realized. The purpose of the article is to consider the phenomenon of the monetary trap as a special case of an unforeseen macroeconomic reaction to the stabilization anti-crisis policy pursued by the state, which is designed to stimulate economic activity and contribute to the growth of aggregate output. The article identified the potential of economic theory (with an emphasis on the New Macroeconomic Consensus) to illuminate the current practice of state stabilization policy, taking into account new historical challenges, as well as modeling the impact of monetary instruments of stabilization policy on the potential for economic recovery of the United States, Japan and Germany. To achieve the goal of the study, scientific and special research methods were used, namely: methods of analysis, abstraction and synthesis, induction and deduction, as well as a system-structural method; hypothetical-deductive method; idealization method; methods of economic and mathematical modeling. An analysis of the consequences of the state policy to counteract the downturn in the economic situation as a result of the COVID-19 pandemic made it possible to periodize it and establish that the stabilization measures at the first stage were mainly of a fiscal nature, while at the second stage they were focused on monetary containment of the volatility of commodity prices. A regression express analysis of the relationship between monetary incentives and changes in GDP and inflation in the United States, Japan, and Germany made it possible to establish that the influence of monetary impulses on price stability manifests itself over a longer period of time and depends on the influence of many factors, including price fluctuations, changes in nominal wages, exchange rate dynamics and expectations of economic agents

Keywords: macroeconomic policy, monetary policy, helicopter money, central bank, economic growth, economic recovery, developed countries

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INTRODUCTION

There are different views on the interaction of economic theory with economic policy. If economic policy is seen as the result of some rational decisions, there is disagreement about the relevance of economic theories and the definition of their role in providing legitimacy and scientific support for decisions proposed by decision makers. The existing relationship between the economic theories accepted by the scientific community and the economic policy of the

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government is controversial. Radical approaches are based on the hypothesis that the goal of economic policy does not imply reference to economic theories and the application of their results, and therefore, for adherents of this position, economic policy is not an expression of the justice or truth of economic theory. At the same time, there are representatives of another approach, according to which economic theory remains relevant for economic policy, and the theorists' reflections turn into the results of real decisions. In some cases, various economic theories can become an effective tool in the struggle for biased intellectual arguments in favor of making certain political decisions. And although the theoretical economist is engaged in the development of economic theory, economic policy does not look like a way to embody its results, because the theory is always associated with many other factors, including politics produced at the supranational level, at the basis of the decisions made by politicians. This means that the idea that the economic policy implemented by the government should reflect the logic of scientific theories is considered illusory. Therefore, the discussion between representatives of different scientific schools should be based on the principle of searching for the optimal economic policy in the existing historical realities in the context of global uncertainty, which is characterized by the irrationality of the behavior of economic agents, asymmetric information and limited resources.

LITERATURE REVIEW

The New Macroeconomic Consensus (NMC) actually became a merger of modern macroeconomic schools (new classical economics and new Keynesian economics), which determined its influence in terms of shaping approaches to interpreting modern macroeconomic processes, and hence the search for analytical arguments in favor of substantiating the need for macroeconomic policy. The term "consensus" indicates that there was an agreement among economists, in whose positions there is usually no unanimity after the collapse of the neoclassical synthesis of the 1970s [1-3]. The statement that the history of economic policy ended in reaching a consensus, is extremely approximative, because a retrospective analysis of its implementation cannot ignore a number of contradictions, which, depending on a particular historical context, either become aggravated (in conditions of the search for an optimal stabilization policy under the conditions of the existing economic realities and challenges of the endogenous and exogenous nature of the stabilization policy) or lose their categorical nature (under the conditions of the implementation of economic policy of its allocative and distributive functions) [4]. Since the 1990s, inflation targeting with a strong emphasis on rational expectations has become one of the central goals of monetary policy [5]. At different times, researchers belonging to different scientific economic schools have determined the impact of monetary policy on price stability and economic growth at various stages of the business cycle, while coming to different conclusions [6-8]. Hence, the key elements of the NMC as an exponent of the methodological consensus within the macroeconomic mainstream were the following: 1) the main task of the Central Bank was to ensure the stability of consumer prices, and the Central Bank must publicly commit itself to achieving the inflation target (usually around 1-3%);) 2) to achieve the goal of inflation targeting, the Central Bank should be functionally and institutionally independent from the government or ministries of finance, which would deprive it of the need to provide loans to the government; 3) giving preference to the use of indirect monetary policy instruments (in particular, interest rate adjustments) as opposed to direct methods of deficit financing or cash financing, credit control or management [9].

Such assumptions are taken from neoclassical economic equilibrium models with rational expectations, where equilibrium is reached at the "natural rate" of interest (the equilibrium real interest rate) when expected savings match the demand for investment [10]. As pointed out in some research work [11], given that nominal price rigidity and friction in the labor market (between workers, unions, employers, and the government that regulates the minimum wage) limit the achievement of short-term equilibrium, the key role of the Central Bank is to use the potential of interest rate policy for the restoration of economic equilibrium [12]. In theory, choosing the goal of achieving low inflation, the Central Bank automatically guarantees the smallest output gap (the difference between actual and potential GDP) or the same level of activity that would be achievable in the absence of the problem of nominal rigidity (in a situation of perfect competition) [11], that's why well-functioning financial markets facilitate the transmission of monetary stimulus, and the use of fiscal policy instruments should be limited not to distort the natural interest rate [13]. And although the founding documents of the ECB recognize the priority over price stability (which could be frivolously interpreted as a certain tilt towards the monetary doctrine), in practice, the central bank, implementing the inflation targeting policy, is engaged in providing conditions for economic growth. Consequently, for the ECB, both goals – price stability and economic growth – are equivalent, which leads to a request for a symbiosis of the ideas of monetarists and Keynesians at the heart of its monetary regulation [14].

It should be emphasized that back in 2012, within the framework of the OECD initiative "New Approaches to Economic Challenges" [15], despite long scientific discussions and political disputes, a compromise was reached towards the formation of a "new economic narrative". According to the agreements reached, it should consist of the following three elements: 1) a new concept of economic progress, which involves a deeper understanding of the relationship between growth, human well-being, inequality reduction and environmental sustainability, which can be used in the development of economic policy; 2) new approaches to interpreting the fundamental generalizations of economic theory, which involves the use of new economic policy tools (quantitative easing, helicopter money); 3) new approaches to the implementation of economic policy, providing for a wider range of political and institutional reforms based on new principles and analysis to achieve new social and economic goals.

Government policies in dealing with the effects of COVID-19 have varied in strength and impact on the economy. It was implemented through monetary and fiscal channels of influence on economic activity, its formal task was to restore the dynamics of GDP, and a side undesirable consequence of fluctuations in the price level in the economy.

The channels of macroeconomic influence on economic activity include: cyclical variations in GDP growth affecting production/demand effects, changes in the country's terms of trade and capital flows; monetary shocks, which in turn determine the level of investment risk, interest rates and yield curves, as well as capital flows; fiscal shocks that act like monetary shocks and, in addition, crowd out private investment; the degree of volatility in key currencies, interest rates and production. The purpose of the article is to analyze the macroeconomic policies implemented by the governments of the United States, Japan and Germany, with an emphasis on the study of the positive and negative effects of the transmission mechanism created by the monetary authorities.

To achieve the goal of the study the following tasks were set: determination of the relationship between economic theory and economic policy in order to determine the potential of economic theory to illuminate the modern practice of the stabilization policy of governments, taking into account new historical challenges; consideration of the key characteristics of the New Macroeconomic Consensus to determine the expectations of the effectiveness of monetary policy to correct the manifestations of the economic downturn; periodization of the policy of stimulating economic activity in the context of the pandemic and determining the defining role of the monetary transmission channel on GDP growth; emphasis on the role of helicopter money in the policy of the Central Banks of the USA, Japan and Germany; modeling the impact of monetary instruments of stabilization policy on the GDP growth potential of the USA, Japan and Germany.

On the basis of a comparative analysis of alternative schools of macroeconomic thought, arguments are proposed in favor of prioritizing the directions of stabilization policy from fiscal to monetary instruments using the concept of "monetary trap". The novelty of the study lies in the explanation of the current practice of stabilization policy on the theoretical basis of the New Macroeconomic Consensus and in determining the effectiveness of monetary policy in correcting the manifestations of the economic downturn.

MATERIALS AND METHODS

A feature of the proposed approach is the study of the phenomenon of a money trap, which is proposed to be considered as a special case of an unforeseen macroeconomic reaction to the stabilization anti-crisis policy pursued by the state, designed to stimulate economic activity and contribute to the growth of aggregate output. The current monetary policy of the three developed countries – the USA, Germany and Japan is considered not only through the prism of empirical facts, but also on the basis of a deep analysis of the theoretical foundations of economic policy. At the same time, the role of economic theory as a science in the choice of monetary policy instruments is not absolutized, but rather is questionable [16-18]. The information base of the study is the scientific developments of theoretical economists and practical economists. The study is based on the categories of theoretical (hypothesis, concept, theory, problem) and empirical (facts, empirical generalizations, empirical dependencies) levels of cognition, the characteristic features of which are: objectivity; rationality; high level of generalization; universality and use of special ways and methods of cognitive activity. A regression express analysis of the relationship between monetary incentives and changes in GDP and inflation in the United States, Japan and Germany made it possible to establish that the influence of monetary impulses (money supply M2) on price stability manifests itself over a longer period of time and depends on the influence of many factors, such as: fluctuations in prices in the markets of raw materials, energy, food products; change in nominal wages; exchange rate dynamics and business expectations. To achieve the goal and solve the problems of the study, scientific and special research methods were used, namely: methods of analysis, abstraction and synthesis, induction and deduction, as well as a system-structural method (when studying monetary policy as a policy and practice; when determining new forms of manifestation of monetary policy, when determining the fundamental bases for the choice of instruments of stabilization policy); hypothetical-deductive method (when creating a system of deductively interconnected hypotheses about the expansion of monetary policy tools to stimulate economic activity); the method of idealization (when determining the conceptual foundations of the New Macroeconomic Consensus doctrine); methods of economic and mathematical modeling (when assessing the impact of an increase in the money supply on the rate of GDP growth).

The purpose of the article is to prove that differences in the effects of monetary policy shocks can be explained by differences in aggregate demand and aggregate supply in individual countries. The higher sensitivity of money demand to changes in the income of economic agents and interest rates, as well as the lower interest rate elasticity of total personal consumption spending, contribute to the improvement of the effectiveness of monetary policy. The paper hypothesizes that capacity constraints (supply shocks) and high price revision rates contribute to monetary policy shocks moving more in nominal terms than in real terms. Moreover, in open economies, central bank interest rate decisions can affect international capital flows, leading to changes in financial conditions and exchange rates in developing countries and then in macroeconomic variables.

The monetary rule is a function of the reaction of the central bank to changes in the main macroeconomic indicators (inflation, output and exchange rate) through a change in the monetary policy instrument. Empirical experience [15; 19; 20] has shown that, in contrast to developed countries, in developing countries the equation of the monetary rule may include both the dynamics of inflation and aggregate output, and other macroeconomic variables – in particular, the exchange rate, the unemployment rate and others. At the same time, the degree of sensitivity of the base interest rate of the central bank to changes in the aggregate output and the exchange rate, as a rule, is lower than to the dynamics of inflation. In the course of this study, it is planned to demonstrate that the use of a monetary channel to stimulate economic activity in developed countries (using the example of the USA, Germany and Japan) does not give the declared results. Increasing the money supply and manipulating the interest rate has no direct effect on total output. This result suggests that the monetary rule for developed countries in the post-pandemic period should undergo some changes. Economic theory argues that in countries with emerging markets, monetary aggregates

(monetary base, money supply, etc.) are often the key instruments of monetary policy. The use of these tools is appropriate in case of high uncertainty in the dynamics of real interest rates (high inflation or high economic growth rates, high dependence of inflation on the dynamics of monetary aggregates, or a complex procedure for estimating a certain equilibrium level of interest rates). On the other hand, with a developed financial architecture and a high velocity of money, interest rate management is the most efficient. The experience of the stabilization policies of developed countries shows that in the face of uncertainty and a crisis in the field of health protection, in the context of a break in value chains and supply chains, the central banks of the United States, Germany and Japan, in an attempt to stimulate economic activity, aggressively used monetary policy tools that are more characteristic of developing countries [20].

RESULTS AND DISCUSSION

The actions taken to contain the coronavirus have caused an economic recession in recent human memory and have upended fiscal and monetary policies of the nations [21]. As part of the policy of countering the economic downturn caused by the COVID-19 pandemic and restoring economic activity, it is proposed to distinguish two periods in the policies of developed countries: 1) an unprecedented increase in debt financing to counter the crisis; 2) build-up of inflationary processes after the revival of economic dynamics.

The period of increasing debt financing (February 2020 – August 2021). At this time, the governments of developed countries introduced restrictive measures for citizens and businesses, recorded failures in various sectors of the economy, mobilized resources and launched diverse economic renewal programs. The depth of the recession due to COVID-19 would have been much greater if massive economic support policies had not stopped a further decline in activity. Direct fiscal measures on revenues and expenditures, programmed for the end of 2020 in developed countries, were estimated at more than 9% of GDP, and another 11% in various forms of liquidity support, including capital injections, asset purchases, loans and credit guarantees. The opportunities for developing countries were much more modest, but still significant: about 3.5% of GDP through fiscal channels and more than 2% through monetary support channels [20].

Not only the scale but also the novelty of the policies also contributed to the recovery. An illustrative example of this was the €750 billion package of European Union pandemic recovery initiatives, consisting of grants and temporary emergency assistance. It contained cash and in-kind transfers to affected firms and households; wage subsidies to maintain employment; extended unemployment insurance; tax deferral; and regulatory initiatives to ease classification rules and provisioning requirements for bank NPLs, while freeing up buffers to absorb losses [22].

During this period central banking activity in advanced economies extended beyond sovereign debt to broader asset purchases and lending to commercial banks, supporting lending to a wide range of borrowers. The Federal Reserve also announced changes to its monetary policy strategy, moving to a flexible average inflation target of 2% with a time lag.

The period of increasing inflationary processes (September 2021 – until now). In response to it many central banks are moving to a tighter monetary policy. The tightening came through an increase in nominal interest rates among sovereign borrowers with developed economies. In 2022, the main focus is on further increases in interest rates and contraction of record high central bank balance sheets. Expectations of a tougher policy led to financial market instability and downward reassessment of risks. According to the IMF survey, capital outflows from emerging markets were as large and fast in early March as they were at the start of the pandemic [23]. The transmission of monetary impulse occurs from the discount rate to GDP (Fig. 1). By lowering the rate, the central bank stimulates business activity, resulting in an increase in GDP.

