МИРОВАЯ ЭКОНОМИКА И МЕЖДУНАРОДНЫЕ ОТНОШЕНИЯ, 2023, том 67, № 3, сс. 5-19
WORLD ECONOMY AND INTERNATIONAL RELATIONS, 2023, vol. 67, no. 3, pp. 5-19

CONTEMPORARY PROBLEMS OF DEVELOPMENT

DOI: 10.20542/0131-2227-2023-67-3-5-19 **EDN:** IYSLVI

INTERNATIONAL POLITICAL ECONOMY OF ICT INDUSTRY

Valentin V. GRIGORYEVSKY,
ORCID 0000-0003-2684-9443, v.grigoryevskiy@gmail.com
Primakov National Research Institute of World Economy and International Relations, Russian Academy of Sciences (IMEMO), 23, Profsoyuznaya Str., Moscow, 117997, Russian Federation.

Denis A. DEGTEREV,
ORCID 0000-0001-7426-1383, degterev-da@rudn.ru
RUDN University, 6, Miklukho-Maklaya Str., Moscow, 117198, Russian Federation;
MGIMO-University, MFA of Russia, 76, Vernadskogo Prosp., Moscow, 119454, Russian Federation.

Danil A. PISKUNOV,
ORCID 0000-0002-4321-3191, piskunov_da@mail.ru
RUDN University, 6, Miklukho-Maklaya Str., Moscow, 117198, Russian Federation.

Irina L. PROKHORENKO,
ORCID 0000-0002-8090-7934, irinapr@imemo.ru
Primakov National Research Institute of World Economy and International Relations, Russian Academy of Sciences (IMEMO), 23, Profsoyuznaya Str., Moscow, 117997, Russian Federation.

Received 25.11.2022. Revised 14.12.2022. Accepted 27.12.2022.

Abstract. The development of the ICT industry in the modern globalized world has an increasing impact on political relationships between states and various non-state actors. The article aims to research the nature of the international system of relations between states in the ICT sphere and to define whether this system is unipolar, bipolar or polycentric. By using the provisions of the international political economy, technology transfer theory and world-systems theory, as well as quantitative methods, the authors developed and substantiated the international rankings methodology of international power research in the global ICT industry based on the data of OECD TiVA FD_EXGR_VA Gross exports by origin of value added and final destination of the ICT three key industries (IT and other information services, Telecommunications, Computers, electronic and optical equipment) for every system actor. Based on this the authors evaluated the distribution of the power between the states and identified key actors, defined state functions and resulting therefrom components of the global ICT industry, competition types for these components, and by typological classification of states defined five of their types ("worker", "altruist", "merchant", "median", "consumer"), analysed their strengths and weaknesses, provided the network analysis of creating value added, which visualises the key connections between countries. Conclusions are drawn that the international system of relations between states in the ICT sphere has a polycentric nature, a number of practical results have been achieved, which contribute to a better understanding of the mechanisms of the uneven development of the states from the point of view of non-hierarchical models and show state functions in the ICT sphere; estimations are provided for the balance of power in the current system as a result of the process of decoupling economies and technological decoupling between USA and China.

Keywords: international political economy, information and communication technologies, value added, international rankings, quantitative methods, USA, China.

About authors:
Valentin V. GRIGORYEVSKY, Postgraduate Student.
Denis A. DEGTEREV, Dr. Sci. (Polit.), Cand. Sci. (Econ.), Professor, Head of Department.
Danil A. PISKUNOV, Student.
Irina L. PROKHORENKO, Dr. Sci. (Polit.), Head of Sector.

МЕЖДУНАРОДНАЯ ПОЛИТЭКОНОМИЯ ИКТ-ИНДУСТРИИ

© 2023 г. В.В. Григорьевский, Д.А. Дегтерев, Д.А. Пискунов, И.Л. Прохоренко

ГРИГОРЬЕВСКИЙ Валентин Валентинович, аспирант,
ORCID 0000-0003-2684-9443, v.grigoryevskiy@gmail.com
ИМЭМО им. Е.М. Примакова РАН, РФ, 117997 Москва, ул. Профсоюзная, 23.

ДЕГТЕРЕВ Денис Андреевич, доктор политических наук, кандидат экономических наук, профессор,
ORCID 0000-0001-7426-1383, degterev-da@rudn.ru
РУДН, РФ, 117198 Москва, ул. Миклухо-Маклая, 6;
МГИМО МИД России, РФ, 119454, Москва, пр. Вернадского, 76.

ПИСКУНОВ Данил Андреевич, студент,
ORCID 0000-0002-4321-3191, piskunov_da@mail.ru
РУДН, РФ, 117198 Москва, ул. Миклухо-Маклая, 6.

ПРОХОРЕНКО Ирина Львовна, доктор политических наук,
ORCID 0000-0002-8090-7934, irinapr@imemo.ru
ИМЭМО им. Е.М. Примакова РАН, РФ, 117997 Москва, ул. Профсоюзная, 23.

Статья поступила 25.11.2022. После доработки 14.12.2022. Принято к печати 27.12.2022.

Аннотация. Глобальная ИКТ-индустрия оказывает все большее влияние на политические взаимоотношения между государствами. Цель статьи – исследовать характер международной системы взаимоотношений государств в сфере ИКТ. Используя положения международной политэкономии и количественные методы анализа, авторы разработали методику исследования международной мощи стран в глобальной ИКТ-индустрии на основе данных ОЭСР и установили распределение мощи между странами, типологизировали их, определили функции стран и типы конкуренции, представили сетевой анализ.

Ключевые слова: международная политическая экономия, информационно-коммуникационные технологии, добавленная стоимость, международные рейтинговые исследования, количественные методы политических исследований, США, КНР.

Long before the advent of modern information and communication technologies (ICT), Schumpeter concluded that technological development changes the organisation of society, its politics and economy [1]. Until the 2010s, industrialised countries unequivocally dominated in the ICT field, and the system of relations between its actors was unipolar with the leading role of the United States [2]. Globalisation has led to the creation of global value chains: production processes have become increasingly outsourced to Asia [3]. The economic development of China, the Republic of Korea and India has seriously affected the balance of power in ICT and called into question the dominance of the United States [4].

The US-China trade war that began in 2018 highlighted the role of technology in the context of international competition and national security [5, 6, 7, 8]. The question arises: what is the real nature of the current international ICT sphere – unipolar, bipolar, or polycentric? The purpose of this paper is to identify the leading countries (poles) that play a key role in global value chains in ICT.

The authors relied on the theory of technology transfer by Krause and the world-systems theory by Wallerstein, making it possible to conceptualise the world order in ICT and reflect the position of actors in it. The ICT world order quantification is based on the OECD Trade in Value Added (TiVA) database. Three aspects of the problem posed are considered – the system of relations between states in ICT as a whole, their position and functions in this system, and the typology of interdependence between countries.

METHODOLOGY

In the world-systems concept, the world is divided into the centre, the semi-periphery, and the periphery. The states included in the core of the system retain their dominant position at the expense of developing countries located on the periphery and semi-periphery [9]. The latter tend to move closer to the centre, reducing their technological gap and investing in advanced sectors.

