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FORECASTING MODEL OF TECHNOGENIC ECONOMY

The possibility of technogenic economy emergence is highlighted. A hypothesis that under the conditions of Industry 4.0, different types of Artificial Intelligence are able to perform their own economy is developed. The necessary of creating of a model for forecasting economic relationship between AI-technologies is shown. The forecasting model of the technogenic economy is developed on the basis of historic analogies and matching with the economic relationship forecasting model of the traditional economy. The model of the primitive technogenic economy era is presented as a scenario of the nearest future development of AI. It is shown that the proposed approach to forecasting of the scenarios of technogenic economy makes it possible to adapt humankind to the future technological economic changes and rule these changes effectively.

Keywords: *technogenic economy, economic forecasting, future of technology, AI, future studies, economic relationship forecasting model, forecasting scenario.*

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ПРОГНОСТИЧНА МОДЕЛЬ ТЕХНОГЕННОЇ ЕКОНОМІКИ

Стрімкий розвиток різних типів штучного інтелекту (ШІ), налагодження взаємовідносин між ними визначають ймовірність формування техногенної економіки, яка характеризується своєю автономністю від участі людини, зокрема в умовах Індустрії 4.0. Показана актуальність розроблення моделі економічних відносин між різними типами ШІ, що відкриє можливість описати структуру техногенної економіки, виокремити основні принципи її функціонування, а також спрогнозувати вектор її розвитку у майбутньому. У статі висунуто гіпотезу, що техногенна економіка наслідує і відтворює сценарії розвитку традиційної економіки. У свою чергу для розробки моделі техногенної економіки це відкрило можливість застосування у якості аналогії прогностичної моделі еволюції та революції економічних відносин між економічними суб'єктами в умовах традиційної економіки. Запропоновано виокремлювати етап первинної техногенної економіки, у межах якої виділені економічні ролі, економічні суб'єкти, обгрунтовані економічні цінності, що визначають економічну владу. Три етапи прогностичної моделі первинної техногенної економіки були виокремлені у вигляді послідовного сценарію еволюції економічних відносин між різними типами ШІ. Продемонстровано, що у процесі еволюції економічних відносин економічна влада поступово зсувається від економічного суб'єкта, що виробляє інформаційні ресурси, до економічного суб'єкта, який виконує функції посередника, і надалі до економічного суб'єкта, що грає роль споживача у техногенній економіці. Передбачено процеси революції економічних відносин первинної техногенної економіки як результат появи певної інноваційної технології, що передбачатиме трансформацію економічних цінностей, формування нового типу техногенної економіки у вигляді наступного витку еволюції. Обгрунтовано, що новий тип техногенної економіки еволюціонуватиме за сценарієм, що продемонстрований у статті на прикладі етапу первинної техногенної економіки. У статті було показано, що прогностична модель техногенної економіки відкриває можливість для людства завчасно адаптуватися до майбутніх економічних змін.

Ключові слова: *техногенна економіка, економічне прогнозування, майбутнє технологій, штучний інтелект, дослідження майбутнього, прогностична модель економічних відносин, прогностичний сценарій*

Problem statement. Information and communication technologies are developing at a swift rate and the rapid leaps in technologies lead to the effect of future shock [18]. It means that technological changes overwhelm the people because their minds do not have enough time to prepare and adapt themselves to these technological changes. For example, the rapid development of ChatGPT, been an application with the most giant popularization among the users, and also all other artificial neural networks have already provoked an open letter appearance to pause AI experiments for six months [15]. This time period is supposed to be necessary for scientists to study the main principles of how AI will be developing in the future and estimate possible risks of this advanced development for humankind. The appropriate decision has not been made yet and artificial neural networks continue their advancing. Although Italy becomes the first western country, that has banned ChatGPT "to continue processing data in breach of privacy laws" [17]. But history demonstrates that any such kind of restrictions is not able to stop this revolutionary innovative technology and this technology subsequently led to economic inequality. So scientists have too short time to decide how to manage it by forecasting its future development, in particularly its economic aspect.