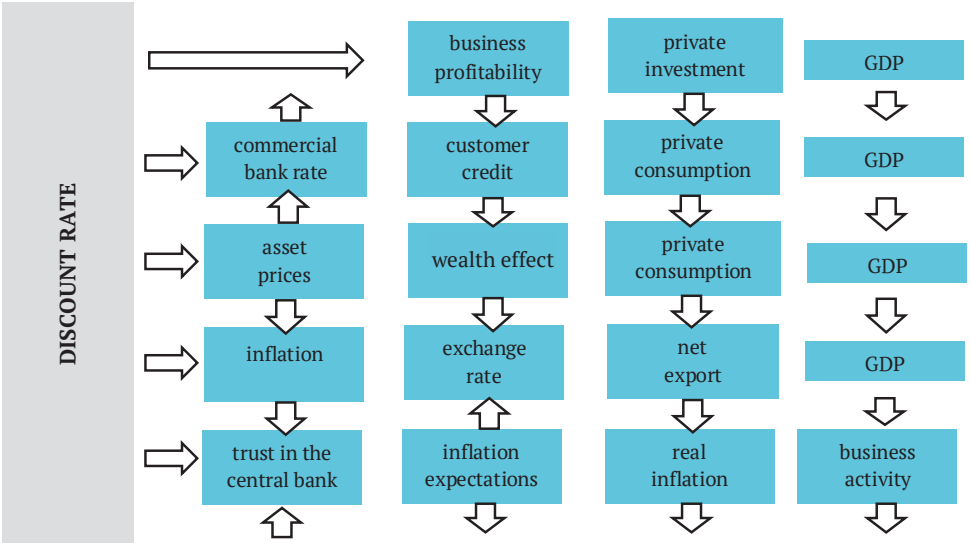

Figure 1. The main channels of monetary transmission (the case of an increase in the discount rate)
Source: [20; 24]

Long before the start of the pandemic, the central banks of the leading countries of the world actively used the monetary mechanism to stimulate economic activity. Several central banks provided additional liquidity to financial institutions by reducing the bank reserve requirement ratio (such as Brazil, China, Malaysia, the Philippines and the United States) [25]. The Bank of Japan in coordination with the Bank of Canada, the Bank of England, the European Central Bank, the Federal Reserve and the Swiss National Bank enhanced the provision of U.S. dollar liquidity on March 15, 2020, by lowering the pricing on the standing U.S. dollar liquidity swap arrangements by 25 basis points. Japan also has several important bilateral and regional swap arrangements with Asian countries. The key measures adopted by the Bank of Canada include: a) reducing the overnight policy rate by 150 bps in March 2020 (to 0.25%); b) an extension of the bond buyback program across all maturities; c) announcing an increase in the target for settlement balances to $1,000 million from $250 million; d) together with central banks from Japan, Euro Area, U.K., U.S., and Switzerland, announcing further enhancing the provision of liquidity via the standing US dollar liquidity swap line arrangements. The Bank of Korea has taken several measures to ensure continued accommodative monetary conditions and facilitate financial system liquidity. These include: 1) lowering the Base Rate by a cumulative 75 basis points, from 1.25% to 0.5%; 2) making unlimited amounts available through open market operations (OMOs); 3) expanding the list of eligible OMO participants to include selected non-bank financial institutions [24].

The rate cut became permanent, as a result of which, before the start of the covid crisis, rates were at zero in all the three countries. Therefore, their central banks were forced to use another monetary instrument – a direct expansion of the money supply (M2 aggregate) or the issue of money. The logic was the same: by offering "helicopter money" to business entities, central banks revive business activity which stimulates GDP growth [20]. This allows the authors to put forward the initial hypothesis that there is a linear effect of the change in the M2 aggregate on the change in GDP in each of the three countries.

While theoretical considerations suggest that helicopter money is particularly effective in extreme economic conditions, it can create difficulties and instability [20; 26]. Some of them are:

1) political-normative: in order to achieve the effect of "helicopter" money, first, it is necessary to coordinate the responsibilities of the government and an independent central bank. Although this is not difficult in theory, in practice the government and the central bank may work on different short and long term strategies to achieve economic growth. For example, coordination between the ECB and national fiscal authorities is extremely difficult, if not impossible, in the Eurozone due to different fiscal policies, different objectives and a single monetary policy throughout the union;

2) spending and saving: Once the money reaches the end consumers, they may decide to save it instead of spending, and in doing so, they defeat the ultimate goal of helicopter money to stimulate consumption;

3) impact on the currency: economists fear that the printing of money may lead to the devaluation of the national currency which hinders the recovery of the economy;

4) inflation may exceed expectations and the central bank may miss the opportunity to control inflation, as there are concerns about weakening the independence of the central bank in the course of the application of the policy of "helicopter money".

Although in theory the concept of "helicopter money" seems attractive and correct, there are problems with its implementation. How efficiently the helicopter money will be distributed, whether the economic agents who receive it will store or spend the funds, or whether this will lead to inflationary pressure are just some of the problems of their implementation. R^2 is a statistical measure that represents the proportion of variance for a dependent variable that is explained by one or more independent variables in a regression model. Using the F-test, it is proposed to calculate the probability that there is no critical difference between the variances of two variances. P-value – the minimum level of significance at which the main hypothesis is rejected.

Table 1. Dependence of GDP growth on M2 growth

Country	R^2	F-test	Equation	P-values of coefficients
USA	0.379	9,167 (0.0084)	*GDP=2,261–64.75*M2*	0.0162 0.0084
Japan	0.015	0.232 (0.637)	*GDP=0.454–28,83*M2*	0.7344 0.6368
Germany	0.256	5,157 (0.038)	*GDP=3,749–160*M2*	0.0538 0.0383

Source: [27; 28]

It follows from the data in Table 1 that in all three countries there is a weak dependence of GDP dynamics on monetary impulses. The change in the state of economic activity is explained by a change in the money supply in the US by 38%, in Germany by 26%, and in both cases the relationship is inverse, which seems counterintuitive. For Japan, the analysis turns out to be irrelevant, the constructed regression does not overcome the quality check (F-test and P-value of the regression coefficients). However, monetary policy (change M2) is better synchronized with GDP, which is shown by each country with a quarter shift. It follows that there is an hourly lag (by about 1 quarter) between monetary policy measures and changes in economic activity. A repeated regression analysis of the relationship between the change in the M2 aggregate and GDP was carried out, taking into account the hourly lag (Table 2).

Table 2. Dependence of GDP growth on M2 growth, taking into account the lag

Country	R^2	F-test	Equation	P-values of coefficients
USA	0.318	6,515 (0.0230)	*GDP=-1.19+5,941*M2*	0.2218 0.0230
Japan	0.227	4,101 (0.063)	*GDP=-2.29+111.54*M2*	0.0835 0.0623
Germany	0.490	13,465 (0.002)	*GDP=-5.24+2,262*M2*	0.0055 0.0025

Source: [27; 28]

The analysis results are improving for Germany and Japan, although not enough for the latter to pass the qualitative test. The logic of the relationship between GDP and M2 is getting in the right direction: an increase in the money supply (by 2.3% in Germany or 5.9% in the US) can stimulate an increase in GDP (by 1%). Although most of the increase in the latter is still due to other factors. It is possible to check the likelihood of inflation as a negative consequence of the active use of the monetary channel to stimulate the conjuncture by identifying the relationship between the change in the M2 aggregate and the change in the consumer price index (CPI) for the selected countries (Table 3).

Table 3. Dependence of the CPI increase on the M2 increase without taking into account the lag

Country	R^2	F-test	Equation	P-values of coefficients
USA	0.055	0.820 (0.380)	*CPI=0.65+6.55*M2*	0.0403 0.3804
Japan	0.066	1,059 (0.320)	*CPI=0.25–8.42*M2*	0.1758 0.3197
Germany	0.039	0.615 (0.445)	*CPI=0.24+15.18*M2*	0.6313 0.4450

Source: [27; 28]

The performed calculations indicate that the relationship between inflation and the increase in the money supply in the economy is not traced and the regressions are unrepresentative. Accounting for the time lag does not significantly improve the quality of the regression. From the regression analysis of the impact of the monetary channel on the dynamics of the economy in the time period from 2018 to 2022, the following conclusions can be drawn for the group of the most developed countries: the monetary channel really ensures the transfer of momentum from money supply to GDP; the influence of the monetary channel on the conjuncture is not decisive, the study needs to be deepened to establish the influence of other factors; in the short term, in a recession, the monetary impulse does not cause a jump in inflation and the accuracy of the study can be deepened by expanding the horizon of analysis of changes in the phenomena.

CONCLUSIONS

The analysis of the consequences of the state policy of counteracting the downturn in the economic situation as a result of the COVID-19 pandemic made it possible to carry out its periodization, which at the initial stage was characterized by an increase in debt financing of state anti-crisis programs, and at the second stage, by counter-inflationary measures to prevent possible negative effects from excessive stimulation of the economy. The measures at the first stage were predominantly fiscal in nature while at the second stage they were focused on monetary containment of the hypothetical volatility of commodity prices.

The regression express analysis of the links between monetary incentives and changes in GDP and inflation in the USA, Japan and Germany, made it possible to establish that the impact of monetary impulses (M2 money supply) on price stability manifests itself over a longer period of time and depends on the influence of many factors. They can be price fluctuations in the markets of raw materials, energy, food products, changes in nominal wages, exchange rate dynamics and business expectations.

Macroeconomic stability in today's mainstream macroeconomy is understood primarily as price stability. This opinion was rooted in the period of low macroeconomic volatility in developed countries in the second half of the 1980s and the first half of the 2000s. The main problem in the new synthesis models is inflation and its control. It is price stability, and not the smoothing of output fluctuations or the achievement of full employment, that is considered the main and only goal of monetary policy. But as a result of the global recession unfolding, the assertion that stable low inflation eliminates the problem of cyclical economic development, which became the leitmotif of the new neoclassical synthesis, has lost its empirical foundation. A properly built monetary policy is the best tool for achieving low price growth rates, but an important condition for its effectiveness is the trust of economic agents in the monetary authorities for the sake of which their actions must be clear, consistent and predictable. With a simultaneous supply shock and demand shock, as well as the announced start of depression, central banks should reconsider their targets, taking into account the challenges that will be placed on governments in

the face of global uncertainty. In this regard, it is promising to continue the study of not only the tools for implementing monetary policy, but also its goal-setting which will make it possible to predict the further merging of economic thought.

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Монетарні пастки нового макроекономічного консенсусу: проблеми стабілізаційної політики після COVID-19

Анотація. Актуальність дослідження полягає у розгляді трансмісійних каналів, якими реалізовувався вплив монетарної політики, яка здійснювалася урядами та центробанками США, Японії та Німеччини. Мета статті полягає в розгляді феномена монетарної пастки як окремого випадку непередбаченої макроекономічної реакції на стабілізаційну антикризову політику, що проводиться державою, яка покликана стимулювати економічну активність і сприяти зростанню сукупного випуску. У статті було визначено потенціал економічної теорії (з акцентом на Новому макроекономічному консенсусі) для висвітлення сучасної практики державної стабілізаційної політики з урахуванням нових історичних викликів, а також проведено моделювання впливу монетарних інструментів стабілізаційної політики на потенціал економічного відновлення США, Японії та Німеччини. Для досягнення мети та вирішення завдань дослідження використовувалися наукові та спеціальні методи дослідження, а саме: методи аналізу, абстрагування та синтезу, індукції та дедукції, а також системно-структурний метод; гіпотетико-дедуктивний метод; метод ідеалізації; методи економіко-математичного моделювання Аналіз наслідків державної політики протидії спаду економічної ситуації в результаті пандемії COVID-19 дозволив провести її періодизацію та встановити, що стабілізаційні заходи на першому етапі мали переважно фіскальний характер, на другому етапі вони були орієнтовані на монетарне стримування волатильності цін. Регресійний експрес-аналіз зв'язків монетарних стимулів зі зміною ВВП та інфляції у США, Японії та Німеччині дозволив встановити, що вплив монетарних імпульсів на цінову стабільність проявляється на більш тривалому періоді часу та залежить від впливу багатьох факторів, серед яких коливання цін, зміна номінальної заробітної плати, курсова динаміка та очікування економічних агентів

Ключові слова: макроекономічна політика, монетарна політика, вертолітні гроші, центральний банк, економічне зростання, економічне відновлення, розвинені країни

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Dynamics of Formation of Transitional Prices on the Chain of Sequential Markets: Analytical Model

Abstract. Although the problem of formation of market prices, determination of equilibrium prices within the model "Demand – Supply" is quite known and a great number of both theoretical works and works that summarize the results of observations are devoted to its research, this problem remains relevant, especially as to the dynamics of pricing processes and the stability of equilibrium prices in relation to changes in parameters that characterize the state of the system. Most studies addressing these issues focus on either a particular local market or the global market for some products in general. The purpose of this work is to build a mathematical model that would allow us to analyze general issues related to the formation of transitional prices in the finite *N*-dimensional chain of sequential markets in accordance with the scheme of market equilibrium. An analytical model is proposed that makes it possible to study the dynamics of prices in adjacent markets. Within this model, which is based on the determination of processes using a system of integral equations, it was assumed that the impact on the chain of sequential markets and the response to this impact are continuous over time. The dynamic aspect of the proposed pricing model in the vertical sequence of markets is the existence of an "after-effect", which is described in an integral form by the delay distributed over time. The issues of adequacy of the model were examined, its internal coherence was studied, the correctness of the transition from the mathematical model of dynamics as a system of integral equations to the model in the form of a system of linear algebraic equations was substantiated. The conditions for the existence of the solution for this system of equations and the area of its stability are formulated. The mathematical model proposed in this paper allows for a qualitative analysis of the system states (by phase trajectories). Examples of numerical implementation of our analytical model for two and three sequential markets are given, equilibrium prices for each link of the chain of sequential markets are determined. Applying simulation modelling, the stability of the solution in relation to changes in such parameters of the model as the elasticity of demand and supply in the market under study and cross-elasticities in adjacent markets as well as the impact of these parameters on such dynamic indicators of the market system as the rate of attainment of equilibrium was examined

Keywords: market vertical, pricing, phase trajectories, Volterra integral equations, model adequacy, simulation modelling, elasticities of supply and demand

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INTRODUCTION

At all stages of production of goods and services, as well as their sale, the structures of interaction of economic agents are quite diverse. However, generally there are two types of relationships distinguished, according to which the classification of relations between economic agents is carried out. Firstly, it is a hierarchical type of relations, i.e. vertical interaction or even integration; secondly, these are relations of competition or cooperation at the same level, i.e. horizontal interaction. In the international model of differentiated goods, the "Rule of Three" market structure (RoT-market) can be implemented, which allows for competition both within the country and between firms of different countries [1]. In this case, the long-term risk of a firm facing domestic competition may be higher or lower

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than the short-term risk, whereas a foreign monopolist has less long-term risk.

While the features of horizontal interaction are explored in many works of both practical and theoretical direction, the issues of vertical interaction are more complex, at least in theoretical terms, but they are becoming increasingly relevant due to the rapid development of globalization processes [2]. The problem of vertical interaction in the product market has become especially acute in recent years due to the COVID-19 epidemic. This has even led to a failure in economic activity and, as a result, affected the efficiency of participants throughout the market vertical [3]. Thus, there is a need to build mathematical models describing the dynamics of processes in a market sequence. Thus, in his review "Mathematical Problems of the Next Century" [4], the leading American mathematician Steve Smale, an expert in the field of mathematical economics, identified the problem of introducing dynamics into economic theory as one of such problems (the so-called Problem 8: Introduction of Dynamics into Economic Theory, according to his definition). And this theory of dynamic equilibrium should be compatible with the theory (static) of equilibrium, which was laid down in the works of Leon Walras [5] and acquired its modern appearance thanks to the works of such scientists as Paul Samuelson [6] and John Hicks [7].

Sales of many goods including, for example, agricultural products, coal, oil, gas, electricity, are carried out through sequential markets. Let's consider the features of the vertical structure of a market. For the commodity market, the links of such chain are extraction of raw materials, its processing, production of semi-finished products (or components), production of finished goods, trade (sale), i.e. delivery to the end consumer. The vertical sequence of commodity markets can be represented by the scheme shown in Figure 1.

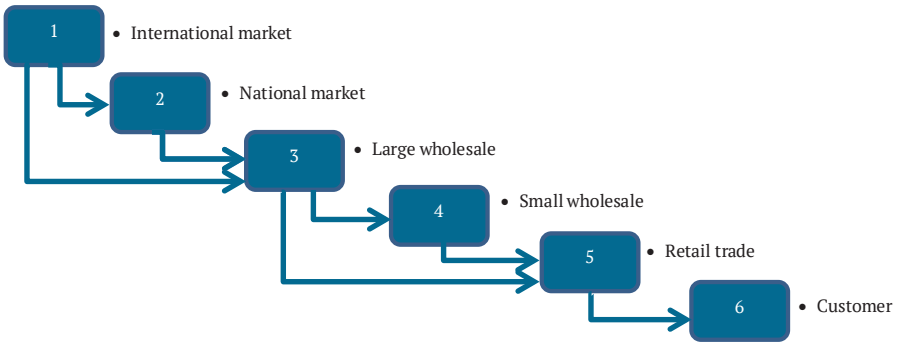

Figure 1. The sequence of links of the vertical chain of markets (hierarchical structure)

In its most extensive form, such sequence is most often observed in commodity markets. However, some types of services, for example, IT technologies business, also have a similar vertical structure of the market [5; 8]. Depending on the type of goods, some chains in this sequence may be missing. If the hierarchy of service markets is considered, such chain includes a minimum number of links. The shortest vertical chains can consist of such levels: 1 – 3 – 5 – 6 or 2 – 4 – 5 – 6. In fact, the vertical sequence of markets reflects a chain of successive stages of value creation. The total sum of value added generated at each level of this chain determines the final value of goods.