The theory of technology diffusion considers the diffusion of technologies and presents it as a hierarchical system, in which developed states belonging to the 1st type of actors manage the technological transfer from the developed ones (1st and 2nd types of actors) to developing states (3rd and 4th types) [10, 11]. A system is emerging in which technological development and the dissemination of advanced developments occur unevenly. The actors that regulate technology transfer derive economic and political benefits [11]. Actors belonging to the "lower" levels of the hierarchy are trying to close the technological gap by investing in R&D and copying existing technologies.

According to Akamatsu's "flying geese" paradigm, states develop along a certain path, with-

in which they go through several stages from labour-intensive to capital-intensive production [12]. Moreover, it is argued that countries not only repeat the economic path of development but also adopt liberal and democratic values [12, 13]. Some authors note the inapplicability of this approach to modern realities [14]. The dynamics of the ICT sphere show that it does not follow the rules described by Akamatsu. Taiwan, Hong Kong, and China do not follow the path of a leading actor but develop within a narrow specialisation, which allows them to successfully compete with traditional industry leaders.

In the context of an analysis of the global ICT network, the theory by Keohane and Nye [15] is useful, according to which complex ("weaponized") interdependence is increasingly used in the interests of national security. The formation of international specialisation and the emergence of value chains, especially in ICT, led to the formation of asymmetric network structures [16] due to the interdependence of state and non-state actors in various fields (political, economic, technological, etc.).

The concept of "power" implies the influence and the strength of the state. Power in such global networks is constructed by restricting access to "bottlenecks", choke points, or by obtaining knowledge/information from this network [17]. For example, with the coming to power of President Biden, the United States began to establish network interaction with microelectronics companies from South Korea, Japan, and Taiwan to establish control over this industry (Chip 4)[1]. At the heart of China's foreign policy is the so-called space of networks. Within its framework, China, being the centre, builds asymmetric networks, giving priority to nearby regions and big powers [18]. Thus, control over the key elements of the global network, including in ICT, is the basis of the power of an actor.

Since the object of research in this paper is the global ICT market (that is, a category of economic science), and the subject is the political influence of states (not companies!) on this market (a category of political science), it is logical to use the approaches of international political economy (IPE) [19, 20]. In 1945, Hirschman studied the relationship between the influence of the state in the international arena and the structure of its foreign trade [21]. This made it possible to include economic and technological components in the list of factors of the state's international influence [22]. The conceptual apparatus of IPE makes it possible to link such concepts as the market and the state and to analyse the relationship between them. On the one hand, the ICT sphere is a field of political competition, where states use relational and/or structural power to coerce other actors to their will [23, 24]. On the other hand, it is a global market where "market power" acts depending on the formation sources or options: monopoly [24], monopsony [25, 26], duopoly and duopsony [19].

Economic and political markets are interconnected and influence each other. In the economic market, the main decision-making factor is an economic benefit, and the key actors are TNCs or other private companies, however in the space of political competition, the main actors are states seeking to establish global influence and control over this area for obtaining political advantages [26]. For example, the United States, due to the activity of international organisations (ICAAN) and BigTech (GAFAM), maintains its global leadership in ICT.

The OECD TiVA data on the indicator Gross exports by final destination and origin of value added (FD_EXGR_VA) is used as the basis for the study of economic and political processes in ICT [27]. This indicator shows the value added created by the first country in the gross exports of intermediate and final goods of the second country to the third. It allows one to evaluate the role of 66 countries in production processes within three key sub-sectors: IT and other information services, D62T63, Telecommunications, D61, Computer, electronic and electrical equipment, D26T27[2]. The latest data on the TiVA FD_EXGR_VA indicator are available for 2018 for 66 actors, and all other countries are grouped into the Rest of World (ROW) index. However, the TiVA database highlights actors such as Hong Kong (HKG) and Taiwan (TWN) that have a prominent place in ICT. For an analysis, the data for Hong Kong and Chi-

[1] Taiwan says U.S. – led "Chip 4" Group discussed Supply Chain Resilience. *Reuters*, 30.09.2022. Available at: https://www.reuters.com/technology/taiwan-says-us-led-chip-4-group-discussed-supply-chain-resilience-2022-09-30/ (accessed 12.10.2022).

[2] *TiVA 2021 – Industries*. Available at: https://www.oecd.org/industry/ind/TiVA-2021-industries.pdf (accessed 07.08.2022).

na (CHN) were combined, and for Taiwan, they are presented separately, given its special role in the processes under study. Thus, the authors analyse data on the TiVA FD_EXGR_VA indicator for 65 actors and 1 ROW group.

The list of the 193 UN states designated following ISO 3166-1:2020 "Codes for the representation of names of countries and their subdivisions"[3] has been supplemented with data for Taiwan. All subsequent calculations cover 194 actors. For an analysis, the methodology of both network and system analysis is used. The first allows one to visualise the connections between individual actors, and the second – to reveal the features of their relationship.

POWER ASSESSMENT OF THE COUNTRIES IN THE GLOBAL ICT INDUSTRY

There are two versions of the power of a country – potential and real. When assessing potential power, only internal factors are considered (territory area, population [28], household access to the Internet). However, it is important to have an idea of its projection on the sphere of international relations. A country can have a huge potential, but not realise it outside, or, conversely, use 100% of its internal capabilities when interacting with other actors of the system or when influencing them. The authors calculate the real power.

In addition, when forming the index, it is important to solve two groups of practical problems:

– implementation of the principles of comparability, combination (clustering) and integration of indicators calculated for different countries and/or based on different data sources;

– a graphical representation of the imbalance between countries.

To calculate the degree of imbalance, it is necessary to set a conditional balance point. For this purpose, a method for calculating the indicators of the interaction of actors based on their fair (equal) participation in international relations is proposed. Thus, the "zero-sum" principle is used to identify the sources of power imbalance [29]: some actors gain or, on the contrary, lose their competitive advantage at the expense of others.

For a graphical representation of the balance of power, the authors propose a technique of a "balance shift pyramid", within which the total amount of power of all actors in the system is normalised and corresponds to the value "+100". At the same time, the threshold value (0) separates actors with a positive balance from those actors whose power indicator is negative. Due to that, the first group of actors gains an advantage. The balance shift pyramid allows to visualise the structure of power distribution in a particular system, demonstrating its absolute and relative performance, the difference in volume, etc. This approach presents the analysed system in a "closed" form, considering all 100% of the participating actors and all 100% of the distributed "resources" (or power) (Fig. 1).

This type of diagram was developed considering the requirement of visual comparability of a set of diagrams calculated according to various indicators – the ratio of the width (the volume of the "resource") and the height (the number of "actors") shows the nature of the indicator imbalance. The examples indicated in Fig. 2 are also justified by the fact that the developed index correlates with the Herfindahl-Hirschman index[4] when the number of participants in the system is more than 10. This is especially applicable when analysing the system of interaction between the countries of the world, consisting of 194 participants.

In addition, by the "black box" principle, *the criteria for the correctness of the application of the developed methodology* have been identified. It is possible to measure only those indicators that exclusively reflect relations between actors, but not a characteristic of the internal state of these actors. For example, the above-mentioned classical universal indicators of the strength of states (area of territory, population, size of GDP) could technically be estimated using the developed methodology, but such an assessment in terms of measuring the balance of power is politically incorrect and one-sided, and an attempt to set a task to assess the balance with these indicators would not be considered effective from the point of view of systems analysis and politically would cast doubt on the

[3] *ISO 3166–1:2020. Codes for the representation of names of countries and their subdivisions – Part 1: Country code.* Available at: https://www.iso.org/standard/72482.html (accessed 07.08.2022).