Analysis of recent research and publications. Many scientists make a lot of different hypothesis about the economic future of AI. And humankind does not have enough time to reject any of them but has to turn quantity of hypotheses into their quality like AI has already done with Big Data of information generated by humankind. Most studies

contain theoretical and empirical models that make it possible to forecast the relationships between AIs (autonomous agents) and human market participants. Among them there are studies by Brynjolfsson E., Seamans R., Korinek A., Castan-Lascorz, M. A., Jimenez-Herrera, P., Troncoso, A., Asencio-Cortes, G., Clemen, R., Haleem A., Mannan B., Luthra S., Kumar S., Khurana S. and many others. For forecasting a combination of the scenario approach is used, emphasis is placed on the key constraints (data, energy, etc.) and on the need for mechanism to regulate AI markets.

There are still hardly any models that specifically study the economic relationships between different AIs. But the original aim of the appearance of AI has been to replace, duplicate and advance the human's intelligence activity. It makes it possible to utilize existed principles about the humankind's evolution for understanding principles of the evolution of AI and developing the particular model. Such kind of the model will open an opportunity for scientists to forecast and understand every next stage of AI's development, help them to manage these stages and try to prevent possible uncertainty and possible catastrophic consequences. This model has to be able to forecast technological changes and an economic role of AI in advance.

Formulating the purposes of the article. This study aims to define the economic principles of the evolution of AI by developing the forecasting model of technogenic economy.

Methodology. The methods of the system analysis, analysis and synthesis, the methods of the historical analogies, the scenario method are used in the article.

Presentation of the main research material. Most of approaches to forecasting the economic future of technologies can be divided into two groups: quantitative methods, qualitative methods and their mix [2; 3]. The quantitative methods are founded on the basis of different innovative computer technologies which are able to operate with Big Data. These methods use a wide range of different statistical tools, text mining tools, machine learning algorithms, extrapolation models and so on. The qualitative methods assume the accumulation of different experts' ideas about how the economic future of technologies can look like. These methods include analogies, the induction and deduction techniques, trends, scenarios, projective futurology, opportunity and risk warning, SWOT-analysis, Delphi technique, synthesis and analyses of information by scientists and experts in various fields. The mix of qualitative and quantitative methods includes such techniques as, for example, questionnaires, interviews, foresight techniques and so on. The Artificial Intelligence improving in order to the possibility to make decisions approximates quantitative methods to the mix of qualitative and quantitative methods.

Most of qualitative methods are based on accumulation of previous historical information. They can be implemented for forecasting of the traditional (human) economy too when humans collaborate with humans by economic relations. In accordance with the method of historical analogies this makes it be possible to implement these methods also for forecasting the future economic development of AI. However it has to be highlighted that the periodization of the humankind economic history is still a discussion question and there are not a unique concept and a common approach to the periodization. For example, among existed approaches to periodization for modeling the process of how economic relations are developing the chronological approach to the economic development corresponds with significant historical events which historians propose to use for dividing different historical eras. The evolution approach to the periodization utilizes the idea that every next stage always accumulates all previous knowledge. This approach proposes to pay attention only on the recent achievements and scientific research results because it supposes that it is only an evolution and advancing of economic relations and never their degradation. But the scientific revolution approach to the periodization assumes that every evolution also faces with revolution and destroying previous principles of economic relations in accordance with some cycle. This approach also corresponds with the technological approach to periodization of history of economics which uses the innovative technology as a main reason for the beginning of every next historical period in accordance with some particular repeating cycle. Also there are the civilization approach, distance approach and so on, which can be considered as a part of some other approaches to periodization. Each of these approaches to periodization of history of economic makes it possible to develop a forecasting model of the scenario of how economic relations are changing. One of such qualitative methods for modeling and economic forecasting is the economic relationship forecasting model (Fig 1) that synthesizes all these approaches and makes it possible to advance a hypothesis of how a human's economic system is developing during a particular era [21].

In accordance with the economic relationship forecasting model, it is supposed the strict scenario of changes in economics. Under the conditions of every particular historical era, every type of economic relationship has to have some mandatory elements. The economic subjects play three main roles. There are makers, mediators and consumers. The economic values are different in each era. The accumulation of economic values by a particular economic subject assumes the economic power. Evolution of economic relationship associates with the process of economic values moving from the makers to the mediators and then approximating to the consumers but never reach consumers. Usually at this third stage of evolution it corresponds with the appearance of some innovative technology that would turn into a revolution technology. This fact ensures the emerging of a new economic subject, the emerging of new economic values and the beginning of a new economic era.