Numerous studies are devoted to assessing the quantitative changes [9] that occur in markets as a result of integration processes, and determining links between factors [10] that define the direction and speed of these processes. Exponential sliding averages may be characteristic of the system states, and the possible states themselves are described with Markov chains [11]. But this analysis reveals mainly the consequences, not the causes of the processes. In order to understand the possible direction of evolution of individual links in the sequence of markets and their consequences, it is necessary to take into account the very nature of qualitative connections between these links as well as to determine the quantitative indicators characterizing these connections with a variety of mathematical tools. Then, based on the analysis of the obtained results, it is necessary to develop a dynamic mathematical model of the system to determine the trajectories of the system development and identify the boundaries of stability of equilibrium states.

Modern theoretical studies of economic and social problems are based on mathematical models of sufficiently large dimensionality, with which the dynamics of the system states by development trajectories is described, i.e., a qualitative analysis of the system is carried out. This analysis is the basis for predicting the development of processes that can occur in the system depending on the implementation of a particular scenario, therefore, on the value of the parameters that are provided in the model. Thus, one of the first reports considered at the meeting of the Club of Rome, namely "Boundaries of Growth" by Dennis L. Meadows [12], included forecasts about human population and the depletion of natural resources. The basis for these forecasts were (this should be emphasized) dynamic mathematical models, in which the state of the system was described through a system of differential equations. The value of this approach is that a comparative analysis of the 1972 mathematical model and the 1993 World3 model made it possible to create a global development strategy aimed at stabilizing the system that can be called "Humanity". The argument in favor of the effectiveness of the application of mathematical modelling in economic and social research also lies in the fact that the analysis of the dynamics of processes that have taken place worldwide over the past 30 years confirmed the consistency of forecasts by the Meadows model [13]. This example most convincingly demonstrates the feasibility of creating mathematical models of dynamics to determine possible directions of development of economic and social systems, the availability of powerful computing equipment allows to

consider scenarios that are determined by a large number of variables, and the possibility of their implementation depends on a large number of parameters. One of the advantages of mathematical modelling is that this approach allows to obtain a fundamental solution of the problem, and by substituting certain values of parameters, you have the ability to determine the prevailing impact, thus the development of the system can be set in the desired direction.

The need to develop mathematical models of the system that would take into account as many significant factors as possible is also explained by the presence of psychological factors affecting pricing, for example, in the financial market [14]. Thus, it has been proved that the need to make decisions in conditions of uncertainty can lead to an increase in the probability of systematic errors in the pricing process.

If you consider the relations between participants that determine the pricing process at different levels of the market vertical [15; 16], then at the lowest level, the relationship between the buyer and the seller has the form of a one-time agreement, and all information about the product is reflected by its price. The next step is repeated transactions, leading to the formation of weak, but certain relations between the buyer and the seller. However, industrial marketing, especially within the global industry [17], is generally based on closer long-term relations that rely heavily on the interaction between market participants. Such relations are inherent in a higher level of the market vertical. Strong partnership relations are also possible; their formation is associated with the transition to quality management (which makes products more attractive to the buyer). A strategic alliance, an example of which is a joint venture, corresponds to the highest level. At the present stage of development, this type of interaction becomes an integral part of a firm's global strategy, since it accelerates the development of its technological capabilities, reduces risks and promotes access to new resources and markets. Thus, there is an evolution of marketing management manifested in the transition from viewing marketing as competition, when the interaction of market participants takes the form of individual transactions, to viewing it as cooperation and formation of vertical relations. Although transactions are considered the most common marketing relations between actors, vertical integration is considered the most complete when raw material suppliers and product sales companies are part of the main product company. Apparently, the vertical market structure involves different types of relations between the buyer and the seller.

Although many works are devoted to the issues of interaction between sequential links of the market vertical, they all have a predominantly practical direction, and only a limited range of works relates to the study of theoretical principles of the dynamics of pricing processes for the market vertical as a single system.

The purpose of the work is to build a mathematical model to determine the formation of transition prices and equilibrium prices for each link in the chain of successive markets and, based on the obtained analytical model, to study the influence of external factors on the dynamics of these processes. As external factors, the elasticities of the supply and demand functions within the market of that link of the vertical sequence for which the study is being carried out, and cross-elasticities for adjacent markets (previous relative to the investigated market and the next after it) will be considered.

MATERIALS AND METHODS

In modern science and technology, models based on differential and integral analysis are successfully applied to model dynamic systems. This approach is also becoming common in the research of economic and social systems. Now we can provide examples of a considerable number of economic problems, for the formalization of which differential and integral equations are used [18-20]. It should be noted that models based on the application of differential equations can be used when the impact on the system and the system's response to this impact are measured both at some fixed points in time and in continuous measurement, while the application of integral equations implies that this impact is distributed over time. However, both integral and differential equations describe the case when the processes that determine the state of the system are continuous in time. When time is considered discrete, difference equations are used to build dynamic models of economic systems [21; 22]. There are also attempts to apply non-local fractional operators, which go beyond the traditional use of elements of differential and integral calculus in building economic models of dynamics [23]. The processes occurring in the system can be considered Markov ones, i.e. when at random moment of time the evolution of the system is determined only by its current state and does not depend on how the system has reached this state. Markov chains are applied to determine possible transitions [11]. Functional autoregressive models are also used for modelling the price market [24]. Recently, another area of study of dynamic systems has emerged, which is related to the application of elements of fuzzy logic in creation mathematical models. In this case, for example, demand and supply are described by fuzzy numbers, and the learning function changes within fuzzy limits [25]. Thus, there is a natural interest in the extended application of mathematical apparatus to the modelling of economic dynamics in the research of pricing processes in the system of sequential markets.

This paper investigates the structure of interaction in sequentially connected markets, the number of which in general can be equal to *N*, based on a simplified scheme of sequential markets, which is presented in Figure 2.

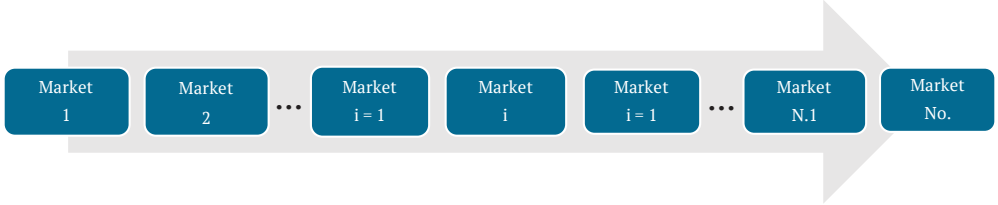

Figure 2. Simplified scheme of the system of sequential markets

To build a deterministic analytical model of sequential markets, principles of the theory of integral equations, the Laplace transform, the theory of matrices and determinants were used, and to test the theoretical principles on the dynamics of the formation of equilibrium prices, simulation modelling using MS Excel was made within the framework of this mathematical model.

RESULTS AND DISCUSSION

The organization of each market is based on mechanisms of the mutual consistency of supply and demand, which are, respectively, functions of price. Let's assume that the demand function D_i in each market depends only on the price p_i in that market, i.e. $D_i=D_i(p_i)$, where $i=(\overline{1,N})$. Whereas the supply function S_i will depend not only on the price p_i in the given market, but also on the prices p_{i+1} and p_{i-1} in adjacent markets, i.e. $S_i=S_i(p_{i-1}, p_i, p_{i+1})$, where $i=(\overline{2,N-1})$. Let's consider boundary cases. Thus, at $i=1$ we will have $S_1=S_1(p_1, p_2)$, and at $i=N$, respectively, we will have $S_N=S_N(p_{N-1}, p_N)$. To formalize the functions of supply and demand, let's assume that they have a linear dependence on price arguments. This assumption, although not expressed, is taken for granted in the interpretation of market equilibrium by both Walras [5] and Marshall [26]. So, let's write the functions of supply and demand as follows:

$$D_i = d_i^o - d_i p_i \quad \text{for} \quad i = \overline{1,N}\,, \tag{1}$$

$$S_i = c_i p_{i-1} + a_i p_i + b_i p_{i+1} - s_i^o \text{ for} \quad i = \overline{2,\ N-1}\,, \tag{2}$$

where constant values d_i^o, s_i^o have autonomous, i.e. independent of prices, values of demand and, consequently, supply functions; parameters d_i and a_i are elasticities of demand and supply at a price p_i; parameters c_i and b_i are the values of cross-elasticities at prices p_{i-1} and p_{i+1} (prices in adjacent markets).

In some cases the marginal supply function takes the form of:

$$S_1 = a_1 p_1 + b_1 p_2 - s_1^o\,, \tag{2'}$$

or

$$S_N = c_N p_{N-1} + a_N p_N - s_N^o\,. \tag{2"}$$

Using the relations (1), (2), (2') and (2"), it is not difficult to create a system of algebraic equations for finding equilibrium (static) values of the price of goods in each of the markets, i.e., the value $p_1^* p_2^*,\ldots, p_3^*$ provided that $D_i=S_i$, where $i=(\overline{1,N})$.

When creating mathematical models of problems of a non-stationary (dynamic) nature, it is quite common to apply integral equations of the Volterra type, which have a variable integration area [27; 28]. The application of integral equations is a method of mathematical modelling, as a result of which a relationship is established between the known source data and the determined characteristics of the phenomenon under study. Most often, integral equations are used to model physical processes, but recently there has been an expansion of their application not only to other branches of natural science, but also to economic processes and phenomena. It is this mathematical apparatus that the authors chose in order to create a dynamic model of a sequential chain of markets.

The dynamic version of the mathematical model of the system of sequential markets has a slightly different basis compared to the static model, since it is necessary to someway take into account the inertia of price evolution. This can be done using a latency factor, which in time dimension can be either a fixed lag or distributed over all previous time periods. In this study, when creating the model, the second option was chosen, i.e. it is assumed that there is a distributed lateness in a continuous time segment. So, let's assume that the demand at a fixed point in time is equal to the supply over the entire previous period of time:

$$D_i(p_i(t)) = \int_0^t K_i(t,\tau) S_i(p_{i-1}(\tau), p_i(\tau), p_{i+1}(\tau))\,d\tau \text{ for } \ i = \overline{1,N}\,, \tag{3}$$

where $K_i(t,\tau)$ is the function of the two arguments, which is the kernel of the integral equation, characterizes the way the "dynamic memory" about the previous supply values is organised in relation to the fixed point in time for which demand is determined. In general, it is a function describing the system's response to external influence at a certain point in time. Obviously, in order to ensure causality, the time variable for all of these functions must be descending.

The system of integral ratios (3) is the basis for determining the price dynamics in each of the studied markets. For the sake of simplifying this system of functional equations, we will consider that all functions $K_i(t,\tau)$ depend on the difference of their arguments in the same way, i.e.

$$K_i(t,\tau) = K(t-\tau) \text{ for } \ \mathrm{i} = \overline{1,N.} \tag{4}$$

With the assumption (4) considered, the system of equations (3) takes the form:

$$\begin{cases} d_1^o - d_1 p_1(t) = \int_0^t K(t-\tau)\cdot(a_1 p_1(\tau) + b_1 p_2(\tau) - s_1^o)\,d\tau, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ d_i^o - d_i p_i(t) = \int_0^t K(t-\tau)\cdot(c_i p_{i-1}(\tau) + a_i p_i(\tau) + b_i p_{i+1}(\tau) - s_i^o)\,d\tau, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ d_N^o - d_N p_N(t) = \int_0^t K(t-\tau)\cdot(c_N p_{N-1}(\tau) + a_N p_N(\tau) - s_N^o)\,d\tau. \end{cases} \tag{5}$$

The system (5) is a system of linear integral equations of the Volterra equation type. It can be solved by traditional methods of the theory of integral equations [20; 29]. However, this system contains a very large number of parameters, so we will look for other solutions. Let's each equation of the system is divided by its corresponding d_i ($i=(\overline{1,N})$, and we get a system of integral equations with fewer parameters:

$$\begin{cases} \mathrm{p}_d - p_1(t) = \int_0^t K(t-\tau)\cdot(a\cdot p_1(\tau) + b\cdot p_2(\tau) - a\cdot \mathrm{p}_s)\,d\tau, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \mathrm{p}_d - p_i(t) = \int_0^t K(t-\tau)\cdot(c\cdot p_{i-1}(\tau) + a\cdot p_i(\tau) + b\cdot p_{i+1}(\tau) - a\cdot \mathrm{p}_s)\,d\tau, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \mathrm{p}_d - p_N(t) = \int_0^t K(t-\tau)\cdot(c\cdot p_{N-1}(\tau) + a\cdot p_N(\tau) - a\cdot \mathrm{p}_s)\,d\tau. \end{cases} \tag{6}$$

The dynamic aspect of the proposed model is the existence of an "after-effect", which is described in an integral form by a distributed time lag. Thus, if the kernel *K(t-τ)* is not taken into account, the system (6) contains five parameters, namely:

$a = \frac{a_i}{d_i}$ – is relative elasticity of supply as to demand for the *i* market;

$b = \frac{b_i}{d_i}$, $c = \frac{c_i}{d_i}$ – are relative cross (reciprocal) elasticities of supply as to demand in markets that are adjacent to the market under study;

$p_d = \frac{a_i^o}{d_i}$ – is price at "zero" demand;

$p_s = \frac{s_i^o}{a_i}$ – is price at "zero" supply.

According to the scheme of formation of "Demand and Supply" market equilibrium by Walras (Fig. 3) prices at zero demand and zero supply are defined as the points of intersection of the graphs of the corresponding functions with the axis of ordinates.

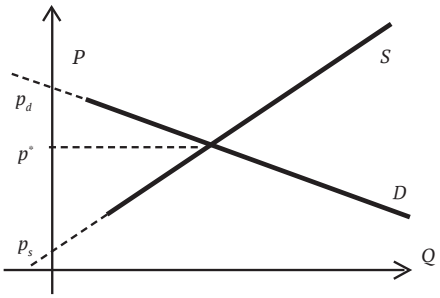

Figure 3. Market equilibrium model by Walras

It should be noted that this well-known scheme is generally given to illustrate the concept of an equilibrium point itself as a point of intersection of graphs of functions describing supply and demand. In this article, the scheme is necessary for a clear explanation of the concepts of zero demand and zero supply which are considered when creating a mathematical model of market dynamics. Given that the right-hand part of each of the equations in the system (6) is an integral convolution, it is advisable to apply the integral Laplace transform to this system:

$$p_i(\lambda) = \int_0^\infty e^{-\lambda t} p_i(t)dt \text{ for } \quad i = \overline{1,N}. \tag{7}$$