[4] The Herfindahl–Hirschman index is used to identify the level of competition and the degree of concentration/monopolisation of markets.

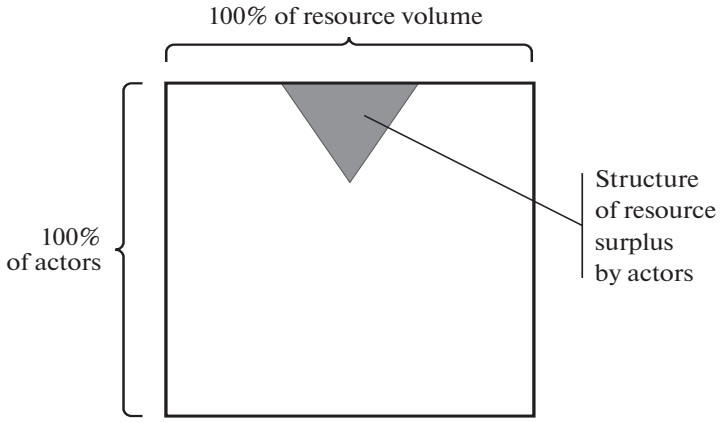

Fig. 1. "Balance shift pyramid"

Source: Compiled by the authors.

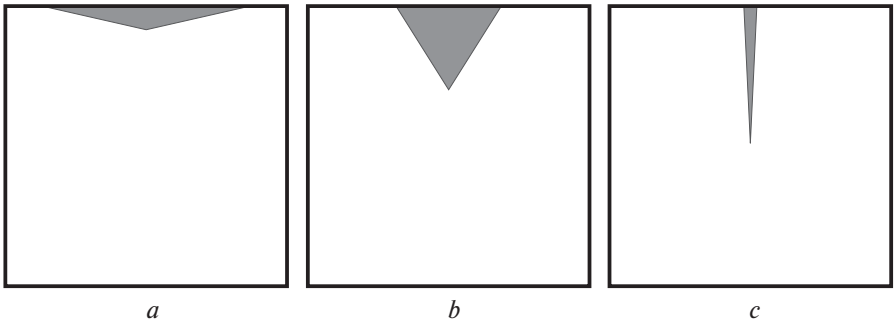

Fig. 2. Various examples of "balance shift pyramids": *a* – monopoly; *b* – oligopoly; *c* – moderate imbalance

Source: Compiled by the authors.

possibility of protecting the sovereignty of individual countries.

The final formula for calculating the power index values is:

$$v_i = \frac{x_i - \overline{x}}{\sum(x_i - \overline{x})} \times 100,$$

where v_i – the index value for each actor; x_i – is the value of the initial data indicator, based on which the index is calculated; $\overline{x}$ – is the sample mean of the initial data indicator.

Therefore, based on all the above principles, the following conditions are true:

$$v_i \in \left[-\frac{100}{N}; 100\right]; \ \sum v_i = 0.$$

Based on TiVA FD_EXGR_VA data on the total volume of output, exports, and imports within three industries (D26T27, D61, D62T63) and the specified methodology, the authors calculated the ICT power index for each actor (Fig. 3). The results obtained show that only 32 states (16.49%) have 91.05% of the world's power. Their positive balance is formed at the expense of other countries that are not shown in the chart (see Fig. 3). The calculation of the imbalance structure makes it possible to characterise the current system of relations in ICT, based on the following conditions:

– monopoly (unipolarity) – one country has 50% or more power;

– duopoly (bipolarity) – two countries together have more than 50% of power;

– oligopoly (polycentricity) – more than two countries together have more than 50% of power;

– polypoly (apolarity) – no single country overcomes the threshold of 15%.

Thus, the current state of the balance of power in ICT can be characterised as an "oligopoly". The most influential actors are China (19.55), the USA (12.05), South Korea (6.35), Japan (4.64), Germany (4.63) and Taiwan (3.87).

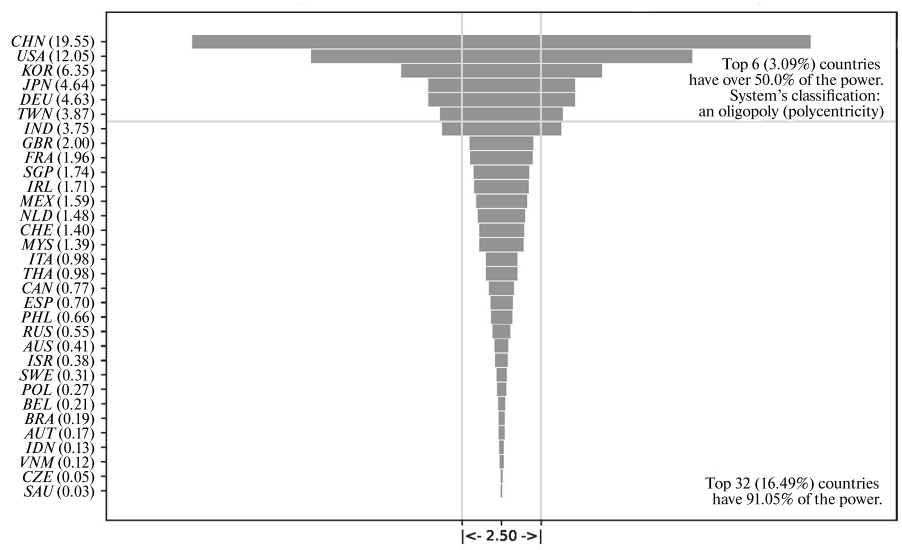

Fig. 3. Country Power Index in global ICT industry, 2018

Source: Compiled by the authors based on TiVA as of 2018.

COUNTRIES' FUNCTIONS IN THE GLOBAL ICT INDUSTRY

The nature of the data presented in the OECD TiVA database makes it possible to study the types of relationships that determine the degree and direction of dependence between the actors. Those types are determined by the functions of the actors that they perform in the system under study: "exporters", "manufacturers" or "importers". Accordingly, the actors enter the following relations:

– exporters provide investments and technologies to manufacturers, who in exchange supply them with goods and services;

– exporters sell goods and services to importers, receiving income from sales.

Assuming that the relationship between manufacturers and importers is transitive (that is, the final consumers of goods and services made/provided by manufacturers are importers), one can get the interdependence scheme shown in Fig. 4.

The diagram shows financial-material-service flows. The dependency is built in the reverse order:

– manufacturers depend on investments and technologies;

– importers depend on the supply of goods and provision of services;

– exporters depend on income from sales.

Based on this, the authors analyse which political advantages and what influence in the global ICT system are received by the states that perform one function or another.

Exporting countries, through the distribution of capital, gain access to the market of another actor (manufacturing country) and form its manufacturing sector in accordance with their needs. Thus, exporters establish influence on manufacturers through dependence on technology and capital. In the same way, exporters can influence importers, but in terms of the supply of products and the provision of ICT services.