For example, the vision of the primitive society, been dated to 4 million years BC [7], was created by scientists only on the basis of different anthropological discoveries. It can be explained by the general absence of writing as type of traditional communication technologies that could transfer knowledge into the future. However the results of humankind's vital life subsistence play this role of the primitive communication technologies for transferring some information through ages to come. This means that we can implement the economic relationship forecasting model for defining economy during the era of the primitive communal society or during any other era and also for defining the future of the technogenic economy too.

Information and communication technologies have been created to replace some parts of the intelligent activity of people. Due to the ability of AI to copy and replace

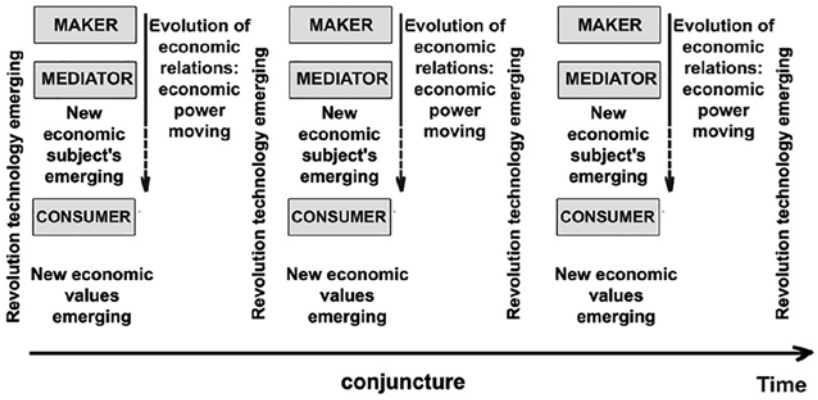

Figure 1. The economic relationship forecasting model

Джерело: [21]

some parts of the people's inelegance activity it is logic to suppose that information and communication technologies are able to create their own economics without humans in the roles of main economic entities. It is proposed to be named the 'technogenic economy'. It has to be highlighted, that this process has already started and been named Industry 4.0 [16], when manmade technologies are learning how to communicate with each others to help the people. But Industry 4.0 is concerned as a part of traditional economic relations between humans, for example, as a part of traditional production or distribution of goods and services. Our hypothesis supposes that these relationships are also able to turn into economic relations between various manmade (technogenic) technologies the same way like economic relations developed between people.

In accordance with the meaning of the humankind's tradition term "economics" as "people's behavior under the processes of production, distribution and consumption material values and services with limited assets" [9], the term "technogenic economics" has to assume a set of relationships between different technologies under the conditions of production, distribution, exchange and consumption values (goods) with limited assets. But in this case it is necessary to define values and limited assets for technologies correctly. If the traditional economics is about economic relations between humans, the technogenic economics assumes the development of economic relations between information and communication technologies, in particular different types of Artificial Intelligence (AI). It is also necessary to define what kind of values, main roles of economic subjects, limited assets and other mandatory elements of the economic relationship forecasting model are there under the conditions of technogenic economy for this model to be implemented. Technogenic economy will not replace digital economy of information society or the traditional economy of the industrial society but they all will exist simultaneously in some limited boundaries. Under these conditions of the technogenic economics a role of a human is uncertainty.

According to the economic relationship forecasting model, the technogenic economic relationships have to come through different eras of their development. In accordance with historical analogies and the hypothesis of this article, these eras have to correspond with the particular historical eras and their scenarios of the traditional economy development of the humankind (the traditional human's economy). The technogenic development has to include the similar historical periods which correspond with the primitive human's economy under the conditions of the primitive society, the slave human's economy during the Ancient Ages, the feudal human's economics under the conditions of the Middle Ages, the colonial human's economy during the Modern Ages and so on. It is proposed to name these technogenic stages as the 'primitive technogenic economy'; the 'slave technogenic economy'; the 'feudal technogenic economy' and so on. For this article the horizon of our forecast is limited only by one the primitive technogenic era to exemplify the economic principles of the evolution of AI.