As a result, the system of linear algebraic equations relative to $p_i(\lambda)$ acquires such a view:

$$\begin{pmatrix} 1+aK(\lambda) & bK(\lambda) & \dots & 0 & 0 & 0 & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & cK(\lambda) & 1+aK(\lambda) & bK(\lambda) & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & 0 & 0 & 0 & \dots & cK(\lambda) & 1+aK(\lambda) \end{pmatrix} \begin{pmatrix} p_1(\lambda) \\ \dots \\ p_i(\lambda) \\ \dots \\ p_N(\lambda) \end{pmatrix} = \begin{pmatrix} \frac{p_d+a\cdot p_s K(\lambda)}{\lambda} \\ \dots \\ \frac{p_d+a\cdot p_s K(\lambda)}{\lambda} \\ \dots \\ \frac{p_d+a\cdot p_s K(\lambda)}{\lambda} \end{pmatrix}, \tag{8}$$

where $K(\lambda)$ is a fractional rational function of the parameter λ. For example, if the kernel is recorded as $K(t-\tau) = exp\left(-\frac{t-\tau}{T}\right)$, then $K(\lambda) = \frac{1}{T\lambda+1}$, where T is a certain constant characteristic of time, namely the parameter that determines lateness. This parameter is distributed by the exponential law from 0 to t. Dividing each equation of the system (8) by the value $K(\lambda)$, we obtain a new system of linear algebraic equations which can be presented in matrix form:

$$\Phi(\lambda) \cdot \mathrm{P}(\lambda) = F(\lambda) \tag{9}$$

where

$$\Phi(\lambda) = \begin{pmatrix} a_0(\lambda) & b & 0 & \dots & 0 & 0 \\ c & a_0(\lambda) & b & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & c & a_0(\lambda) \end{pmatrix}; \mathrm{P}(\lambda) = \begin{pmatrix} \mathrm{p}_1(\lambda) \\ \mathrm{p}_2(\lambda) \\ \dots \\ \mathrm{p}_N(\lambda) \end{pmatrix}; F(\lambda) = \frac{\mathrm{p}_d \cdot K^{-1}(\lambda) + a \cdot \mathrm{p}_s}{\lambda} \begin{pmatrix} 1 \\ 1 \\ \dots \\ 1 \end{pmatrix},$$

accordingly,

$$a_0(\lambda) = K^{-1}(\lambda) + a.$$

The matrix equation (9) will have the following solution:

$$\mathrm{P}(\lambda) = \Phi^{-1}(\lambda) \cdot F(\lambda), \tag{10}$$

if there is an inverted matrix $\Phi^{-1}(\lambda)$ for the matrix $\Phi(\lambda)$. Thus, it is necessary to check whether the determinant of the matrix $\Phi(\lambda)$ is different from 0. It should be noted that the matrix $\Phi(\lambda)$ is a tridiagonal matrix or Jacobi matrix [30, p.34]. There is a recurrent ratio with the corresponding initial conditions for calculating the determinant of such matrix:

$$\Delta_N(\lambda) = a_0(\lambda) \cdot \Delta_{N-1}(\lambda) - bc \cdot \Delta_{N-2}(\lambda). \tag{11}$$

Upon converting it, we get the formula:

$$\Delta_N = \frac{\left(a_0+\sqrt{a_0^2-4bc}\right)^{N+1} - \left(a_0-\sqrt{a_0^2-4bc}\right)^{N-1}}{2^{N+1}\cdot\sqrt{a_0^2-4bc}}. \tag{12}$$

Let's determine under what conditions the matrix $\Phi(\lambda)$ becomes degenerate, since in this case the matrix equation (9) will not have a solution. To do this, we need to solve the following equation $\Delta_N(\lambda)=0$. Therefore, from the formula (12) we obtain

$$\left(\frac{a_0+\sqrt{a_0^2-4bc}}{2\sqrt{bc}}\right)^{2(N+1)} = 1. \tag{13}$$

Given that $a_0(\lambda)=K^{-1}(\lambda)+a$, this means that:

$$\frac{K^{-1}(\lambda)+a}{2\cdot\sqrt{bc}} = \sqrt[2(N+1)]{1}, \text{ or } K^{-1}(\lambda)+a = 2\sqrt{bc}\cdot cos\frac{\pi m}{N+1} \text{ for } \quad m=\overline{0,N}. \tag{14}$$

In the case where $K(\lambda)=\frac{1}{T\lambda+1}$ there is a relationship:

$$T\lambda_m + 1 + a = 2\sqrt{bc}\cdot cos\frac{\pi m}{N+1} \text{ for } m=\overline{0,N}. \tag{14'}$$

Hence you can find that:

$$\lambda_m = \frac{1}{\mathrm{T}}\cdot\left(-1-\mathrm{a}+2\sqrt{bc}\cdot cos\frac{\pi m}{N+1}\right) \text{ for } m=\overline{0,N}. \tag{15}$$

Thus, to ensure the fulfillment of the stability conditions for the system (9), i.e. the existence of its solution (10), it is necessary and sufficient that the following condition is met: $\lambda_m<0$. Therefore, as follows from the ratio (15), it is necessary to solve the inequality:

$$1+\mathrm{a} > 2\sqrt{bc}. \tag{16}$$

Taking into account the meaning of the parameters, the condition (16) acquires this economic interpretation. In order for the system of algebraic linear equations (9) relative to the price of a particular product in each of the sequential markets in the market vertical to have a stable solution, the following condition must be met: the arithmetic mean of the elasticities of demand and supply for each of the markets must be greater than the geometric mean of the cross-elasticities of supply in their adjacent markets.

Let's consider how this mathematical model is implemented on the example of a small number of sequential markets. Further we will examine the sequential chain of markets, for which the markets adjacent to the studied one are symmetrical, i.e. $b=c$ as well as $K(\lambda)=\frac{1}{T\lambda+1}$ and, respectively, $a_0(\lambda)=K^{-1}(\lambda)+a$.

Example 1 (analytical model). Let there be only two sequential markets, i.e. $N=2$. In this case the system of linear algebraic equations in matrix form (9) is recorded as follows:

$$\begin{pmatrix} a_0(\lambda) & b \\ b & a_0(\lambda)\end{pmatrix}\cdot\begin{pmatrix}\mathrm{p}_1(\lambda)\\ p_2(\lambda)\end{pmatrix} = \frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda}\cdot\begin{pmatrix}1\\1\end{pmatrix}. \tag{17}$$

Therefore, you can write down the solution of the system of equations (17) in matrix form:

$$\begin{pmatrix}p_1(\lambda)\\ p_2(\lambda)\end{pmatrix} = \frac{1}{a_0^2(\lambda)-b^2}\begin{pmatrix} a_0(\lambda) & -b \\ -b & a_0(\lambda)\end{pmatrix}\cdot\frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda}\cdot\begin{pmatrix}1\\1\end{pmatrix}. \tag{18}$$

It follows from the ratio (18) that:

$$p_1(\lambda) = p_2(\lambda) = \frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda\cdot(a_0(\lambda)+b)} = \frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda\cdot(T\lambda+1+a+b)}, \tag{19}$$

or

$$p_1(\lambda) = p_2(\lambda) = \frac{p_d+a\cdot p_s}{\lambda\cdot(1+a+b)} + \frac{(a+b)\cdot p_d - a\cdot p_s}{(1+a+b)\cdot(\lambda+(1+a+b)/T)}. \tag{20}$$

Using the inverted Laplace transform, we obtain a formula that determines the change in the transitional market price over time:

$$P_1(t) = P_2(t) = p_{1,2}^* + \frac{(a+b)\cdot p_d - a\cdot p_s}{(1+a+b)}\cdot exp\left(-\frac{1+a+b}{T}\cdot t\right), \tag{21}$$

where $p_{1,2}^*$ is the equilibrium price for each of the markets.

This price is determined by the ratio between the price at "zero" demand, the price at "zero" supply for this market and elasticities in this market and the ones adjacent to it:

$$p_{1,2}^* = \frac{p_d+a\cdot p_s}{1+a+b}. \tag{22}$$

Example 2 (analytical model). Let there be three sequential markets, i.e. $N=3$. In this case, the system of linear algebraic equations in matrix (9) is recorded as follows:

$$\begin{pmatrix}p_1(\lambda)\\ p_2(\lambda)\\ p_3(\lambda)\end{pmatrix} = \frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda\cdot a_0(\lambda)\cdot(a_0^2(\lambda)-2b^2)}\cdot\begin{pmatrix} a_0^2(\lambda)-b^2 & -a_0(\lambda)\cdot b & b^2 \\ -a_0(\lambda)\cdot b & a_0^2(\lambda) & -a_0(\lambda)\cdot b \\ b^2 & -a_0(\lambda)\cdot b & a_0^2(\lambda)-b^2\end{pmatrix}\cdot\begin{pmatrix}1\\1\\1\end{pmatrix}. \tag{23}$$

Therefore, the solution to the system of equations (23) can be written as follows:

$$\begin{pmatrix}p_1(\lambda)\\ p_2(\lambda)\\ p_3(\lambda)\end{pmatrix} = \frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda\cdot a_0(\lambda)\cdot(a_0^2(\lambda)-2b^2)}\cdot\begin{pmatrix} a_0^2(\lambda)-b^2 & -a_0(\lambda)\cdot b & b^2 \\ -a_0(\lambda)\cdot b & a_0^2(\lambda) & -a_0(\lambda)\cdot b \\ b^2 & -a_0(\lambda)\cdot b & a_0^2(\lambda)-b^2\end{pmatrix}\cdot\begin{pmatrix}1\\1\\1\end{pmatrix}. \tag{24}$$

After the necessary transformations we get the ratio to determine the price in each of the markets:

$$p_{1,3}(\lambda) = \frac{a_0(\lambda)-b}{a_0^2(\lambda)-2b^2}\cdot\frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda} \tag{25}$$

$$p_2(\lambda) = \frac{a_0(\lambda)-2b}{a_0^2(\lambda)-2b^2}\cdot\frac{p_d\cdot(T\lambda+1)+a\cdot p_s}{\lambda}. \tag{26}$$

From (25) and (26) we find equilibrium prices for each of the markets:

$$p_{1,3}^* = \frac{1+a-b}{(1+a)^2-2b^2}\cdot(p_d+a\cdot p_s); \tag{27}$$

$$p_2^* = \frac{1+a-2b}{(1+a)^2-2b^2}\cdot(p_d+a\cdot p_s), \tag{28}$$

and the ratios defining transition regime prices for the first and third markets:

$$P_{1,3}(t) = p_{1,3}^* + \mathrm{A}_1\cdot exp\left(\frac{-1-a+b\sqrt{2}}{T}\cdot t\right) + \mathrm{A}_2\cdot exp\left(\frac{-1-a-b\sqrt{2}}{T}\cdot t\right),$$

where:

$$A_1 = \frac{(1+(\sqrt{2}-1)\cdot b)\cdot p_d + a\cdot p_s - (1+a+b\sqrt{2})\cdot p^*_{1,3}}{2\sqrt{2}\cdot b};$$
$$A_2 = \frac{((\sqrt{2}+1)\cdot b-1)\cdot p_d - a\cdot p_s + (1+a-b\sqrt{2})\cdot p^*_{1,3}}{2\sqrt{2}\cdot b}, \quad (29)$$

as well as for the transition price in the second market:

$$P_2(t) = p^*_2 + D_1 \cdot exp\left(\frac{-1-a+b\sqrt{2}}{T}\cdot t\right) + D_2 \cdot exp\left(\frac{-1-a-b\sqrt{2}}{T}\cdot t\right)$$

where

$$D_1 = \frac{(1+(\sqrt{2}-2)\cdot b)\cdot p_d + a\cdot p_s - (1+a+b\sqrt{2})\cdot p^*_2}{2\sqrt{2}\cdot b};$$
$$D_2 = \frac{((\sqrt{2}+2)\cdot b-1)\cdot p_d - a\cdot p_s + (1+a-b\sqrt{2})\cdot p^*_2}{2\sqrt{2}\cdot b}. \quad (30)$$

Note that in the general case for the systems (9) and (10) there are analytical solutions that are based on the explicit form of the inverted matrix $\Phi^{-1}(\lambda)$. Its elements take the form of Chebyshov polynomials of the second kind [31; 32], but this issue lies beyond the scope of this work. Based on the analytical models given in Examples 1 and 2, we will analyze the impact of the elasticities of supply and demand functions on the magnitude of equilibrium prices and the dynamics of changes in transition market price for the case of two and three sequential markets using simulation modelling.

Example 1 (results of simulation modelling). When calculating the analytical model for two sequential markets, the following values of the system parameters were adopted, namely: for both markets, the price at zero demand was taken as 100 percent and amounted to p_d=100 conventional units, and the price at zero supply was 10 percent of the price of zero demand, i.e. p_s=0.1·p_d=10 conventional units. Let us remind that the change in transitional market prices over time for both the first and second markets is described by the same ratio (21). Figure 4 shows the results of the study of the impact of "demand-supply" elasticities that occur in the market under study (Fig. 4a) and in the adjacent market (Fig. 4b) on the dynamics of changes in transitional prices.

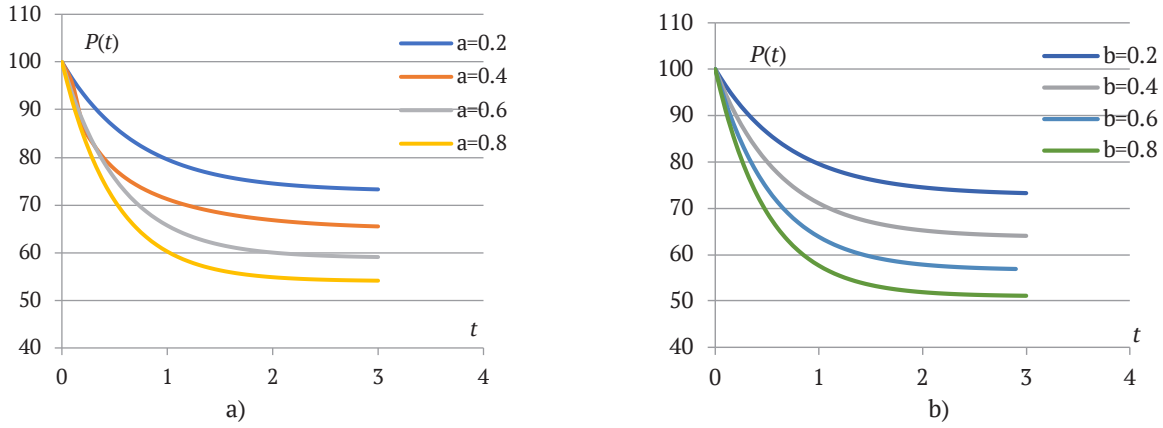

Figure 4. Dynamics of transition prices in two adjacent markets depending "demand-supply" elasticities in the market under study (a) and in the adjacent market (b)

As can be seen in Figure 4, the transitional prices in both the first and second markets decrease monotonically over time. This result is not unexpected since the ratio (21) contains an exponent. It should be noted that although the growth of elasticity "demand-supply" both in the market itself, for which the study is conducted, and cross-elasticity accelerate the price reduction, they do not noticeably affect the speed of reaching the equilibrium price.

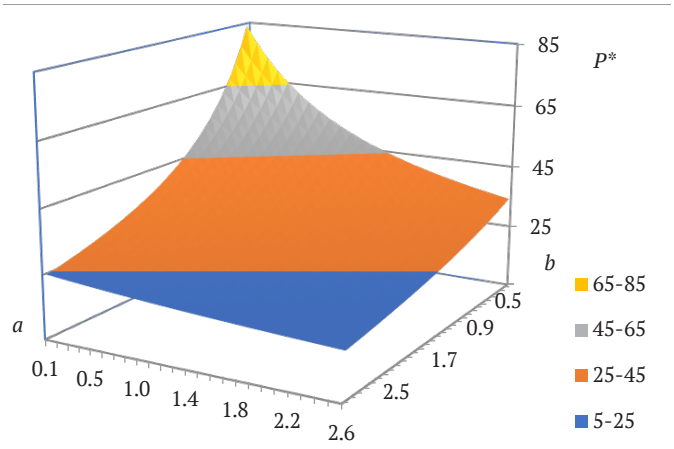

Figure 5. Equilibrium price as a function of elasticities in two adjacent markets

This can be explained by the fact that with increasing elasticity the value of the equilibrium price in each of the markets significantly decreases. Thus, Figure 5 presents a diagram showing the changes in equilibrium prices in the chain of adjacent markets with a simultaneous change in elasticities both in the market under study and in cross-elasticities.

The features described above are inherent in both inelastic and elastic markets. It is also interesting to note that for the case of two sequential markets it was found that the violation of condition (16) does not affect the results of the calculations in any way.

Example 2 (results of simulation modelling). In order to compare the results of calculations, when calculating the analytical model for three sequential markets the same values of the system parameters were adopted, namely: the price at zero demand was p_d=100 conventional units, and the price at zero supply was equal to p_s=0.1·p_d=10 conventional units. Let us remind that the change in transitional market prices over time for the first and third markets is described by the same ratio (29), while for the second market the change in transitional market prices over time is described by the ratio (30).

Let's consider the dynamics of transition prices in each of the three markets, depending on the elasticities in the market under study and cross-elasticities. Unlike with the sequence of two markets, the change in transitional prices is not monotonous for a chain of three markets. With certain elasticities, the price reaches the minimum value in a short time, and then it increases slightly and reaches the equilibrium value. As an example, Table 1 shows the results of calculations of such characteristics as the equilibrium price in each of the three markets, the lowest value of the price ($min\ p_{1,3}$ and $min\ p_2$) that it achieves throughout the duration of the study (50 conventional units), the time period corresponding to the attainment of this minimum value $t(p=min\ p_{1,3})$ and $t(p=min\ p_2)$ depending on the elasticity in the market under study, provided that the cross elasticities are constant and equal b=0.3.