The actors belonging to the category "manufacturer" perform the function of an intermediate link between exporters and importers and can act

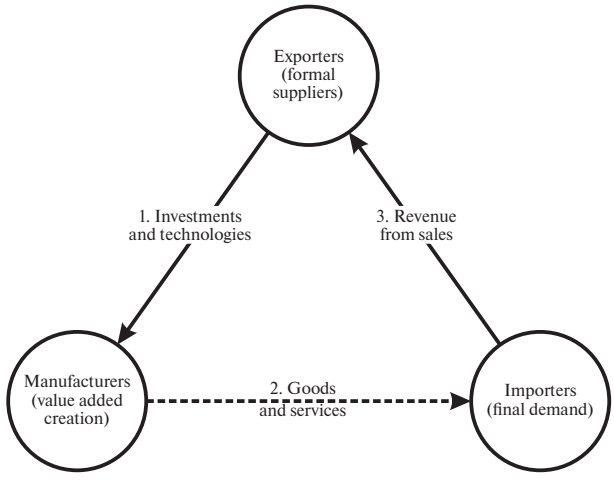

Fig. 4. Country functions in the global ICT industry

Source: Compiled by the authors.

as “choke points” in the value added chains. This means that a manufacturer can manipulate its position in the event of a trade or economic conflict and call into question the stability of the supply chain, despite economic losses. Importers also receive a political advantage through the possibility of restricting imports of goods and services supplied by a particular exporter or manufactured in a particular country.

Thus, each function has not only political advantages but also vulnerabilities that other states can use to achieve their political goals. If the overall system is balanced, then it can be argued that the above types of dependencies are equivalent. That is, one cannot, for example, say that manufacturers depend on exporters more than exporters on importers, etc. To assess whether they are in fact equivalent, one needs to consider the system as a whole. The vertices in the diagram may represent not just functions of individual countries, but components of the system formed from sets of countries. For example, there is a group of exporting countries, which means that they form a component of the system that implements the supply of the total volume of goods and services in this system. The following conditions are possible for the “exporter” component:

– monopoly – there is only one large exporting country in the world, occupying 50% of the market;

– duopoly – two large exporting countries together occupy 50% of the market and compete for sales markets;

– oligopoly – a small group of exporting countries, collectively occupying 50% of the market;

– polypoly – there are many equivalent exporting countries, competition is close to ideal.

Similarly, this applies to the “manufacturer” and “importer” components. As a result, the degree of balance in the system depends on the configuration of each of the three components. All combinations are shown in Fig. 5.

The authors considered it necessary to introduce the term “monoctisy” (ancient Greek μόνος “one” + κτίζω “to make, create”), which de-

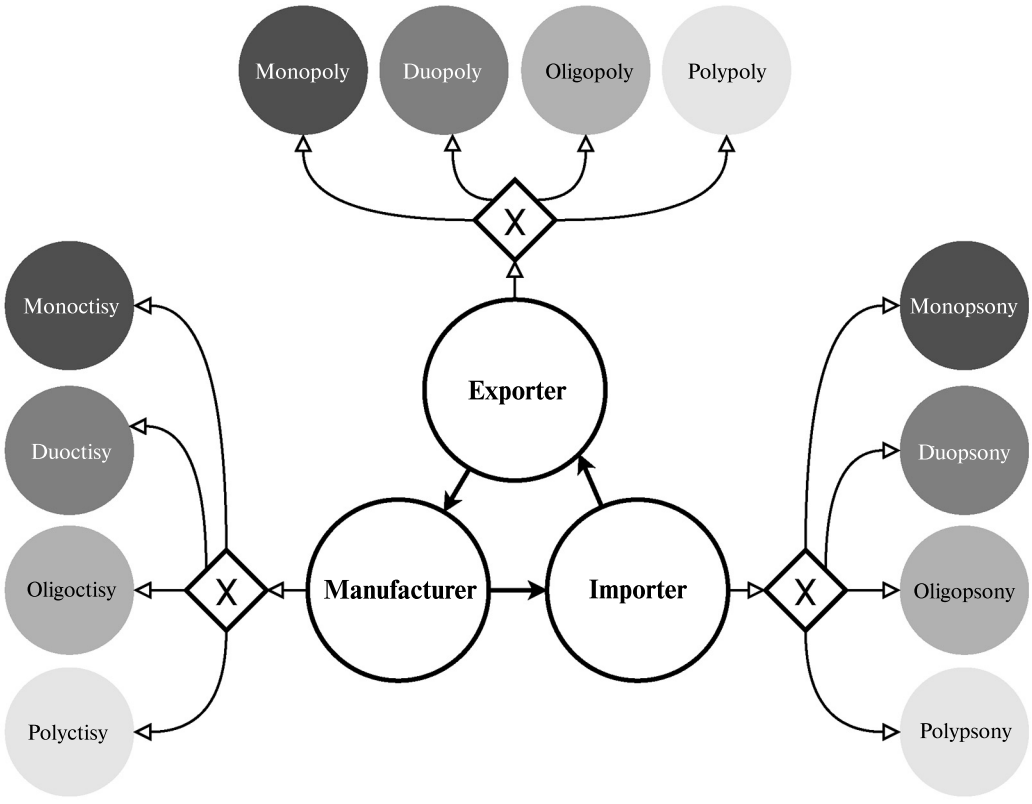

Fig. 5. Types of competition by components of the global ICT industry

Source: Compiled by the authors.

scribes the situation with one manufacturer, the identification of which as an independent player is an integral part of the analysis of chains creating value added.

Thus, the configuration of the system's components also determines the degree of dependence between them (and, accordingly, countries). For example, if the configuration of the "exporter" component is of a monopolistic type, then the degree of dependence of exporters on importers is less than the degree of dependence of importers on exporters. Therefore, it is necessary to identify the configuration of each component of the system. In general, such a system, in a first approximation, can acquire one of 64 states: any of the four "exporter" configurations is combined with one of the four "manufacturer" configurations and with one of the four "importer" configurations. However, there can be more final states of the system if one considers special cases; for example, both components – "exporter" and "manufacturer" – can be monopoly and monoctisy, respectively, but there are two different states: whether it is the same country or two different ones. The evaluation of all possible system states, as well as the analysis of states other than the current one, is beyond the scope of this study.

To assess the current state of the system, the power estimation method described in the previous section was applied, but in the context of the functions of "exporter", "manufacturer", and "importer" (Fig. 6). The components have unique imbalance structures, and different countries have more power in each of the components. Thus, each of them has an oligopolistic (polycentric) type of configuration, based on which it can be assumed that the dependence forces between these components are uniform. Therefore, in the network analysis of the participants in the system, coefficients were not used to assess the strength of ties between countries.

Based on the calculations carried out, the following conclusions can be made:

– China (CHN) is the undisputed leader in the "exporter" and "manufacturer" functions, but is inferior to the United States (USA) in the "importer" function;

– only seven country actors have a key influence in the global ICT industry, while six of them – in at least two of the three functions of the system ("exporter", "manufacturer" and "importer"): China (CHN), United States (USA), South Korea (KOR), Japan (JPN), Germany (DEU) and Taiwan (TWN). These states are the centres of the modern polycentric system in ICT;

– Russia (RUS) has only insignificant power, and only in terms of the functions "manufacturer" and "importer";

– 156 actors (80%) do not have a positive power balance in any of the functions.

Moving to the next level of analysis, it should be noted that each country, being a participant of the system, can simultaneously perform from one to three functions. For example, it can only be an "importer" or equally act as both a "manufacturer" and an "exporter". The degree of correlation between the functions performed determines the actor's type.