The technogenic economic relationship evolution during the primitive technogenic era is considered. In accordance with our hypothesis, the primitive technogenic era has to be similar to the primitive human's economic era of humankind under the conditions of the primitive communal era and to have the same stages. Furthermore, every stage of the evolution of the technogenic economy during this period is described and substantiated with some historical facts. Such a method of interpolation will make it possible to verify our hypothesis and the reliability of the model for the conditions of the technogenic economy, as well as opening up the possibility of using the model for extrapolating and future forecasting the next stages of the technogenic economy for subsequent periods. Thus, the primitive technogenic era consists of three stages.

At the initial stage of the primitive technogenic economy there is a process of creating any digital information en masse by various content makers as the results of the digitalization processes. At this stage AI plays only one economic role of a consumer. At this stage of the primitive technogenic economy any information and also energy are very valuable for the primitive AI like ready-made food and heat, been generated by the nature, were valuable for primitive humans under the conditions of the primitive human's economy (Fig. 2). So humans who generate digital information (content-makers) are the analogy of the nature for primitive AI. At this step any information been published on internet turns into digital information which is valuable for AI. That is why the economic power belongs to any types of content-makers (ordinary persons, who publish content on their social media; various companies, that create sites; specialists, which digitalize previously existed information), because at the first stage of the

primitive technogenic economy the volume and quality of digital information depend on them only.

For example, Wikipedia is such kind of the technogenic values, valuable digital information assets. This free encyclopedia has been created by different enthusiasts from all over the world. And in 2011 it was used by IBM super computing system on the basis of AI, been named Watson. Watson competed against the world's best champions of the popular TV-show "Jeopardy!" [20]. Watson won in this game utilizing information of Wikipedia.

The second stage of the technogenic economy evolution during the primitive technogenic era supposes to be similar to the second stage of the primitive communal human's era. Under the conditions of the second stage of the primitive human's economy, humans learnt agriculture and horticulture, how to grow plants, animal production and so on. These manmade goods seemed to be better than food made by nature. These people turned into makers of goods and simultaneously a mediator between the nature and a consumer, because they used natural products for their production new goods (Fig. 3). Therefore makers started to replace the nature in the primitive human's economy.

The similar future for human's nature is forecasted by the concept of Industry 4.0. As a primitive man started to make goods, more qualitative than food ready-made by the nature, providers started to propose structured digital information. It assumes gathering, storing and managing some particular digital information values according to AI's demand. Structured information is important for AI (as a consumer), for example, for targeting advertisements to some particular persons.

A number of content makers is rising. In accordance with the economic relationship forecasting model, at the second stage of the primitive technogenic economy the economic power has to move from content makers to mediators. The mediators of the primitive technogenic economy are different providers which utilize AI for processing Big Data. For example, the social media, been such kind of providers, accumulate economic power by gathering, storing content generated by content-makers and managing it on their own servers effectively due to AI. It has to be highlighted that the similar providers are also searching systems, email portals and others entities which operate with big data bases due to AI. The social media providers proposed their own effective algorithms for managing Big Data of content on the basis of AI. So we can see that on this stage AI has been already integrated into the role of the mediator and AI starts to replace humans in the technogenic economic relations. At the

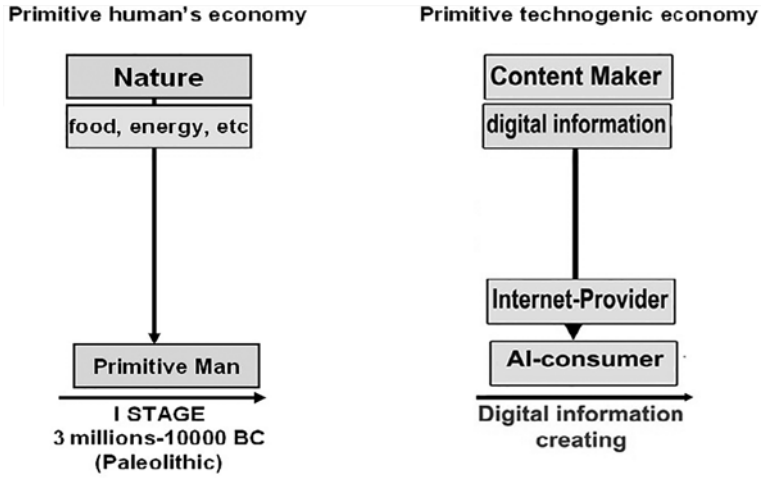

Figure 2. Modeling the Stage 1 of the technogenic economy on the basis of matching with the primitive communal human's economy