Table 1. Characteristics of price dynamics in three sequential markets

a	0.2	0.4	0.6	0.8	1.0	1.2	1.4
$p^*_{1,3}$	72.86	64.27	57.90	52.94	48.95	45.67	42.90
p^*_2	48-57.	46.74	44,54	42.35	40.31	38.45	36.77
$min\ p_{1,3}$	72.65	64.27	57.90	52.94	48.95	45.67	42.90
$min\ p_2$	48-57.	46.74	44.53	42.34	40-30	38.44	36.77
$t(p=min\ p_{1,3})$	3.2	5.0	18.8	15.8	11.6	12.0	10.4
$t(p=min\ p_2)$	27.8	21.6	4.6	3.6	3.2	3.0	3.0

As shown in Table 1, for the given conditions the equilibrium prices in all three markets decrease monotonically with an increase in the relative elasticity of supply as to the demand in the market under study. For the first and third markets, this trend was observed at almost any ratio of elasticities in adjacent markets (Fig. 6a), since at low values of the parameter b, the growth of the parameter a ensured the fulfillment of the condition (16). Violation of this condition occurred only when combining small values of the parameter a with large values of the parameter b. For the second market, a monotonic decrease in the equilibrium price was found only at small values of cross-elasticities when the condition (16) was not violated. At large values of the parameter b there was initially a slight increase in the equilibrium price, which was then followed by its monotonic decrease (Fig. 6b);

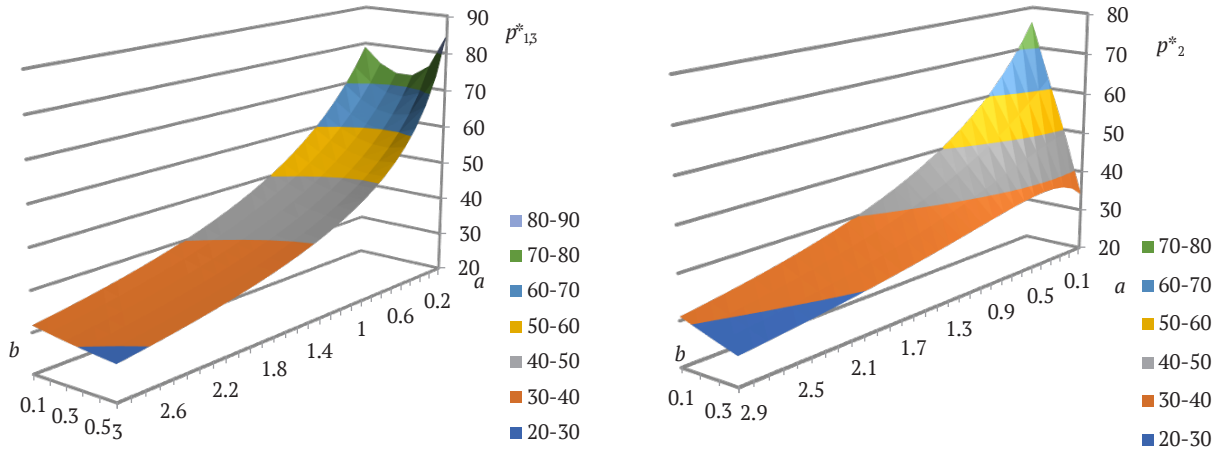

Figure 6. Equilibrium price depending on the elasticities for the first and third (a) and for the second market (b) in three adjacent markets

Let's note another feature of pricing, which is illustrated by the data given in the four bottom lines of Table 1, i.e. the process of establishing an equilibrium price is not monotonous in time. It was found that with certain a and *b* parameter ratios and the "transition price-time" function reaches a minimum value in a sufficiently short period of time and then it reaches an equilibrium value. Thus, when the *a*=0.2 difference between the lowest price and the equilibrium price for the first and third markets is 0.29% of the equilibrium price, whereas for the second market the transition price changes monotonically over time and its minimum value is equal to the equilibrium price. Conversely, at *a*=0.6 (and more) transition prices in the first and third markets change monotonically. In the second market, the minimum price is observed at *t*=4.6, then the price rises to an equilibrium value. Under these conditions, the difference between the lowest price and the equilibrium price for the second market is only 0.01% of the equilibrium price. But this difference grows with the increase in elasticity in the market under study and at *a*=0.9 it already reaches 0.03% of the equilibrium price. We should also note that the time period, during which the transition price becomes equal to the equilibrium price, decreases with increasing elasticity. This is observed for all links of the chain of three markets, although the equilibrium in the second market is reached in a shorter period of time than in the first or third ones.

It should be noted that the results in Table 1 are only one example of the impact of elasticities of "demand-supply" curves on price dynamics. Similar calculations within the scope of this work were carried out for other elasticity ratios both in the market under study and for cross-elasticities as well as for other values of marginal prices.

Let's compare the obtained results with the findings of other researchers. As noted in the literature review, the problem of equilibrium in the system of "demand-supply" is multifaceted and has a very large number of research areas. As a rule, they consider the interaction of two actors in the horizontal market [33; 34]. This is due to the fact that the interaction of actors in the vertical market is considered more complex [35]. Game theory [36] and differential calculus [37] are most often used as a mathematical apparatus for modeling. In this study, we propose a general model of the sequence of N-dimensional vertical markets, which takes into account the effect of time-distributed lateness, i.e. when present demand is affected by supply in the past. Unlike other models, this model of economic dynamics is a system of integral equations. The same distributed lateness was investigated in the paper [38], but on the example of a specific market – the labor market. Just like in our study, the results of simulation modelling also confirmed the existence of two points of equilibrium for the labor market. Similar results regarding the existence of attractors were also obtained using simulation modelling in the research [38]. Thus, although research in this direction is quite active, however, compared to the model proposed in this paper, it is devoted to partial issues with a limited number of participants. Yet, upon considering these issues, the obtained results coincide with those obtained for the general model of economic dynamics proposed in this paper.

CONCLUSIONS

The results of analytical research and simulation modelling have shown that the mathematical model proposed in this paper adequately describes the dynamics of pricing for a system of sequential markets and gives the opportunity to determine the dependence of this process on a set of parameters that characterize demand and supply in each of the markets. The dynamic aspect of the proposed model is the existence of an "after-effect", which is described in an integral form by a distributed time lag. At the first stage, we recorded the initial mathematical model of sequentially connected markets as a system of Volterra integral equations. This model than was subsequently transformed into a system of linear algebraic equations using the Laplace integral transform in order to determine the price in each of the markets at each time point. The existence of a tridiagonal Jacobi matrix is specific to the resulting system of linear algebraic equations, which makes it possible to find analytical solutions. Moreover, the conditions for the stability of analytical solutions in the vicinity of the equilibrium state of the system of sequentially connected markets were formulated on the basis of these equations. The application of simulation modelling for systems consisting of two and three sequential markets allowed us to identify which processes occur when the stability condition is violated.

The results of calculations by the proposed analytical model give scope for additional research. The authors envisage further development of this model in the study of the impact of parameters characterizing demand and supply in each of the markets on the dynamics of pricing for four or more sequentially connected markets and in a more detailed analysis of the processes that are observed when the conditions of solution stability are violated.

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Динаміка формування перехідних цін на ланцюгу послідовних ринків: аналітична модель

Анотація. Хоча проблема формування ринкових цін, визначення рівноважних цін в межах моделі «Попит - пропозиція» є достатньо відомою, і її дослідженню присвячено чимало як теоретичних робіт, так і робіт, в яких узагальнюються результати спостережень, ця проблема залишається актуальною, особливо в тій її частині, що стосується динаміки процесів ціноутворення і стійкості рівноважних цін відносно зміни параметрів, що характеризують стан системи. У більшості досліджень, що присвячені цим питанням, основна увага приділяється або певному локальному ринку, або глобальному ринку деякої продукції в цілому. Метою даної роботи є побудова математичної моделі, яка б дозволяла у загальному вигляді здійснювати аналіз питань, що пов'язані з формуванням перехідних цін на скінченому *N*-мірному ланцюгу послідовних ринків згідно зі схемою ринкової рівноваги. Запропоновано аналітичну модель, що дозволяє досліджувати динаміку цін на суміжних ринках. У межах цієї моделі, що базується на визначенні процесів за допомогою системи інтегральних рівнянь, передбачалось, що вплив на ланцюг послідовних ринків і реакція на цей вплив є неперервними у часі. Динамічний аспект запропонованої моделі ціноутворення на вертикальній послідовності ринків полягає в існуванні «ефекту післядії», який в інтегральній формі описується запізненням, розподіленим у часі. Розглянуті питання адекватності моделі, проведено дослідження її внутрішньої узгодженості, обґрунтована коректність переходу від математичної моделі динаміки як системи інтегральних рівнянь до моделі у формі системи лінійних алгебраїчних рівнянь. Сформульовані умови існування розв'язку цієї системи рівнянь і визначена область його стійкості. Математична модель, що запропонована у даній роботі, дозволяє здійснювати якісний аналіз станів системи (за фазовими траєкторіями). Наведено приклади чисельної реалізації отриманої аналітичної моделі для випадку двох і трьох послідовних ринків, визначені рівноважні ціни для кожної ланки ланцюга послідовних ринків. За допомогою імітаційного моделювання досліджувалась стійкість розв'язку відносно зміни таких параметрів моделі, як еластичності попиту і пропозиції на ринку, що досліджується, і перехресних еластичностей на суміжних з ним ринках, а також вплив цих параметрів на такі динамічні показники ринкової системи, як швидкість досягнення рівноваги

Ключові слова: ринкова вертикаль, ціноутворення, фазові траєкторії, інтегральні рівняння Вольтерра, адекватність моделі, імітаційне моделювання, еластичності попиту і пропозиції

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Technology of Determining Motivation Reserves for Management Staff

Abstract. In modern crisis conditions, the development and implementation of a mechanism for motivating management staff at enterprise faces a number of complications, the main of which is the lack of financial resources. The purpose of the article is to develop a technology for determining the reserves of motivational influence on the management staff of the enterprise. To achieve this goal, the following methods of scientific research were used: generalization, comparison, analysis and synthesis, the method of expert assessments, the questionnaire method, factor analysis, ranking and the graphic method. Therefore, in order to reduce costs and ensure effective motivation of management staff, it is proposed to identify reserves of motivational influence using the developed technology, which includes methods of factor analysis (identification of latent factors influencing work behavior), assessment of the level of job satisfaction (identification of positions that lag behind the standard) and ranking (arrangement of reserves by degree of influence). The list of motivation factors includes 16 indicators: organizational structuring of work; professional development, acquisition of new knowledge and skills; working conditions; financial incentive (salary and bonuses); power and influence; nature of relations with colleagues; the possibility of success at work; the possibility of career growth; the opportunity to be informed about the company's affairs, to take part in the resolution of cases; recognition and approval of work results; high level of responsibility; the possibility of creative and personal growth; confidence in the future, guarantee of employment, stability; the nature of the relationship with management; level of work control; transparent assessment of work. The application of the proposed technology at PJSC "Kharkivenergozbut" confirmed the possibility and necessity of its use for determining reserves of motivational influence, and therefore, reducing motivation costs, forming an effective mechanism for motivating management staff

Keywords: motivation research, job satisfaction, motivation factors, expert survey

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INTRODUCTION

Numerous studies [1-3] show that Ukrainian enterprises in the energy sector need a significant reform of the staff motivation mechanism. The relevance and urgency of this problem is confirmed by the low level of achievement of economic and social goals of both enterprises and employees. The mechanism of motivation is a complex system, the intervention of which must be substantiated, the effectiveness of the methods must be proven by applied research. It is especially important to properly motivate management staff – managers, employees of the management apparatus, specialists of structural divisions that ensure the smooth functioning and development of enterprises and organizations. A significant obstacle in solving the problem of motivation is also the fact that most Ukrainian enterprises today have financial problems and are not ready to spend money on motivation. Such a situation is a closed circle, because without managers and specialists who will be interested in the effective functioning of the enterprise in which they work, the enterprise is doomed. Therefore, it is necessary to look for the most important factors of motivation and apply them in the practical activities of staff management.

Recent studies and publications show that motivation does not lose its relevance even now. Many studies raise the issue of determining the essence and improvement of motivation in various organizations and enterprises. Among them, it is possible to note the publications of

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J. Breaugh, A. Ritz, K. Alfes, which study the peculiarities of the motivation of public service [4]; A. Sarandi, L. Kibalnyk, N. Zachosova, who investigate the theoretical aspects of staff motivation management, and the place of motivation in the system of staff policy and staff security [5]; Z.V. Smirnova, O.I. Vaganova, S. Sirotyk, who propose measures to improve the motivation system of service enterprises [6]; I.N. Sycheva, O.Yu. Voronkova, I.V. Kovaleva et al., who analyze the theoretical foundations of the motivation staff of trade enterprises [7].

Researchers also pay considerable attention to motivation factors. L.D. Garmider and L.A. Gonchar list the motivational factors of the productivity of the company's staff and analyze them [8]. Sh. Ritchie and P. Martin suggest managing motivation using 12 motivation factors [9]. J. Taylor, G. Brewer, G. Ripoll, analyzing the motivation of public service, single out four factors of motivation: public-service orientation, legitimacy, merit and support [10]. Some authors offer practical recommendations for creating a motivation system and a staff reward system [11-13].

The conducted analysis allows us to state that there are insufficiently studied and unresolved issues of employee motivation that require further scientific research. Thus, more attention should be paid to the motivation of management staff, whose role in modern conditions has grown significantly. There are practical problems regarding the determination of the most significant factors of motivation, because in order to ensure that funds for motivation are not spent in vain, it is necessary to implement only those methods and means that will be oriented towards meeting the most urgent needs of management staff. That is, it is necessary to determine the reserves of motivational influence on this category of employees.

The purpose of the study is to develop a technology for determining the reserves of motivational influence on the management staff of the enterprise.

MATERIALS AND METHODS

Since motivation is a complex system, which is described mainly by qualitative characteristics, it is proposed to obtain the information necessary for the determination of reserves using the method of expert assessments. This method is a method of obtaining the information, needed by the researcher, from experts, that is, the people who are specialists (professionals) in the field of knowledge, and further processing of this data. According to numerous studies on the application of the method of expert assessments in management [14-16], experts largely compensate for the lack of quantitative information about system elements. And, in addition, their use provides an opportunity:

– carry out an analysis of complex systems, which are mainly characterized by qualitative, informal processes, situations, phenomena;

– carry out an a priori determination and ranking of the most significant factors, that describe the behavior of the system, in relation to the given criterion;

– establish the optimal composition of information that is needed for effective management of objects, including development and decision-making;

– reveal additional subjective information in case of impossibility or difficulty of obtaining objective information;

– increase the effectiveness of mathematical methods by increasing the accuracy of the definition and assessment of qualitative aspects that are inherent in these methods;

– increase the reliability of target functions, which are quantitative or qualitative in nature, by averaging the opinions of highly qualified specialists;

– set initial conditions a priori and quickly adjust them in management systems

In this study it is proposed to use the expert survey scheme proposed in the work [17]. The author proposes the following stages of an expert survey: selection of experts, carrying out of the expert survey procedure, processing of the obtained results. a representative sample of experts

When organizing the survey, care should be taken to form a representative selective group of experts. Their number can be determined in formal or informal ways. Determining the required number of experts in a formal way involves the use of special formulas. In addition to this method, the number of experts is proposed to be chosen arbitrarily from 10 to 20 people, although in some cases their certain increase or decrease is allowed [18].

In this study it is proposed to apply a formal method, determine the number of experts according to the Bernoulli formula [17, p. 219]. Based on this calculation, a sufficient number of experts was determined – 10 people. Since there are methods that allow to determine the number of the expert group with sufficient certainty, the researchers emphasize that all efforts should be spent not on increasing the number of experts, but on staffing the expert group with the most qualified experts. Motivation as an object of research has a number of features, among which the most significant is that it is a component of the employee's personality, and therefore the management staff themselves should act as experts.