TYPOLOGY OF COUNTRIES IN THE GLOBAL ICT INDUSTRY

The next step, involving a more detailed analysis of the political power of states in the global ICT market, is the identification of types of countries depending on the ratio of their exports, imports, and output based on TiVA data. A country's type in the global ICT sphere characterises its position in terms of ICT value added creation and indicates the country's political benefits and vulnerabilities. The authors identify five such types: "altruist", "worker", "merchant", "median" and "consumer".

The results of the analysis are visualised on the graph (Fig. 7), where the size of the country marker corresponds to the value of the calculated power index. States that are among the "global oligopolists" and collectively accumulate more than 50% of the power in this system are highlighted.

Authors consider the types of countries in an interconnected system of value added formation. Actors belonging to the "median" type are in the centre of the graph and have relatively equal shares in the three indicators. The influence of such countries on other actors (as well as dependence on them) is balanced since they do not have a significant bias toward a particular function ("exporter", "manufacturer", "importer").

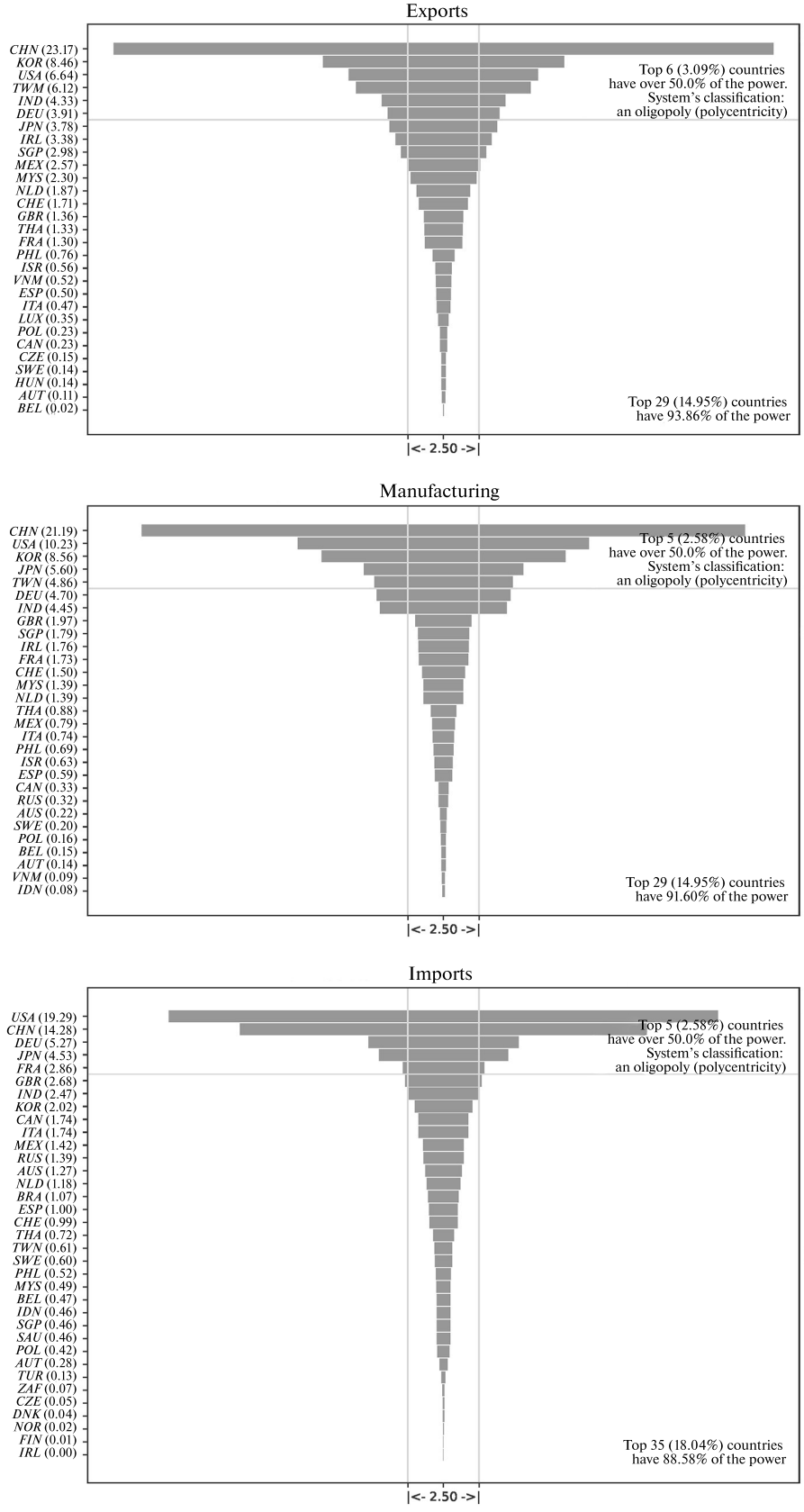

Fig. 6. Power indices by three functions (exports, manufacturing, imports), 2018

Source: Compiled by the authors based on TiVA as of 2018.

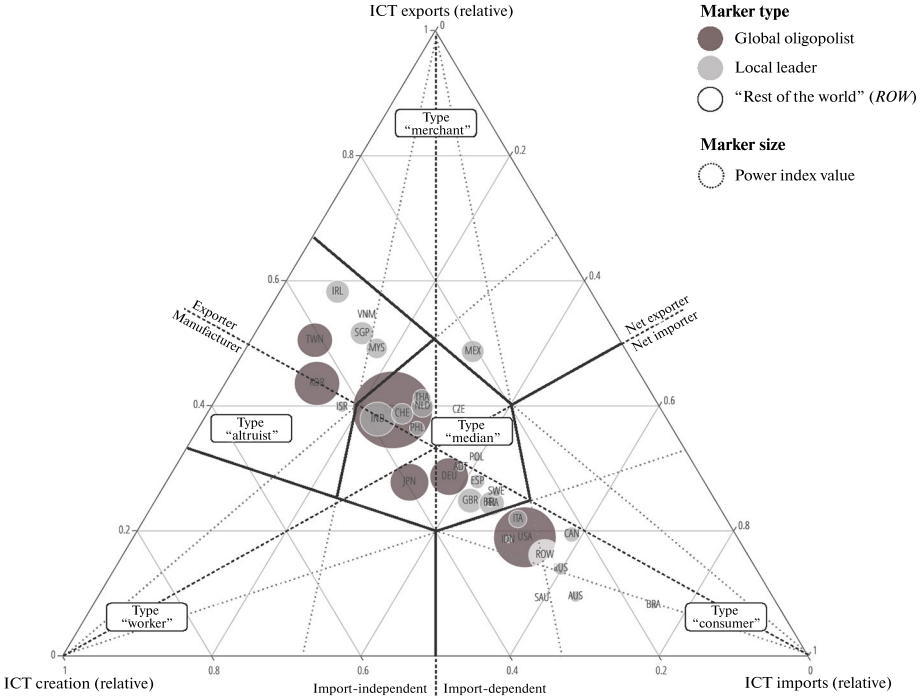

Fig. 7. Typology of countries in the global ICT industry based on the ratio of their exports, imports, and manufacturing, 2018

Source: Compiled by the authors based on TiVA as of 2018.

This type can be contributed to Japan (JPN), Germany (DEU), China (CHN), France (FRA) and the UK (GBR).

The main types to which most of the actors belong are the "altruist" and the "consumer".

It is typical for an "altruist" to perform the functions of an "exporter" and a "manufacturer" simultaneously and to a greater extent than the functions of an "importer": for example, South Korea (KOR) and Taiwan (TWN). The advantage of this type lies in the dependence of other states on their manufacturing and export.