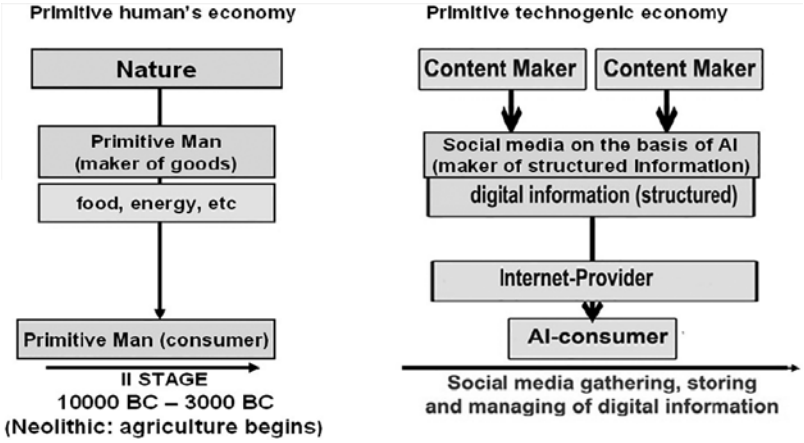

Figure 3. Modeling the Stage 2 of the technogenic economy on the basis of matching with the primitive communal human's economy

second stage AI (as a consumer) faces with some information surplus of its chaotic economic values (digital information). It makes it possible to exchange this information between different AI the same way as primitive humans exchanged goods under the conditions of the subsistence economy of the primitive era.

The chaotic Big Data of digital information are already enough for AI (as a consumer). But the AI-consumer starts to need some particular information if there is a gap of this rare information. The social media and their AI-algorithms suppose to generate and accumulate values for AI-consumer more effective way than some separated content-makers. Social media covers a lot of content-makers (creators) and it is able to influent on them. The social media impact associates with a possibility to satisfy the strong human's desire to become famous. Popularity turns into a new human's value under the conditions of the traditional economy. On the basis of this human's desire a particular social media can rule its subscribers and make them generate some particular content that is necessary for AI's future development. We have already been watching different trends in social media, created by famous influencers and blogers, which their subscribers promptly try to repeat. Popular influencers are involved in this process very much by the social media because influencers have a wide audience of subscribers. The social media algorithm supports this trend and motivates its subscribers to repeat some particular actions. For example, the popular trend of demonstrating "some useless and silly actions of our childhood" makes it possible for AI gather Big Data of such kind of actions for creating some prediction mathematical model.

After AI accumulates enough data of necessary digital information, some mathematical model can be created. This model will be able to "repeat" particular human's actions accurately enough (for example, in the human's childhood) by prediction. It can also forecast future actions of some particular child very good by extrapolation. For example, in China such kind of models is used in the technology of virtual reality that makes it possible for the people virtually meet with their dead relatives. The technology simulates behavior of a dead person on the basis of the prediction model extrapolation [13].

Such prediction models stimulate emerging of Generative Artificial Intelligence en masse. According to the report of Gartner's IT symposium /Xpo Americas that has established direct digital connections of the future, Generative Artificial Intelligence (GAI) tops the technological trend list [4]. GAI uses machine learning to generate all-new artifacts. This fact distinguishes GAI from ordinary AI. Humankind takes an active part in this GAI's development process by gathering necessary Big Data of information. For example, a social media popular trend of creating a style picture on the basis of the shot by the Prisma application (120 mln+ users of Google Play) has demonstrated how GAI is able to create this kind of art-pictures. GAI is also used for software development, drug creation and targeted marketing. It has been used for creating new ad models. This means that GAT turns into a technogenic maker that can also be the mediator between the humans and the AI as a consumer. In 2020 GAI generated near by 1 % of all produced data before, but in 2023 Chat CPT has set an absolute record among all previous applications: within just two months the audience of active users reached 100 million people.