The form of obtaining information from experts is a survey. The survey method involves obtaining information in a situation of social and psychological communication. In order to avoid conformity and reduce resource costs (time, human, and financial), a written survey (questionnaire) was conducted. The authors developed a questionnaire that contains a list of questions, ordered by content and form, related to the importance of various motivational factors for staff and their level of satisfaction at the enterprise. It was distributed among managers, employees of the management apparatus and specialists of the divisions of PrJSC "Kharkivenergozbut" (4 women, 6 men). The survey was conducted in December 2021.

The results of the survey were processed by the method of factor analysis using the package of statistical processing of information "STATISTICA", version 10.0. It is proposed to determine the possibilities of motivational influence (reserves) in the sequence shown in Figure 1.

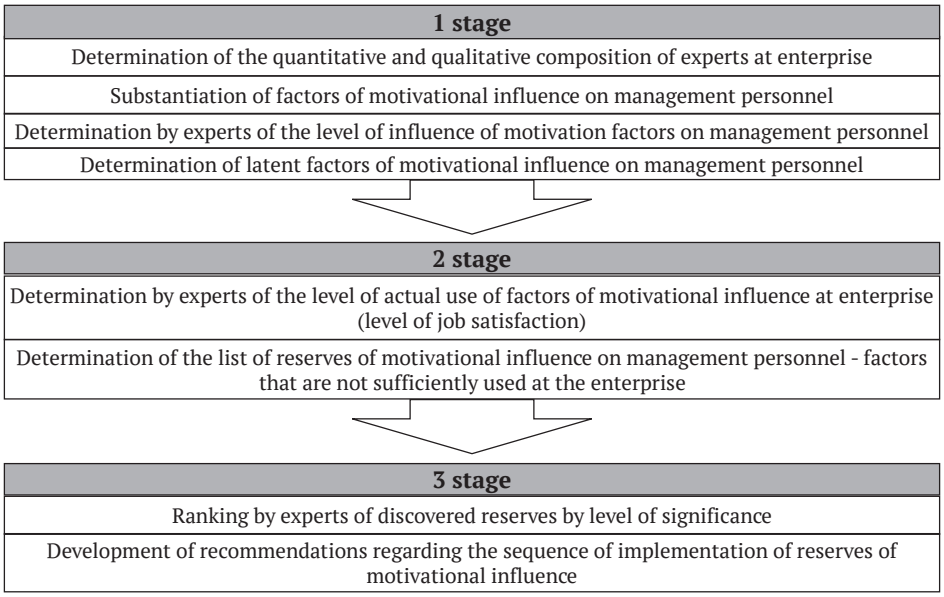

Figure 1. Technology for determining motivation reserves of management staff

The sequential implementation of technology stages (Fig. 1), each of which contains a number of procedures, ensures the achievement of the goal – determination of reserves of motivational influence in the most rational way. Approbation of the proposed technology was carried out on the example of PrJSC "Kharkivenergozbut".

The assessment of the motivational situation at the enterprise under study is carried out by the method of factor analysis, which helps to assess the loading of factors on each characteristic of motivation.

RESULTS AND DISCUSSIONS

The analysis of works devoted to the study of motivation shows that among researchers there is no unified approach to understanding the factors of motivational influence [8; 9; 11]. The classification of motivation factors by Sh. Ritchie and P. Martin is considered to be the most successful and the one that corresponds to modern realities [9]. However it is believed that for employees of Ukrainian enterprises, especially those who hold management positions, these factors alone are not enough, therefore, a more extended list of 16 indicators is proposed: F1 – organizational structuring of work; F2 – professional development, acquisition of new knowledge and skills; F3 – working conditions; F4 – material incentive (salary and bonuses); F5 – power and influence; F6 – nature of relations with colleagues; F7 – the possibility of success at work; F8 – the possibility of career growth; F9 – the opportunity to be informed about the company's affairs, participate in solving cases; F10 – recognition and approval of work results; F11 – high level of responsibility; F12 – the possibility of creative and personal growth; F13 – confidence in the future, guarantee of employment, stability; F14 – the nature of the relationship with management; F15 – work control level; F16 – transparent assessment of work (Fig. 2).

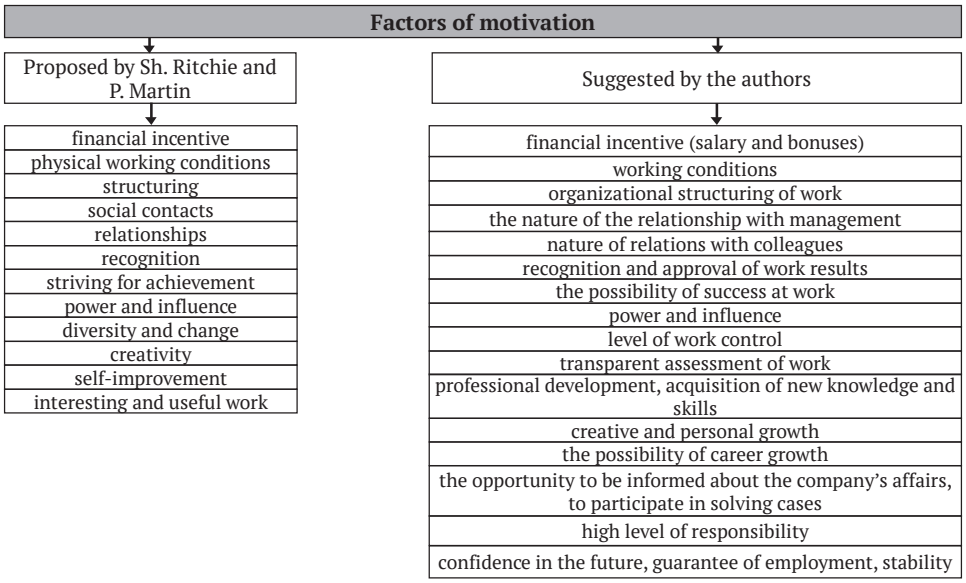

Figure 2. Comparison of the motivation factors of Sh. Ritchie, P. Martin and the author's list

The motivation factors that stood out at the enterprise have a special set of characteristics for top and middle managers and specialists of the enterprise's structural units.

According to the results of the survey of managers, 3 factors of motivational influence were distinguished with a dispersion of 38.64; 26.2; 12.4 (Table 1).

Table 1. Loading characteristics of the indicators according to the results of the survey of the managers of PJSC "Kharkivenergozbut"

Factors	Dispersion, %	Indicator code	Load
Factor 1	38.6	F4	0.790144
		F10	0.791152
		F11	0.825852
		F12	0.943176
		F15	0.825852
		F16	0.791152
Factor 2	26.2	F5	0.930064
		F6	0.830531
		F14	0.930064
Factor 3	12.4	F1	0.781703
		F2	0.933438

The most significant is the first factor, which describes 38.6% of the variance. It included the following characteristics: material incentive (salary and bonuses), recognition and approval of work results, high level of responsibility, creative and personal growth, level of control over work, transparent evaluation of work. This allows us to interpret it as a component of achievement in work.

The second factor, the level of dispersion of which is 26.2%, includes indicators: management style, nature of relations with colleagues, nature of relations with management. The structure of this factor allows us to define it as social interaction. The third factor includes indicators: organizational structuring of work, professional development, acquisition of new knowledge and skills. This allows us to interpret it as an intellectual component of motivational influence. As a result of data processing based on the results of a survey of specialists, three factors with a variance of 30.7 were identified; 26.6; 15.6 (Table 2).

Table 2. Load characteristics of indicators according to the results of a survey of specialists of PJSC "Kharkivenergozbut"

Factors	Dispersion, %	Indicator Code	Load
Factor 1	30.7	F4	0.712196
		F5	0.942650
		F6	0.900705
		F14	0.942650
Factor 2	26.6	F10	0.934909
		F11	0.952253
		F15	0.952253
		F16	0.934909
Factor 3	15.6	F1	-0.701765
		F12	0.959017

The first factor is the most influential (explains 30.7% of the total dispersion) and includes the following indicators: salary, management style, nature of relations with colleagues, nature of relations with management. It can be seen that basis of this factor is social indicators, so it can be interpreted as a component of social functioning and consumption.

The second factor reflects managers' desire for justice and includes indicators: recognition and approval of work results, high level of responsibility, level of control over work, transparent assessment of work.

The third factor includes such indicators as organizational structuring of work and the possibility of creative and personal growth, which allows us to interpret it as a component of growth. It should be noted that these characteristics have opposite effects and they cannot be implemented simultaneously, especially for creativity, which is difficult to tie to a certain schedule and order.

In order for the managers to fully realize their creativity, ability to generate new ideas, find new solutions, it is necessary to implement a more flexible work schedule for such employees, provide freedom of action and the opportunity to acquire new knowledge, acquire new skills and develop personal qualities.

The use of all significant factors of motivation of management staff is an ideal option for influencing the work behavior of this category of staff, but in modern conditions, most engineering enterprises have financial difficulties and are unable to implement it. On the other hand,

ensuring the effective motivation of management staff is an urgent necessity, because only high-quality performance of management functions can lead the enterprise to a new stage of development.

To resolve this contradiction, it is proposed to determine the level of satisfaction with the use of factors of motivational influence at each enterprise. This will allow us to reduce the enterprise's costs for motivation due to the implementation of only those factors that are not sufficiently used at enterprise. To determine the level of use of factors of motivational influence, a program is proposed to assess the level of job satisfaction based on the indicators determined at the first stage.

The importance of job satisfaction in the context of motivation is mentioned in works [4; 19]. The measure of job satisfaction is a subjective assessment by employees of the fulfillment of their requirements regarding the content, character, and working conditions at enterprise. To determine the level of job satisfaction in our study, a rating scale from 1 (insufficient provision) to 5 (good provision) was adopted: completely satisfied – 5 points; satisfied – 4 points; not completely satisfied – 3 points; not satisfied 2 points; completely dissatisfied – 1 point. The positions that lag behind the standard (5 points) indicate the presence of reserves of motivational influence on employees. Basic reserves (satisfaction level from 1 to 3.4 points) and additional reserves (satisfaction level from 3.5 to 4.4 points) can be distinguished. The second stage of the study gave the following results:

– at the enterprise PJSC "Kharkivenergozbut", most of the factors of motivational influence determined at the first stage of the research are used and allow meeting the relevant needs of managers;

– there are no motivational factors, the use of which allows to absolutely satisfy the relevant needs of management staff, both for managers and for specialists, that is, they can be defined as additional reserves of motivational influence.

For managers, the main reserves are professional development, acquisition of new knowledge and skills, salary, recognition and approval of work results, transparent assessment of work. Additional reserves are the possibility of creative and personal growth, organizational structuring of work.

For specialists, the main reserves are salary, recognition and approval of work results, high level of responsibility, creative and personal growth, level of control over work, transparent evaluation of work. Additional ones – organizational structuring of work; leadership style; nature of relations with colleagues; nature of relations with management.

In order to determine the level of significance of the discovered reserves, it is necessary to rank them. Let's consider the procedures of the third stage of the proposed technology. A survey of experts was organized in the form given in the work [15, p. 25], to determine the degree of importance of reserves

The ranking method involves determining the concordance of experts' opinions. For this, it is necessary to calculate the concordance coefficient (W). It is calculated according to the formula proposed by Kendall [20]:

$$W = \frac{12\varepsilon}{N^2(n^3-n)} \quad (1)$$

where ε is the sum of squared deviations of the sum of ranks from their average value; N – number of experts; n is the number of assessment parameters.

A concordance coefficient close to 0 indicates a lack of concordance, and 1 indicates a complete concordance of experts' opinions. For managers, the concordance coefficients were:

– regarding the main reserves of motivational influence: $W = \frac{12*302}{10^2(4^3-4)} = 0{,}60$;

– regarding additional ones – $W = \frac{12*50}{10^2(2^3-2)} = 1$

For specialists:

– regarding the main reserves of motivational influence $W = \frac{12*1287}{10^2(6^3-6)} = 0{,}74$;

– regarding additional ones – $W = \frac{12*306}{10^2(4^3-4)} = 0{,}61$.

The obtained concordance coefficients indicate the existence of consistency of experts' opinions in both cases: both regarding the main reserves of motivational influence and additional ones.

In addition, to assess the significance of the concordance coefficients, the χ^2 [15] criterion was calculated [15]:

$$\chi^2 = N(n-1)W, \quad (2)$$

where W is the concordance coefficient; N – number of experts; n is the number of assessment parameters

For managers:

– regarding the main reserves of motivational influence $18.12 \rangle 11.14$;

– regarding additional ones – $10 \rangle 7.38$.

For specialists:

– regarding the main reserves of motivational influence $36.77 \rangle 14.45$;

– regarding additional ones – $18.36 \rangle 11.14$.

The calculated value of χ^2 exceeds the table value, and therefore, the consistency of the experts' conclusions is not accidental. The conducted research allows us to determine the sequence of putting into effect reserves of motivational influence on managers and specialists at enterprise (Figs. 3, 4).

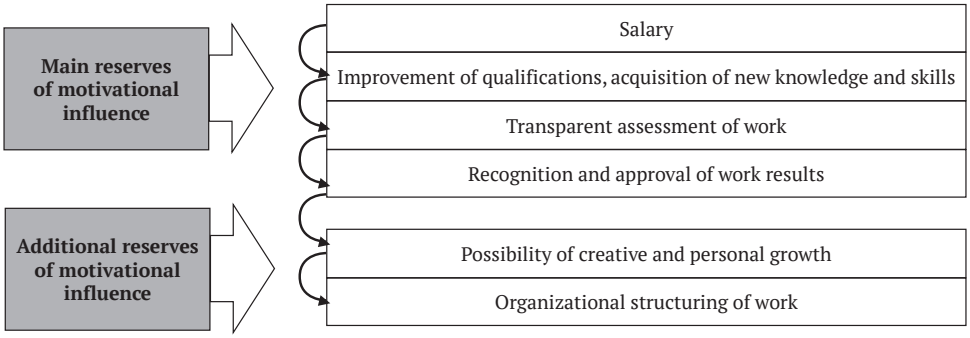

Figure 3. The sequence of putting into effect reserves of motivational influence on managers of PJSC "Kharkivenergozbut"

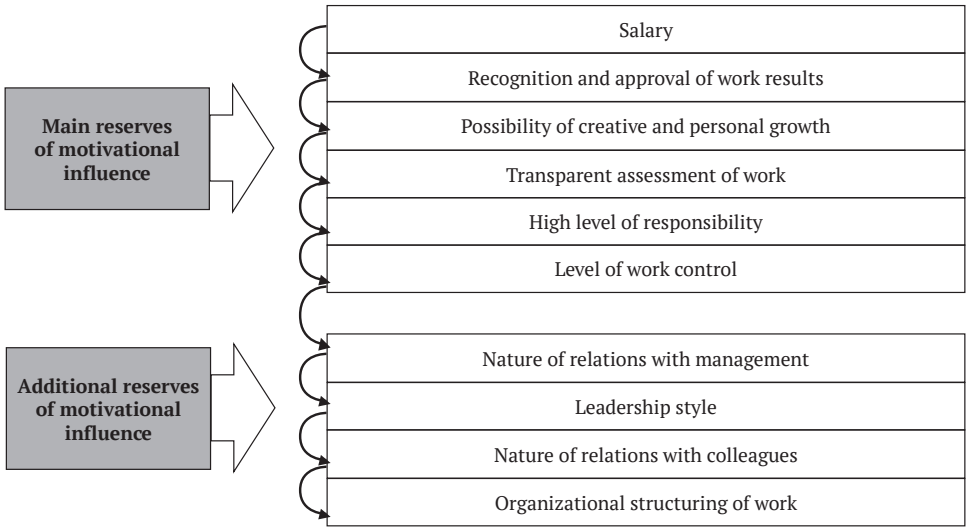

Figure 4. The sequence of putting into effect the reserves of motivational influence on specialists of PJSC "Kharkivenergozbut"

The conducted research allows us to conclude that there are significant differences in the context of problems of motivational influence for different categories of employees at PJSC "Kharkivenergozbut". Yes, the difference lies both in the number of main influence reserves and in their composition. The same can be said about additional reserves of influence – their number is much lower among management staff. All this actualizes the expediency of an individual approach in the process of motivating employees working at enterprises of the energy complex.