The final product of such countries is mainly imported by entities of the "consumer" type (United States (USA) and Italy (ITA)). Their distinguishing characteristic is the explicit function of the "importer" (compared to the functions of the "exporter" and the "manufacturer"). This position of these countries in the system gives them the power of an importer since they can find whether goods and services exported from and/or produced in specific countries will be in due demand. Despite the power of large "consumers", they still depend on the supply of goods and services produced by other actors.

Two more types in this system – the "merchant" and the "worker" – in a particular case are complementary to each other. Within the framework of the existing system, Mexico (MEX) can be attributed to the actors of the "merchant" type, with its main feature being the volume of exports, which significantly exceeds the volumes of manufacturing and imports. A "merchant" seeks to obtain economic benefits from trading value added produced in other countries. However, the power of such countries is rather limited, since they can only influence other manufacturers whose goods and services are sold, but these countries also depend on these manufacturers to the same extent. At the same time, both exporters and manufacturers are always dependent on larger importers.

In turn, the "worker" type just characterises the reverse situation, when the manufacturing output significantly exceeds both exports and imports. That is, the country does not benefit from the implementation of the created value added and does not use the created benefits. There are no representatives of this type in the system under consideration, and this situation probably developed precisely because the power of this type is rather weak and such countries are very dependent

on both exporters (investment and technology) and importers as a market.

It is necessary to note the key property of the used graphical representation of the system. The volume of realised exports in countries above the line "net exporter – net importer" is equal to the volume of imports in countries below this line. Similarly, the surplus of value added produced in countries to the left of the line "import-dependent – import-independent" is equal to the volume of imports of such a surplus by countries to the right of this line.

Considering that most of the countries in Fig. 7 are located along the "exporter-producer" line, one can conclude that in the current system for actors there is no significant opposition between the "exporter" and "manufacturer" functions they perform. Then it is necessary to investigate based on what the opposition is formed (and, accordingly, how the balance of the system is established).

The two-dimensional graph (Fig. 8) demonstrates the current balance of the system, which does not show the difference between the executable functions of the "exporter" and "manufacturer". At the same time, it more accurately represents the difference between two other pairs of factors: the ratio of exports and imports (x-axis) and the ratio of value added and imports (y-axis).

Based on the key points of the graphical representation described above, one can conclude that the combined power of the countries at the top of the graph in Fig. 8 is equal to that at the bottom, and the combined power of the countries on the left side of the graph is equal to the combined power of the countries on the right side. Thus, in terms of total power, the countries of the upper right and lower left quadrants, where the majority of the analysed actors are located, are equal. This conclusion is also confirmed by the trend line shown in the chart. In practice, this means that if the position and/or power of countries in the upper right quadrant changes (for example, due to decoupling processes), then in most cases this would have an impact on countries in the lower left quad-

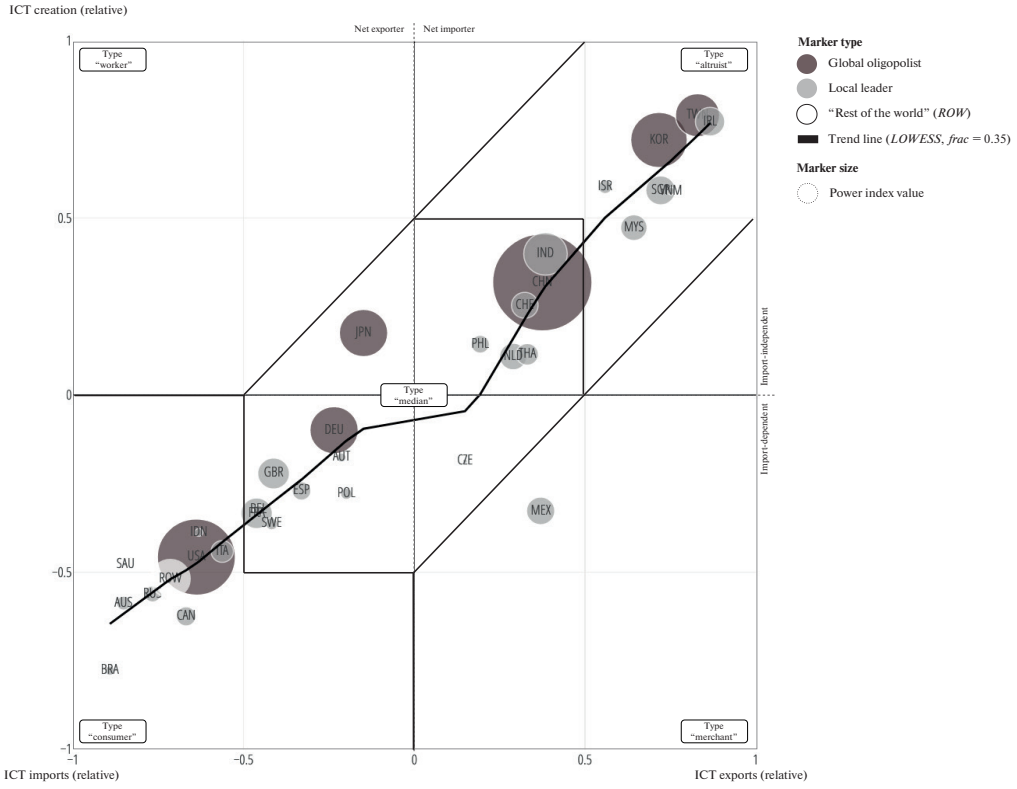

Fig. 8. Typology of countries in the global ICT industry based on the ratio of their exports, imports, and manufacturing, 2018

Source: Compiled by the authors.

rant. This dependence also works in the opposite direction.

A NETWORK ANALYSIS OF COUNTRIES PARTICIPATING IN THE GLOBAL ICT INDUSTRY

The final step in the analysis of the system is the assessment of the network of links between countries. The main tasks of this stage are the identification of the network density and system-forming links, as well as the network visualisation. The network density indicates the degree of integration of the elements in the system and the total number of implemented connections out of all possible ones. The higher the network density, the higher its stability since the violation of one of the links can be quickly compensated by other existing links without an increased load on the system. For example, for 194 actors, the total number of connections (considering the direction of the connection, without the connections of actors with themselves) is 37,442. Unfortunately, one cannot estimate this indicator for the set of all actors, since the initial data provides statistics for only 65 of them, and all the remaining actors are grouped into the ROW index. Thus, the total number of connections (considering the direction of the connection, without the connections of actors with themselves) for 66 elements is 4,290.