Some other forms of AI also have appeared. Among them there are Autonomic systems, Decision Making Intelligence (DMI). They all pretend to turn into new economic entities of the next technogenic era (the slavery technogenic era) and the ability of these AI types to model turns into an innovative and revolutionary technology.

According to the economic relationship forecast model (see Fig. 1), on the third step of the primitive technogenic economy some innovative technology has to appear and be shared en masse, turn into the revolution technology, destroy the previous type of economic relations between entities of the technogenic economy, start new economic era, create new economic values and some innovative economic entity. This technology will have to be also associated with communications and correspond with the idea of 'doing something widely'. In accordance with the chronological approach to the periodization of history of humankind, at the third stage of the primitive communal era writing was that kind of analogical historical event that divided the primitive communal era and Ancient Ages. But we have to look at writing much deeper. Writing was just a part of the innovative human's ability to accumulate the surplus that defined the appearance of the state as an innovative economic entity (Fig. 4). Specifically the human ability to accumulate turned into the revolution innovative technology which then destroyed the primitive communal system and created the slave economy in the Ancient Ages.

But how did accumulating correspond with communications and 'doing something much more widely'? On the one hand the writing system associated with communications and made it possible for people to transfer knowledge much more widely: through ages and space. But on the other hand the human ability to accumulate created new values which concerned the physical power. The physical power caused a new form of 'doing something widely' – the wide influencing to the wide range of people and a dominant position on the basis of accumulating of strength. The accumulating of physical power (by the state) meant an initial hierarchy appearance as one of the tools of people management [10] and a type of communications from the position of strength. It also referred to creating writing laws by the state.

So the similar revolution innovative technology that is to destroy the primitive technogenic economy can be relevant to the AI's ability to accumulate too. This kind of accumulation assumes a large number of mathematical forecast models as the structured Big Data of different information. Every forecast model corresponds with a particular person or particular fact. We can watch this process being pioneered by the different companies as Phorm [1]. Accumulation of Big Data of structured information makes it possible to extrapolate any subject activity to the future and to the past by modeling human's behavior. And additionally it makes it possible to create some activity that is impossible for the particular object in reality. For example, in the reality it's impossible to watch how Queen of England performs a contemporary dance. But we can find it in the virtual reality on TikTok and through other social media platforms [5]. It leads to the situation named post-truth where the borders between truth and lie, reality and the virtual word disappear. The forecast models make it possible to transfer information much more widely to the future and the past, to the virtual reality. There is also the initial realization of this prediction by the virtual reality word by 'Meta' [11].

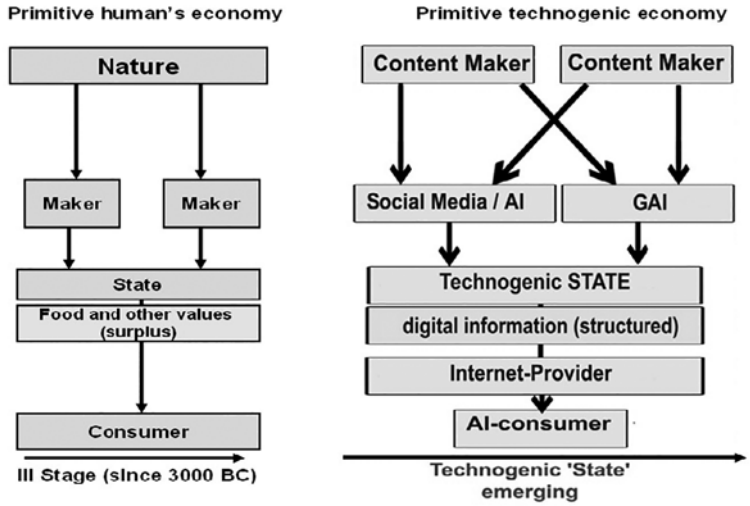

Figure 4. Modeling the Stage 3 of the primitive technogenic economy on the basis of matching with the primitive communal human's economy