Determining the reserves of motivational influence and successively putting them into effect in compliance with the basic requirements, given in previous studies by the authors [21], allows us to form an effective mechanism for motivating the management staff of the enterprise.

CONCLUSIONS

Thus, the conducted research confirmed the possibility and necessity of using the proposed technology, which includes methods of factor analysis to determine latent factors, which influence work behavior, determine the level of job satisfaction to determine the positions that lag behind the standard and ranking in order to arrange reserves according to the degree of influence to determine reserves of motivational influence. The proposed technology allows us to move from qualitative assessments of employees' satisfaction with the existing motivation system at the enterprise under study to its quantitative measurement.

An important result of the conducted research was the determination of a significant difference in motivational preferences among employees of different categories. So, for example, the most significant reserves of motivational influence for management staff have become salaries, professional development, transparent assessment of work, as well as recognition and approval of work results. Additional reserves are the possibility of creative and personal growth, organizational structuring of work. For specialists, a high level of responsibility, a level of control over work and the possibility of creative and personal growth are added to the list of main factors of motivational influence; additional – organizational structuring of work, management style, nature of relations with colleagues, nature of relations with management. This actualizes the possibility of forming individual motivational packages for employees of each category at enterprises of the energy complex. Further research by the authors will be aimed at developing recommendations for the formation of an effective mechanism for motivating management staff at enterprises in the energy industry, taking into account the identified reserves.

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Технологія визначення резервів мотивації управлінського персоналу

Анотація. В сучасних кризових умовах розробка та впровадження механізму мотивації управлінського персоналу на підприємстві стикається з рядом ускладнень, головним з яких є брак фінансових ресурсів. Метою статті є розроблення технології визначення резервів мотиваційного впливу на управлінський персонал підприємства. Для досягнення цієї мети використовувались такі методи наукових досліджень: узагальнення, порівняння, аналіз та синтез, метод експертних оцінок, метод анкетування, факторний аналіз, ранжирування та графічний метод. Тому для скорочення витрат та забезпечення ефективної мотивації управлінського персоналу запропоновано виявляти резерви мотиваційного впливу за допомогою розробленої технології, що включає прийоми факторного аналізу (визначення латентних чинників впливу на трудову поведінку), оцінки рівня задоволеності працею (визначення позицій, за якими є відставання від еталона) та ранжирування (упорядкування резервів за мірою впливу). До переліку чинників мотивації ввійшли 16 показників: організаційне структурування роботи; підвищення кваліфікації, отримання нових знань і навичок; умови праці; матеріальне заохочення (заробітна плата та премії); влада і впливовість; характер відносин з колегами; можливість досягнення успіхів на роботі; можливість кар'єрного росту; можливість бути інформованим про справи фірми, приймати участь у вирішенні справ; визнання і схвалення результатів роботи; високий рівень відповідальності; можливість творчого і особистого зростання; впевненість у майбутньому, гарантія зайнятості, стабільність; характер відносини з керівництвом; рівень контролю за роботою; прозора оцінка праці. Застосування запропонованої технології на ПрАТ "Харківенергозбут" підтвердило можливість і необхідність її використання для визначення резервів мотиваційного впливу, а отже, скорочення витрат на мотивацію, формування ефективного механізму мотивації управлінського персоналу

Ключові слова: дослідження мотивації, задоволеність працею, фактори мотивації, експертне опитування

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Peculiarities of a Team Leader's Role Behaviour

Abstract. The article deals with the problem of the distribution of roles in a team at work. The efficiency of the distribution of roles in the team ensures the efficiency of activities, reduces the conflict of interaction and increases the level of adaptability of the team to changes in the external environment. The main attention is paid to the team role of a leader, which determines the organization and peculiarities of the team. Therefore, the purpose of the study is to determine the problems of the distribution of team roles and the peculiarities of the leader's role behaviour. The theories of the distribution of team roles proposed by such authors as R.M. Belbin, R. Schindler, and T. Bazarov were analyzed. Each of the theories was analyzed and their features, possibilities of use for the study of the leader's roles and problems of application in practice were determined. The main problem is the difficulty with the distribution of team roles in functional divisions (mainly the same types of functions are performed) compared to project teams. By modeling the leader's behaviour, the influence of his team role on the functioning of the division and the distribution of roles in it was determined. As a result, it was identified that the main problem of determining the distribution of roles in a functional division is a significant shift in the result towards the main type of its activity, which requires clarification or adaptation of the diagnostic apparatus. It is proposed to distinguish a social and labour role that combines functional (labour) and team (social), focusing only on the type of activity. The following types of social and labour roles are distinguished: executive, adaptive and creative. It is proposed to apply the same classification to the leader, which will allow his role to be considered inseparable from the roles of employees, which is especially important for functional divisions. This classification makes it possible to facilitate the process of diagnosing the predominant roles and determine the features of the basic functions of the division and the problems of the team's activity

Keywords: theory of roles, R.M. Belbin's model of team roles, R. Schindler's model of rank dynamics, T. Bazarov's model of management roles, modeling of leader behaviour, leader's social and labour roles

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INTRODUCTION

Modern world trends have a significant impact on social and economic processes. The accelerated development of science and technology, modernization of technological processes in all spheres (from manufacturing to everyday life), informatization and intellectualization of life radically change the usual ways of work and life. The political, economic and social challenges facing Ukraine in the 2020s have had a negative impact on the scale of unemployment, the demographic situation, the level of income of the population, and the provision of social standards of living. The shortage of resources, including financial ones, requires the search for new ways of increasing efficiency and competitiveness of enterprises. One of these ways is the application of the theory of roles [1] in the process of formation and development of a team. An employee's performance of his own role, which most of all corresponds to his aspirations and abilities, allows him to significantly increase his efficiency.

The distribution of roles in a team has a significant impact on the efficiency of its activities. On the one hand, roles ensure high-quality division of labour. On the other hand, they contribute to the improvement of the process of

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interaction between employees. Therefore, special attention is paid to the study of the theoretical foundations and models of the distribution of roles in the team. Employee relations (both formal and informal) are determined by the distribution of roles among employees and the balance between them. Over time, each employee focuses more and more on performing his own role, gains significant experience, develops certain skills and abilities. This allows him to significantly increase the efficiency of his work and interaction with other roles.

However, in theories of team roles, a leader remains the most difficult element. On the one hand, he influences the activities of his subordinates, in particular, the distribution of roles in the team. On the other hand, like any worker, he also has certain preferred roles that he has to perform or that he has a knack for. This situation proves the importance of determining the role of the leader and its adequacy to the tasks and his abilities.

In this regard, the purpose of this study is to analyze and generalize the theoretical prerequisites for clarifying the list of roles of team members and to determine the characteristics of the leader's role behaviour to increase the efficiency of interaction in the team.

In the work, the process of the distribution of team roles as a synthesis of labour and team roles has been improved, which makes it possible to facilitate the diagnostic procedure and take into account the peculiarities of the work of the functional division and model the behaviour of different types of leaders, depending on their role.

LITERATURE REVIEW

The central idea of all role theories is that the main part of people's everyday behaviour is the fulfillment of their social roles. Each role is a set of expectations for actions corresponding to the social position of its bearer. Role theories emphasize the perception and understanding of a person within his social connections and organizations. According to their concepts, the role a person plays in each specific situation shapes his attitudes and beliefs. The person aligns his attitudes with the expectations associated with a certain role. Each status has certain roles with corresponding expectations and norms of behaviour. On the one hand, each person is subject to norms of behaviour and expectations. On the other hand, people around him evaluate how the individual adheres to these norms of behaviour.

A team role is a list of the types of behaviour and tasks that a person is expected to perform in his current position in a team and organization. Each role has corresponding responsibilities and rights. Exercising these rights and responsibilities is a powerful tool for controlling and self-monitoring of team members' behaviour. First of all, roles determine the list of functions and tasks to be performed. Second, roles identify specific standards of behaviour that allow it to be evaluated and enable the team to demand that its members be held responsible for their actions. Third, roles help the leader determine the degree of reward for each team member. [1; 2]

The problems of the study of the role structure of a team are considered in the works of many scientists, but the classic one is R.M. Belbin [3], who substantiated the need for the distribution of roles in a team, identified 9 main roles, which were divided according to the directions of teamwork, and provided a list of factors that affect the efficiency of role performance.

R.M. Belbin singles out 9 roles that are focused on different areas of work (practical, intellectual, interactive). Factors underlying team role behaviour are as follows:

1. Psychophysiological features of personality.
2. Intellectual abilities.
3. Personal values and principles.
4. External influence.
5. Personal experience, cultural traditions and norms of behaviour.
6. Degree of mastery of the role [3].

R.M. Belbin groups team roles according to two characteristics: the nature of activity and the directions of team member's activity.

According to the nature of activity, R.M. Belbin singles out the following groups: "People of action" (which includes motivators, implementers, and controllers); "Socially-oriented" (which includes coordinators, resource investigators, and team workers); "Intellectual roles" (which are performed by idea generators, analysts, and specialists). This feature takes into account the type of activity that an employee must perform. Thus, "people of action" focus on conscientious performance of activities ("hand work"). The difference between the roles is that the implementer simply does the work conscientiously, the controller checks and corrects errors, and the motivator performs in such a way that he inspires others with his own activity. The "socially-oriented" provide communication and interaction between colleagues ("language work"). Coordinators formulate and distribute tasks, team workers support internal interaction, and resource investigators search for information and opportunities for the implementation of tasks. "Intellectual roles" are aimed at mental work ("head work"). The difference is that idea generators are engaged in creative work, analysts deal with analytical and evaluation work and specialists focus on their own specialized skills [3].

According to the areas of activity, R.M. Belbin distinguishes the following groups: "Management and organization of work" (which includes coordinators, motivators, and team workers); "Ideas and proposals" (which includes idea generators, resource investigators, and strategy analysts), "Performance of work" (which includes implementers, controllers, and specialists). This classification system takes into account the function performed by a person in a team. Thus, "performance of work" focuses on the performance of ordinary activities. "Management and organization of work" ensures the interaction of employees, stimulating their activity, ensuring a comfortable moral climate, i.e. performing "socially important" functions. The group of "ideas and proposals" deals with the strategic development of the team and atypical or unpredictable problems that can disrupt the current activities of the team. A comparison of roles according to different grouping systems is provided in Table 1.

Table 1. R.M. Belbin's grouping of team roles

Main characteristics of roles	R.M. Belbin's team roles	Areas of activity	Nature of activity
Professional in a narrow field of knowledge	Specialist	Performance of work	Intellectual roles
Disciplined, reliable, efficient, conservative and practical	Implementer		People of action
Conscientious, notices mistakes and oversights, able to control	Controller		
Able to listen, diplomatic, capable of compromise	Motivator	Management and organization of work	
Mature, confident, formulates clear goals, promotes solutions, leader, delegates responsibilities	Coordinator		Socially-oriented
Flexible, sociable	Team worker		
A dynamic leader, challenges and pushes	Resource investigator	Ideas and proposals	
Thoughtful, perceptive, possesses strategic thinking	Analyst		Intellectual roles
Has a rich imagination, knows how to solve non-standard problems	Idea generator		

Source: [3]

In the concept of R.M. Belbin, it is distinguished a separate group of roles which are more characteristic of the leader ("Management and Organization"). Such a leader performs one's duties as efficiently as possible. According to R.M. Belbin's model, two main types of leaders are distinguished: "Motivators" and "Coordinators". The main features of the "coordinator" are perseverance, enthusiasm and the ability to influence subordinates. Such a leader activates the team, mobilizes its reserves and is able to lead the whole team by one's own example. The "coordinator" is aimed at the effective distribution of functions and resources, predicting threats and risks.

However, in addition to the proposed roles, an "intellectual" type of leaders is sometimes distinguished. It prevails in teams with a large number of "intellectual roles", where interaction and teamwork are very difficult. Such a leader combines the approaches of the previous ones, but tries to act more carefully.

In general, the model of R.M. Belbin is one of the most common models; it has been tested by many researchers [4-6]. It demonstrates the greatest effectiveness in project teams, where the distribution of various functions is possible [7-9]. However, its use for functional divisions requires some clarification.

The model of R.M. Belbin has become the basis for the development of models by many other scientists who tried to clarify and improve it for certain areas of use [10-12]. These models leave the general principle of distribution of roles based on the functions performed by a team member. The key differences of their models are the clarification of the list of roles and the improvement of diagnostic technologies. Nevertheless, the fundamental problem of role imbalance in the functional division remains.

Another classification of team roles was proposed by R. Schindler in his rank dynamics model [13]. He places a special emphasis on the dynamic aspect of intragroup processes (typical models of contact behaviour for each team position were studied by T. Bachmann [14]). This approach is well suited for finding the "rules of the game" on the basis of which the dynamics of the team flows and according to which the therapeutic process proceeds [13]. This model assumes the allocation of the following roles:

Alpha is a leader who personifies a group, motivates it to act, draws up a programme of action, directs, gives it confidence and determination (everyone looks at him and goes quiet when he starts speaking).

Beta is an expert who has special knowledge, skills, and abilities that the group needs or that the group respects. The experts analyze and consider the situation from different angles, their behaviour is rational, self-critical, neutral and indifferent (they ask questions and think a lot).

Gammas are ordinary, easily adaptable members of the group; most of them identify themselves with the leader and support the idea of the leader. Adaptability and conformity in actions are their most important features. They are the basis of the team, the so-called "working bees".

Omega is an outsider, the most "extreme" individual who lags behind the group due to some differences from everyone else. Their role is to relieve emotional tension. Sometimes they identify themselves with the enemy of the group. By their behaviour, they allow the group to direct group aggressions on them, and not on other team members.

Po is an adversary who actively opposes the leader and is outside the group. Being a threat to the leader and the group, they help to develop themselves and the group as a whole. This model is aimed at the study of intragroup processes and interaction between group members. It is weakly related to labour activity, as it almost does not take functional roles into account. If it is considered from the point of view of a team, it is possible to highlight certain features [13; 15].

The Alpha usually acts as a team leader, assigns duties and functions to his own employees, motivates them to work (according to R.M. Belbin, he is a coordinator, a motivator, and sometimes an idea generator). However, in addition to this, the alpha must be perceived by the group as the personification of its essence, key ideas and goals (if the alpha does not cope with this, the group loses momentum and may collapse). Thus, the position of the alpha is due to a value judgement rather than a competence assessment of the team.

The Beta involves a wide range of personalities who ensure the current functioning of this team and build its structure. According to R.M. Belbin's concept, this can include specialists, idea generators, analysts, resource investigators,

and controllers, that is, those who perform specific socially useful functions. The position of the most betas is more stable compared to the alpha position, there are fewer expectations of their behaviour and they have a narrow specialization. In addition, the betas have their own position due to compliance with professional requirements, so if they perform their functions well, there is no point in dismissing them, even with a change of the alpha.

The Gamma is the majority of ordinary workers who do not perform specific functions (according to R.M. Belbin, these are implementers and team workers, although representatives of other functions, especially the so-called "second places", may be included). The gamma position is characterized by a minimum of responsibility, conformity and executive behaviour. The Gammas rarely express their own opinion (except in cases of overload or difficulties, where the Gammas are the first to complain) and expect ready-made solutions. Unlike the Alpha and the Beta, personal qualities and quantity play almost no role for the Gamma. That is, changes in the composition of the Gamma are almost imperceptible from the point of view of the entire team.

The Omega is a rather specific and unstable position in the group. Employees of this group are constantly exposed to powerful psychological influence from other team members. Therefore, they must have certain psychological qualities (stress resistance, reduced emotionality, carelessness, etc.), otherwise they will be able to perform this role only for a short period of time (either they leave the team, or they provoke a powerful internal conflict). R.M. Belbin does not have an omega analogue (his model is aimed at stable and flexible work), but the omegas may perform the functions of implementers, controllers, analysts, and in rare cases they perform the functions of specialists.