The estimated network density is 99.02%. This value indicates a high degree of integration of the analysed actors into the global process of manufacture and sale of goods and services in ICT and acts as a reflection of the globalisation results. A key factor in this state is also the very

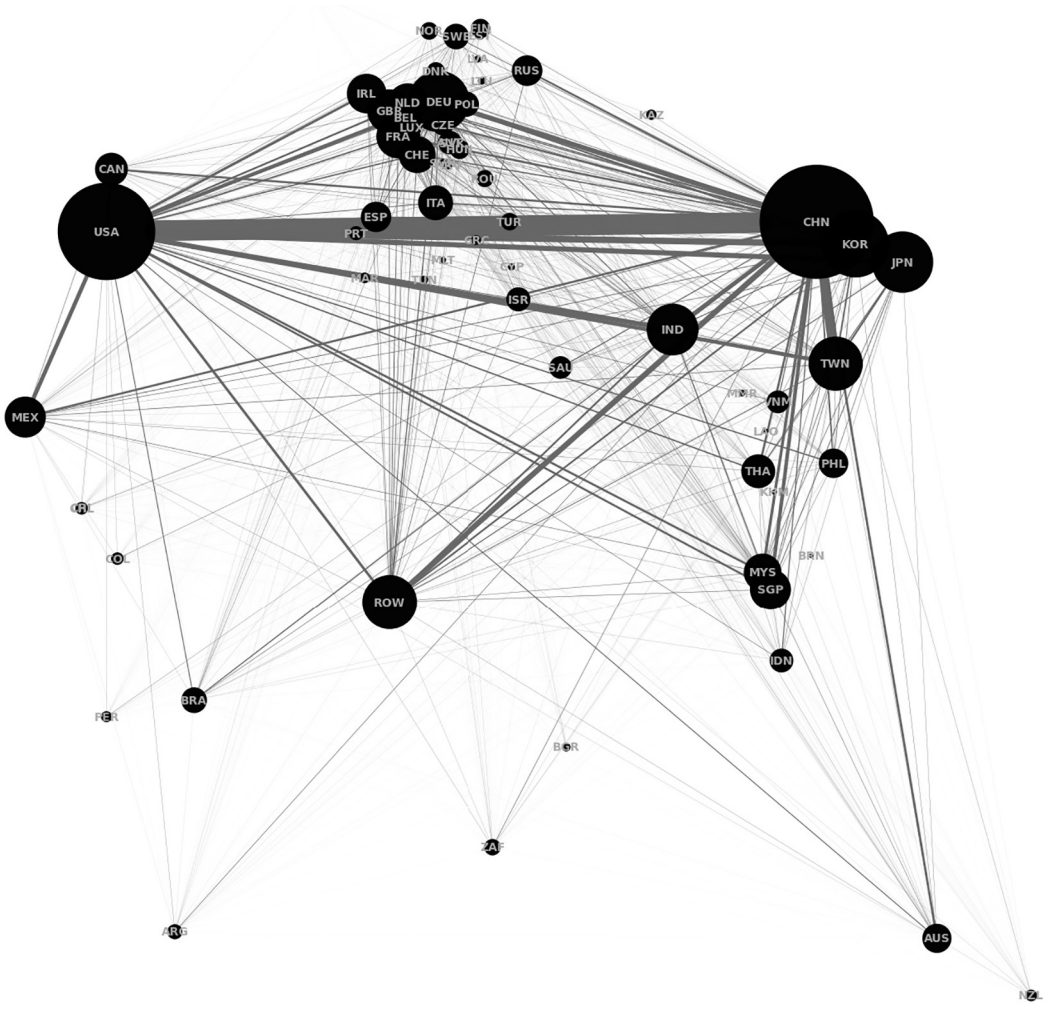

Fig. 9. Network graph of global ICT creation chains, 2018

Source: Compiled by the authors, is based on the 2018 data.

nature of ICT goods and services (software, service maintenance, etc.), it is often much less expensive to organise their creation, exports, and imports and require neither the physical presence nor physical movement of materials. In this regard, it is also necessary to note the valuable quality of this system – in the event of a rupture and violation of the chains in creating value added, alternative chains will likely arise in it that will bypass bottlenecks.

Links between countries can be represented graphically to visually show both the network density calculated above and the strength of links between actors. In this case, the strength of links is calculated by the volume of manufacturing-exports-imports operations (in monetary terms). The dependency graph is shown in Fig. 9. The coordinates of the countries on the chart correspond to the coordinates of the capitals of these countries. All other countries of the world (ROW index) are conditionally located at a point on the prime meridian. The size of the vertices on the graph is proportional to the calculated power index, and the thickness of the edges reflects the degree of interdependence, measured by the volume of service-material-financial flows.

The main conclusions that can be drawn from this graph are:

– countries of the world (*ROW*) are more connected with China (CHN) than with the United States (USA);

– the United States (USA) is connected with the European countries by "bigger" links, but China (CHN) has a higher number of links with the European countries;

– Taiwan (TWN) is more connected with China (CHN) than with anyone else;

– Russia (RUS) is more connected with China (CHN) than with anyone else;

– the largest connection in the system is between the USA (USA) and China (CHN).

Taking a closer look at the last point, the calculations confirm that the China-US tandem takes part in about 16% of transactions (USD380 billion) in monetary terms, which is only about 0.84% of the total number of value chains. It can be stated that the relationship between the US and China is still system-forming. This means that any of its violations (quantitative or qualitative) will have a critical impact on all participants in the system.

RESULTS AND CONCLUSIONS

The modern system of relations between states in the field of ICT has a polycentric nature. The centres are China and the United States with the most influence, as well as South Korea, Japan, Germany, and Taiwan.

The conducted research contributes to the development of the assessment of countries' power and influence in the global ICT industry. In addition, some practical results have been obtained in the study, which contribute to a deeper understanding of the mechanisms of uneven development of states in terms of non-hierarchical models and describe countries' functions in the field of ICT. First, the authors formulated and calculated an index that shows the distribution of power among states in the ICT industry, and showed that more than 50% of the world's calculated power comes from just six countries.

Second, the authors analysed the functions of states and their interdependence, identified based on this the main components of the global ICT industry and the types of competition of these components, introduced a new term "monoctisy" to identify the type of competition among manufacturing countries, and found the current state of the system as oligopolistic (polycentric).

Third, with the ratio of the performed functions as the basis, the authors identified the types of states, and the features of their influence and dependence, identified and graphically presented the principle of forming a balance in the existing system of international trade in ICT. Fourth, the authors carried out a network analysis of actors in the studied system, calculated the system density as high, identified the system-forming relationship between China and the United States, and presented the network graphically.

The above conclusions confirm several theoretical concepts. First, ICT is a space in which political and economic factors interact. Using the latter, states seek to form and consolidate "market power" in ICT, which, as a result, will be the basis for the formation of political power in the global network. Second, according to the theory of com-

plex interdependence, states compete for control over the sphere of ICT as a key tool of influence in a polycentric system. Third, according to the network analysis, the authors conclude that the process of separation of the economies of the USA and China does not yet affect the volume of interaction between these two actors, their connection is currently a system-forming one. In the future, the structure of links will change, in accordance with geopolitical risks for both states and the already emerging process of technological decoupling.

REFERENCES

1. Schumpeter J.A. *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. New York, Toronto, London, McGraw-Hill, 1939. 461 p.
2. Рябов А.В. От целостности к новому расколу и соперничеству? (миросистема и мировой порядок в меняющихся реалиях). *Контуры глобальных трансформаций: политика, экономика, право*, 2019, т. 12, № 4, сс. 32-48.

   Ryabov A.V. From Integrity to the New Split and Rivalry? (World System and World Order in Changing Realities). *Outlines of Global Transformations: Politics, Economics, Law*, 2019, vol. 12, no. 4, pp. 32-48. (In Russ.) Available at: https://doi.org/10.23932/2542-0240-2019-12-4-32-48
3. Варнавский В.Г. Международная торговля в категориях добавленной стоимости: вопросы методологии. *Мировая экономика и международные отношения*, 2018, т. 62, № 1, сс. 5-15.