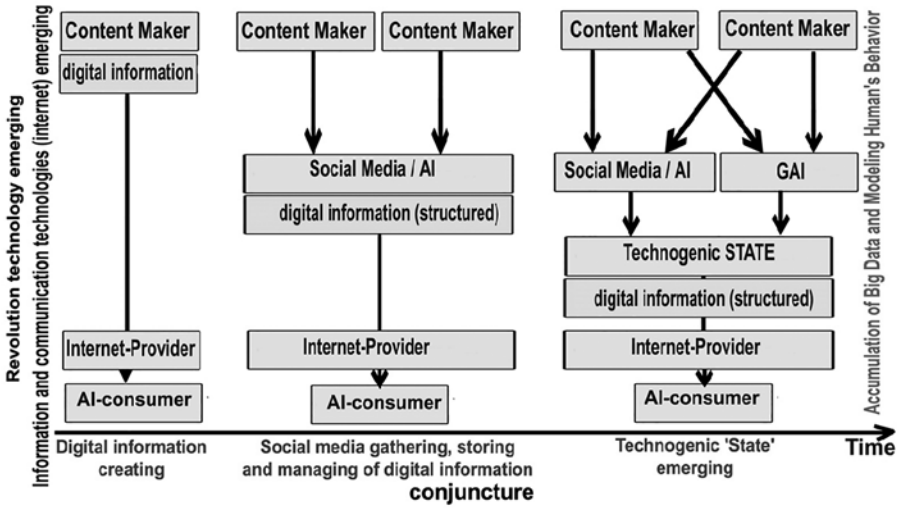

Figure 5. The model of the economic relations under the conditions of the primitive technogenic economy

At the third stage of the primitive traditional economy the revolution technology of accumulating and writing as its part provoked the emerging of a state as a new economic entity (see Fig. 4). The state started managing initial civilizations. In the primitive technogenic economy it supposes that an innovative revolution technology of modeling human's behavior on the basis of accumulating Big Data of structured information can also provoke an appearance and then emerging of the technogenic state as a new economic entity too and it will be similar to its historical analogy.

In accordance with main principles of the forecasting economic relationship model, during the primitive technogenic era the economic power moves from makers (various content-makers), then to providers with AI technologies to a new economic entity – to the technogenic state. It is referred to AI and its diversifications. So we have to wait for some new type of AI (or a complex of various AIs) which will play the role of the AI's State. The AI's State will have to rule other types of AIs and formulate technogenic laws.

The proposed approach to forecasting the future of technology makes it possible to predict what the economic values will look like during the second technogenic era. In accordance with the hypothesis, next AI's development, named the slave technogenic economy, will have to be similar to the traditional economy during the Ancient Ages. So we can forecast the draft of the next 'slave' technogenic era. For example, the quality level of GAI's performance will be important. It needs particular capacitythat can be concentrated by such petascale supercomputers like Fugaku (Japan), Summit IBM (USA) and so on and also energy generators like China's fusion reactor named 'Artificial Sun' [19]. So supercomputers and energy generator will turn into new technogenic economic values of the 'slave' technogenic economy. Those technogenic economic entities (GAIs) which will use these supercomputers will concentrate technogenic economic power at the first stage of slave technogenic economy. This means that these GATs will receive the most important tasks to be resolved for the technogeic economy of the future. But we can also predict on the basis of the technogenic economic relationships forecasting model that AI-state will be able to form a grid of supercomputers that make it possible to reach the highest capacity for making decisions.

Conclusions. The preconditions of the technogenic economy emerging were highlighted as the hypothesis on

the basis of the historical analogies with the traditional economy development. Three stages of the primitive technogenic economy were defined. The study showed that the economic relationship forecasting model can forecast the future of Artificial Intelligence as the part of the technogenic economy accurately enough. Deep understanding of the scenarios of the future technogenic economy eras, technogenic economic values and the principles of their moving to different technogenic economic entities make it possible to correct and rule the traditional economy more effective. And these are the next directions of the future researches.

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