The Po is the opponent of the group, who is outside its borders. Such an opponent can act as an individual, a team, or, in general, as an abstract "system". The Pi's role is important when mobilizing the group's efforts against its "external enemy" and for its development. In teams, this function is most often performed by competing divisions or leaders (divisions of a higher level).

In contrast to the model of R.M. Belbin, the model of R. Schindler is aimed at the development of the team, which means ensuring its stability in the long term through the operation of intragroup dynamic mechanisms ("external enemy", the presence of internal opposition, exclusion of the non-initiative majority from the decision-making process). It minimizes the importance of a particular person in the work of the team (in general, even the alpha and the beta can be replaced). The model of R.M. Belbin is more sustainable, but it establishes strict requirements for the qualities of team members [3; 15; 16].

In this concept, the role of a leader is clearly defined and includes a certain list of functions. However, the flexibility of the model of R. Schindler contributes to the spread of diversity of types of leaders, which depends not only on the qualities of the leader, but also on the peculiarities of interaction in the team, its structure and the distribution of functions. In case the alpha is not the leader of the team, this team has problems with the distribution of functions, potential power conflicts and, in general, becomes very unstable.

Next, let us consider T. Bazarov's model of management roles [17]. Based on G. Shchedrovitsky's model of management activities [18], T. Bazarov developed the model of professional and management roles, distinguishing four types of management tasks, which are connected by a common logic according to the principle "from specific to general", and each management task corresponds to a particular management role with its competences. He showed that in order to effectively function in a higher management position, it is necessary to possess each of the four professional and management roles at a certain level:

1) a manager – one of the roles of a manager, associated with the responsibility for the situation analysis, identifying priority directions for the development, formulating goals and drawing up programmes for the development and functioning of one's division. It is the manager who is responsible for finding new directions for the development and success of the division in changing situations or at a time of crisis;

2) an organizer – one of the roles of a manager, associated with the responsibility for the development of organizational structures and other forms of organization of personnel activities, which are most effective in the given conditions. The organizer analyzes activities, external situation, goals and strategy of the organization (division), as well as its personnel potential, and selects (or designs) the organizational structure that will be most effective at the moment;

3) an administrator – one of the roles associated with the responsibility for provision of resources and implementation of organization (division) plans, ensuring control over the activities of subordinates. The activity of the administrator, unlike the activity of all other managers, takes place in a fairly stable environment. The main task of his activity is to control the implementation of the plans, instructions and standards of provision that have been developed by the organizer to achieve a certain goal;

4) an executive – one of the roles associated with the responsibility for staffing, correct understanding and execution of assigned tasks by subordinates. The success of management is often due to equally high knowledge of both the technology of activity and the individual characteristics of employees. As a rule, the leader has a sufficient level of trust in the team, which is based on informal authority, has the decisive moral right to eliminate contradictions and resolve conflicts between subordinates.

The choice of professional and management roles is determined by the area of activity they perform. Thus, the manager is mainly engaged in strategic activities (determination of development directions and strategy). The organizer deals with the design of processes, organizational structures, distribution of functions, etc. The administrator implements current activities and operational management, provides and distributes resources, monitors current activities. The leader works with people – ensures motivation, training, staffing, conflict resolution and cooperation in the team.

MATERIALS AND METHODS

The theoretical basis of the research includes the concepts of sociology, social psychology and management, namely the theory of roles (role theory) [1], according to which the personality is described with the help of social functions and behaviour models (roles), which are learned and accepted or forced to perform by the individual.

The method of theoretical generalization was used to define the conceptual apparatus. The paper selected three of the most well-known theories of the distribution of team roles (namely, the model of team roles of R.M. Belbin [3], the model of rank dynamics of R. Schindler [13], and the model of management roles of T. Bazarov [17]). The theories of team roles were chosen based on their popularity in the scientific community and availability of their approval. Each theory of team roles was analyzed according to the following aspects: the principles or criteria for the distribution of roles, the list of team roles, the characteristics of their behaviour and functions, the peculiarities of the manifestation of these roles by a team leader. By comparing and generalizing the theories of team roles, the key problems of their practical use in the work of functional divisions (where employees perform mainly the same type of functions) were identified. Based on the generalization of the concepts of various theories and taking into account the problems of their implementation in functional divisions, the list of social and labour roles and the principles of their distribution were proposed and substantiated.

With the help of leader behaviour modeling, the main problems of the study of leaders' team roles were determined. The same method was used to determine the characteristics of the leader's social and labour roles based on the predominant types of activity.

RESULTS AND DISCUSSION

The role of a particular employee is determined by his contribution to the work of the team, the result of his work and his relationships with others. When assigning roles in a team, two principles are applied: the principle of competence and the principle of preference.

The principle of competence emphasizes that in a team, roles are distributed according to a person's competence (that is, the person who can handle it best gets the role). That is, it ensures a more effective performance of the role. The principle of preference states that roles are allocated based on employee preference (allocation based on self-interest rather than suitability for a particular role). This ensures greater employee satisfaction and well-being.

However, following the principle of competence can increase the efficiency of current individual activities, but reduce overall group results, especially in the long term (that is, an employee who is dissatisfied with his own role interacts less with others and accumulates dissatisfaction, which over time can reduce even his own efficiency). On the other hand, following the principle of preference reduces current role performance, but increases employee satisfaction. Nevertheless, in the long run, performing difficult activities (or low quality) can deeply demotivate the employee and colleagues. Therefore, the team leader should strive for a balance between these two principles when assigning roles. The best course of action is a gradual combination of the employee's competence and interests. That is, it is necessary to help increase motivation to perform the activity that the employee does best or to teach the employee to effectively perform the activity that he likes.

The generalization of the theoretical prerequisites for the distribution of roles in a group (team), performed by the authors [2], made it possible to draw the following basic conclusions and recommendations:

1. The essence of any role is realized through the employee's behavioral model, which requires certain functions, responsibilities, rights and expectations of the group from the employee.

2. The list of roles, their content and methods of assignment do not have a single standard and may differ significantly in different teams.

3. High-quality distribution and performance of roles in the team ensure increased efficiency, improved interaction due to the distribution and coordination of work.

4. Each of the employees can perform and, most importantly, performs several roles, the choice and combination of which are determined by the situation.

5. The key to successful joint activity is to maintain a balance of roles, which ensures effective division of tasks, coverage of all types of teamwork activities, and flexibility of the group in the face of the external environment.

Based on the generalization of the role theories, it is proposed to apply the "social and labour role". This role focuses not only on functions, but also on interactions between employees. Therefore, it is proposed to allocate roles based on types of activities. The main idea is that employees are forced to perform a wide range of functions. However, the advantages of one or another function indicate the specificity of the role and the difference in competencies that employees should possess [19].

It is proposed to distinguish three types of activities:

1) executive – current performance of labour activities (performance of basic functions, quality control, etc.);

2) adaptive – ensuring the efficiency of external and internal interaction (distribution of activities, motivation, establishing connections, resolving conflicts);

3) creative – development and implementation of new ideas (determination of activity areas, team development, etc.).

Consolidation of roles is advisable as an employee is often forced to perform not only a specific function, but also related ones. Thus, the implementer often checks the work himself (not necessarily his own work). Also the activity of the "coordinator" often overlaps with the activity of the "motivator". And the "idea generator" is often forced to analyze the usefulness of ideas himself. It is clear that this consolidation of roles is not very appropriate from the point of view of efficiency (certain advantages of the distribution of roles and specialization are lost), but this may be due to the functional responsibilities of the employees of the division. That is, these functions are inseparable from each other. Therefore, workers in real teams often combine them. In addition, the distinction between functional and team roles is eliminated and attention is focused on the characteristics of the activity. In real teams, most employees are forced to change their own activities and adapt to new conditions and requirements.

The model of R.M. Belbin served as a basis for the proposed model (Table 2).

Table 2. Division of social and labour roles of employees in a team

Role	R.M. Belbin's team roles
Implementer (practical actions)	Implementer
	Specialist
	Controller
Adaptive worker (organization of interaction)	Team worker
	Coordinator
	Motivator
Creative worker (creative functions)	Idea generator
	Analyst
	Resource investigator

When choosing the role of the implementer, an employee is psychologically ready to implement routine, standard, technologically designed operations at the workplace. The main characteristics of such an employee include discipline, reliability, efficiency, orientation to practical tasks. He is usually a fairly high professional in a narrow field of knowledge. The manager characterizes this subordinate as conscientious, capable of constructive control of his work. When being in the role of an adaptive worker, he positively perceives the need to interact with colleagues in the process of performing work; he is characterized by confidence, the ability to clearly formulate goals, and organize joint work; he positively perceives the delegation of authority related to independent decision-making at work. In relations with colleagues, he is diplomatic, capable of compromise, and sociable. A creative worker has a rich imagination, knows how to formulate the essence of an unusual practical problem and find non-trivial solutions to it. This employee has strategic thinking and dynamic response to a situation; he positively perceives non-standard situations, which he considers as a challenge to test his potential.

The result of the application of this technique is a profile of the employee, which indicates the functions that prevail in his activity. In addition, it is advisable to measure the desired state of the distribution of functions. That is, the second profile, which will reflect the employee's aspirations and interests. Obtaining such results for all employees makes it possible to more effectively distribute their functions in the team. In addition, it will be clear which areas of activity are poorly developed in the team.

Each of these types of activity requires certain psychological qualities and skills. Thus, implementers need discipline, attentiveness, responsibility, and deep professional knowledge. Adaptive workers require sociability, flexibility, ability to establish and maintain connections. Creative workers need creativity, skills in working with information, a global view of problems, and analytical thinking.

However, as with most team role models, there remains the problem of the interaction of role and job responsibilities. Thus, the leading role of an employee is determined primarily by his job responsibilities and largely affects the results of diagnostics. Therefore, some researchers propose to single out a separate (functional) role, which is connected precisely with the main functions of the employee [7]. On the one hand, this approach simplifies the process of comparing team roles, but on the other hand, it requires an individual approach to developing a diagnostic system.

The model of T. Bazarov [17] needs special attention, as his research is focused on management teams. The model is optimal for cases when it is necessary to assess the managerial potential, determine the managerial abilities of one or another employee, and then form a management team, for example, when forming a reserve of management personnel. The model helps to form a team that is likely to cope with management tasks of various types, and to determine the limits of its authority. In addition, the model can be used to analyze the management system of the organization as a whole due to the fact that it describes crucial management points.

This model is rather difficult to use in a traditional hierarchical organizational system. The management team involves the specialization of managers in a certain type of management activity, which requires a developed collegial decision-making system. In addition, each of the managers is considered not only as an individual employee, but as a representative of an entire area of activity with his subordinates (usually employees of a functional division).

In this model, each of the roles takes into account not only the characteristics of the manager, but also the characteristics of the subordinates who help him perform a certain activity. The problems of the system of interaction between managers are ignored. That is, the function of interaction between managers is not considered (the activity of the "leader" is aimed at subordinates, not colleagues). Therefore, in the event of a conflict between managers, the efficiency decreases sharply. In addition, there is a limit to the size of such a team (the more participants are involved, the less efficient their interaction is).

The peculiarity of the leader's role behaviour is determined by the list of functions he performs in the team. In addition to the organizational functions inherent in the leader, he can perform certain general functions (functions of controllers, idea generators, etc.). Most of the role techniques [13; 17; 20] provide for the allocation of a particular role for the team leader. However, the leader's own activity may also be dominated by certain types of activity. Depending on the predominant social and labour role, his leadership style will change. These comparisons are given in Table 3.

Table 3. Social and labour roles of a team leader

Role type	Leadership style	Leadership characteristics
Executive (practical) roles	Professional manager	He has the highest qualifications, the widest experience in the main activity. They often turn to him for help and advice. In fact, he is able to perform the current work better than anyone else in the team.
Adaptive (interactive) roles	Manager - leader	Aimed at work organization, division of duties, and motivation of subordinates. Focuses more on making connections than getting things done. Charges others with enthusiasm. Resolves conflicts.
Creative (intellectual) roles	Creative leader	Aimed at intellectual and creative work. His main area of activity is strategic planning, idea generation, evaluation and selection of ideas. He may have some rare skills and knowledge that make him almost indispensable. However, he tries to delegate current and communication activities to subordinates

A leader, like an ordinary employee, must perform his functions within the limits of his job duties. However, the main duties of leaders involve the organization of work, that is, the performance of adaptive (interactive) roles. This situation was repeatedly emphasized by the researchers of team roles [4; 7; 21]. In fact, the leader performs a significant part of the adaptive roles in the team (according to M. Chemin, "leaders' coordination abilities are especially important in the context of a non-routine cognitive task which supposes the transfer of knowledge and the flow of creative ideas" [20]). When diagnosing roles [22], these roles will prevail in the leader, which complicates the diagnosis of other types of roles (executive and creative ones). Therefore, the study of the leader's team roles must be carried out in close interaction with the determination of the team roles of his subordinates.

CONCLUSIONS

To eliminate the problem of inconsistency between functional and team roles, it was proposed to consider the social and labour role that combines the labour function and the team role of an employee, focusing on the nature rather than the content of the activity. The advantage of this model of social and labour roles is its relative universality. It is suitable for the analysis of any team (project teams, working groups, functional divisions, subsidiaries, etc.). The difference will be only in the degree of application of certain functions (for example, marketing departments will have more adaptive and creative activities, and accounting departments will have more executive ones). The main requirement for using this model is more or less stable functioning over a certain period of time (employees need to adapt to work and try different types of activities to adequately assess their own benefits). Therefore, it is difficult to use this model to form new teams. However, it is quite effective for researching the current state of teams.

Thus, the division and cooperation of labour forces workers to perform different roles. However, it is impossible to study these roles in isolation from the social ties of each individual, his place and role in the team. The theory of roles provides for a clear division of people by roles, but this is rarely done in real teams. Due to the size, uneven amount of work of various types, variability of tasks facing modern teams, it is impossible to clearly and unambiguously divide employees by roles (especially when dealing with a significant number of employees). Therefore, it is expedient to consider the social and labour roles that focus attention precisely on the functional division, which makes it easier to diagnose their condition and increase the efficiency of team members.

Further research will focus on: 1) improvement of the research tools, which will reveal the distribution of social and labour roles in a team, 2) analysis of the influence of a leader's social and labour role on a team and the peculiarities of his work in different situations.

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Особливості рольової поведінки керівника трудового колективу

Анотація. В статті розглянуто проблему розподілу ролей у трудовому колективі. Ефективність розподілу ролей в колективі забезпечує результативність діяльності, зменшує конфліктність взаємодії та підвищує рівень адаптивності колективу до змін зовнішнього середовища. Основна увага приділена командній ролі керівника, яка є визначає організацію та особливості колективу. Тому метою дослідження є визначення проблем розподілу командних ролей в колективі та особливостей рольової поведінки керівника. Було проаналізовано теорії розподілу командних ролей таких авторів як Р.М. Белбін, Р. Шиндлер, Т. Базаров. Проаналізовано кожну з теорій та визначено їх особливості, можливості використання для дослідження ролей керівника та проблеми застосування на практиці. Головною проблемою є складнощі з розподілом командних ролей в функціональних підрозділах (виконуються переважно однотипні функції), порівняно з проектними командами. Шляхом моделювання поведінки керівника визначено вплив його командної ролі на функціонування підрозділу та розподіл ролей в ньому. В результаті визначено, що головною проблемою визначення розподілу ролей в функціональному підрозділі є значний зсув результату в бік основного типу діяльності підрозділу, що потребує уточнення або адаптації діагностичного апарату. Запропоновано виділяти соціально-трудову роль, яка поєднує функціональну (трудову) та командну (соціальну), акцентуючи уваги лише на типі діяльності. Виділено такі типи соціально-трудових ролей: виконавчі, адаптивні та творчі. Цю ж класифікацію пропонується застосовувати і до керівника, що дозволить його роль розглядати невід'ємно від ролей працівників, що важливо саме для функціональних підрозділів. Така класифікація дозволяє полегшити процес діагностування переважних ролей, визначити особливості базових функцій підрозділу та проблеми діяльності колективу

Ключові слова: теорія ролей, модель командних ролей Р.М. Белбіна, модель рангової динаміки Р. Шиндлера, модель управлінських ролей Т. Базарова, моделювання поведінки керівника, соціально-трудові ролі керівника

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