   Varnavskii V.G. International Trade in Value added Terms: Methodological Issues. *World Economy and International Relations*, 2018, vol. 62, no. 1, pp. 5-15. (In Russ.) Available at: https://doi.org/10.20542/0131-2227-2018-62-1-5-15
4. Дегтерев Д.А., Рамич М.С., Пискунов Д.А. Подходы США и КНР к глобальному управлению киберпространством: “новая биполярность” в “сетевом обществе”. *Вестник международных организаций*, 2021, т. 16, № 3, сс. 7-33.

   Degterev D.A., Ramich M.S., Piskunov D.A. U.S. & China Approaches to Global Internet Governance: “New Bipolarity” in Terms of “The Network Society”. *International Organisations Research Journal*, 2021, vol. 16, no. 3, pp. 7-33. (In Russ.) Available at: https://doi.org/10.17323/1996-7845-2021-03-01
5. Дегтерев Д.А., Рамич М.С., Цвык А.В. США–КНР: “властный транзит” и контуры “конфликтной биполярности”. *Вестник Российского университета дружбы народов. Серия: Международные отношения*, 2021, т. 21, № 2, сс. 210-231.

   Degterev D.A., Ramich M.S., Tsvyk A.V. U.S.–China: “Power Transition” and the Outlines of “Conflict Bipolarity”. *Vestnik RUDN. International Relations*, 2021, vol. 21, no. 2, pp. 210-231. (In Russ.) Available at: https://doi.org/10.22363/2313-0660-2021-21-2-210-231
6. Данилин И.В. Влияние цифровых технологий на лидерство в глобальных процессах: от платформ к рынкам? *Вестник МГИМО-Университета*, 2020, т. 13, № 1, сс. 100-116.

   Danilin I.V. The Impact of Digital Technologies on Leadership in Global Processes: from Platforms to Markets? *MGIMO Review of International Relations*, 2020, vol. 13, no. 1, pp. 100-116. (In Russ.) Available at: https://doi.org/10.24833/2071-8160-2020-1-70-100-116
7. Satoru M. US Technological Competition with China: The Military, Industrial and Digital Network Dimensions. *Asia-Pacific Review*, 2019, vol. 26, no. 1, pp. 77-120. Available at: https://doi.org/10.1080/13439006.2019.1622871
8. Кондратьев В.Б. Мировая экономика как система глобальных цепочек стоимости. *Мировая экономика и международные отношения*, 2015, № 3, сс. 5-17.

   Kondrat’ev V.B. World Economy as Global Value Chain’s Network. *World Economy and International Relations*, 2015, no. 3, pp. 5-17. (In Russ.) Available at: https://doi.org/10.20542/0131-2227-2015-3-5-17
9. Wallerstein I. *The Capitalist World-Economy*. Cambridge University Press, 1979. 320 p.
10. Krause K. The Political Economy of the International Arms Transfer System: The Diffusion of Military Technique via Arms Transfers. *International Journal*, 1990, vol. 45, no. 3, pp. 687-722. Available at: https://doi.org/10.2307/40202695
11. Мальцев А.М. Сетевая динамика “диффузии технологий” в системе международных трансферов вооружений. *Международные процессы*, 2020, т. 18, № 4, сс. 36-61.

    Mal’tsev A.M. Network Dynamics of Technology Diffusion in International Arms Transfers. *International Trends*, 2020, vol. 18, no. 4, pp. 36-61. (In Russ.) Available at: https://doi.org/10.17994/IT.2020.18.4.63.5
12. Akamatsu K.A. Historical Pattern of Economic Growth in Developing Countries. *Journal of Developing Economies*, 1962, vol. 1, no. 1, pp. 3-25.
13. Kojima K. The “Flying Geese” Model of Asian Economic Development: Origin, Theoretical Extensions, and Regional Policy Implications. *Journal of Asian Economics*, 2000, vol. 11, no. 4, pp. 375-401.

14. Tung A.C. Beyond Flying Geese: The Expansion of East Asia's Electronics Trade. *German Economic Review*, 2003, vol. 4, no. 1, pp. 35-51.
15. Keohane R.O., Nye J.S. *Power and Interdependence*. London, Pearson Education, 2011. 368 p.
16. Lanteigne M. "E-breakout"? Weaponised Interdependence and the Strategic Dimensions of China's Digital Currency. *The Chinese Journal of International Politics*, 2022, vol. 15, no. 2, pp. 140-162.
17. Farrell H., Newman A.L. Weaponized Interdependence: How Global Economic Networks Shape State Coercion. *International Security*, 2019, vol. 44, no. 1, pp. 42-79.
18. Грачиков Е.Н. Геополитика Китая*:* эгоцентризм и пространство сетей. Москва, Русайнс, 2017. 234 с.
Grachikov E.N. *Geopolitics of China: Egocentrism and Space of Networks*. Moscow, RuScience, 2017. 234 p. (In Russ.)
19. Shaw T.M. et al., eds. *The Palgrave Handbook of Contemporary International Political Economy*. London, Palgrave Macmillan, 2019. 743 p.
20. Афонцев С.А. *Политические рынки и экономическая политика*. Москва, Комкнига, 2010. 380 с.
Afontsev S.A. *Political Markets and Economic Policies*. Moscow, Komkniga, 2010. 380 p. (In Russ.)
21. Hirschman Al. *National Power and the Structure of Foreign Trade*. University of California Press, 1945. 194 p.
22. Цыганков П.А. *Теория международных отношений: Учеб. пособие*. Москва, Гардарики, 2003. 590 с.
Tsygankov P.A. *International relations theory*: *textbook*. Moscow, Gardariki, 2003. 590 p. (In Russ.)
23. Чан Я., Останин В.А. Международная политическая экономия как теоретическая база познания процессов на политических рынках. *Вестник Алтайской академии экономики и права*, 2021, т. 5, № 1, сс. 128-134.
Zhang Y., Ostanin V.A. International Political Economy as a Theoretical Basis for knowing the Processes in Political Markets. *Vestnik Altaiskoi akademii ekonomiki i prava*, 2021, vol. 5, no. 1, pp. 128-134. (In Russ.) Available at: https://doi.org/10.17513/vaael.1697
24. Kovacic W.E. Transatlantic Turbulence: The Boeing – McDonnell Douglas Merger and International Competition Policy. *Antitrust Law Journal*, 2001, no. 68, pp. 805-874.
25. Galbraith J.K. *American Capitalism: The Concept of Countervailing Power*. Boston, Houghton Mifflin, 1952. 234 p.
26. Олейнов А.Г. Международная политэкономия: предмет и метод. *Мировая экономика и международные отношения*, 2017, т. 61, № 2, сс. 54-64.
Oleinov A.G. International Political Economy: Subject Matter and Method. *World Economy and International Relations*, 2017, vol. 61, no. 2, pp. 54-64. (In Russ.) Available at: https://doi.org/10.20542/0131-2227-2017-61-2-54-64
27. Martins Guilhoto J., Webb C., Yamano N. *Guide to OECD TiVA Indicators*, *2021 edition*. OECD Publishing, 2022, no. 2. 55 p. Available at: https://doi.org/10.1787/58aa22b1-en
28. Aron R. *Paix et guerre entre les nations*. Paris, Calmann-Lévy, 1984. 832 p.
29. Gilpin R.G. *The Political Economy of International Relations*. Princeton, Princeton University Press, 2016. 472 p.