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Internalizing of Externalities through Blockchain Technology in the Economic System

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Abstract

The economic system generates positive and negative externalities in the process of its functioning. Currently, there are exacerbating problems associated with the need to minimize negative externalities, which pose global risks to the global economic system. The most acute risks relate to the sustainability of the financial system, environmental pollution, climate change, outbreaks of new deadly diseases types. The solution to this problem of minimizing negative externalities is associated with the creation of a mechanism for accounting for externalities and a mechanism to stimulate economic entities to minimize the negative external effects produced by their activities and maximize positive external effects. Externalities can be divided into two classes: (a) quantitative, numerically measurable [11], (b) qualitative, which do not have an unambiguous quantitative assessment (Coase-externalities). Blockchain provides the ability to create a mechanism for collecting, storing and recording data that allows us to estimate the magnitude of the both classes' externalities. To do this, it is proposed to use the technologies of the "Internet of Things" and "digital democracy". The blockchain platform will provide cryptographic protection of stored data, their immutability and reliability, as well as the accessibility of society to it. Such a system will increase the effectiveness of national projects to reduce negative externalities, for example, in the field of ecology and waste management.

Keywords: Externalities, Blockchain, Tokens, Sustainable Development, Internet Of Things (Iot), Digital Democracy, Ecology

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I. INTRODUCTION

The current state of the world economic system is characterized as unstable and recessionary. The problems of environmental pollution, uneven distribution of wealth, and a lack of access for a significant part of the population to health and education systems are exacerbating. To overcome these problems, the UN adopted a memorandum [13] on achieving sustainable economic development by 2030, for which joint efforts of all countries should achieve 17 global goals, including overcoming poverty and hunger, ensuring health and access to education, universal access to modern types of "green" energy, a steady economic growth rate of 7% annually, full employment, pollution prevention and the fight against climate change.

The question arises: how much the existing economic system is able to overcome global risks [14], as well as achieve universal sustainable development by 2030? The functioning of the modern model of the economic system is inevitably associated with the production of externalities, or side effects, which can be either positive or negative. The most dangerous type of negative externalities is associated with environmental pollution as the industrial system grows. Increasing satisfaction level of the people's needs for goods and services results in a cascading increase in garbage and household waste [12].

No effective mechanism has been proposed so far for accounting externalities and their compensation for public ends. Blockchain technology together with the "Internet of Things" and "digital democracy" allows us to propose a model for solving these problems and increasing the stability of the economic system. In this regards there are some works that can refer to the work wich is done by Nagel and Kranz in 2020. They have studied developing a multi-layer taxonomy that indicates how blockchain is used in various smart city business models [8]. Also in the year of 2019, economic and technological characteristics of blockchain based smart city applications have been investigated [9].

II. METHODS

The economic system in the process of its functioning, like any other economic agent operating within the framework of the given system, generates a whole complex of side effects that are not provided for by their target functions. These side effects, or externalities, have a negative or positive effect on those who are not directly involved in the process flows of these economic agents. The most common types of negative externalities are environmental pollution during the production of goods and services, CO2 emissions, high noise levels characteristic of airports and large cities, as well as climate changes as a result of the global economic system. Positive externalities are associated with an increase in human capital as a result of the development of cultural institutions in a country (museums, theaters, and galleries), a decrease in

crime, where young people have wide access to sports and leisure infrastructure, etc.

The main problem of the externalities' existence is the need for their internalization, i.e. assessment of value and its inclusion in the cost of goods and services production; otherwise, this production is not carried out in conditions of economic equilibrium at the Pareto-optimal level. As a result, damage to the environment and people is not compensated in any form. One of the externalities theory founders, Arthur Pigou (Pigou, 1985), proposed introducing additional taxation of economic agents responsible for the production of negative externalities, for example, for environmental pollution or emissions of harmful substances. This internalization type of externalities is possible not for all types of external effects, but only for those that can be quantified, as well as could be linked with a cause-and-effect to one or another business entity. For example, it is technically uncomplicated to determine CO2 emissions from enterprises and establish an appropriate tax burden scale. Within the framework of further analysis, we call the type of externalities that can be quantified and have a precisely defined source of their production (enterprise, factory, etc.) as Pigou-externalities.

At the same time, R. Coase in his work "The Problem of Social Costs" [4] showed concrete examples that external effects (externalities) arise where there are unsettled property relations. Such an approach significantly expands the toolkit of possible options for internalization, and, what is especially important, allows us to propose ways of internalizing externalities, for which it is not always possible to indicate a quantitative assessment method (qualitative externalities). Therefore it requires the introduction of a different method of calculating them, for example, through a public voting system with the subsequent reaching an agreement to assess the level of certain external effects. Again, we call this type of external effects as Coase-externalities.

It should be understood that regardless of whether we can offer some technological accounting tools for Pigou-externalities and Coase-externalities (as we will show below, such tools are available), externalities are, at least in the sphere of impact on the environment, reproduced in one way or another and will be reproduced with the existing economic system model. Tightening environmental standards in the sphere of goods and services production, transport and energy does not remove this problem, since the corresponding "dirty" industries, technological chains and links are transferred to those countries where the relevant standards are not strict or even absent.

III. RESULTS AND DISCUSSION

In the process of its functioning, the economic system inevitably generates external effects, or externalities, which can be either positive or negative. Negative externalities traditionally include the damage caused by the industrial system to the environment (CO2 emissions, garbage, noise, climate change). Positive externalities are characterized by education, healthcare, environmental protection, etc.

One of the serious problems for the economy was the creation of an effective system for evaluating positive and negative externalities and a system for their support that is stimulating the positive and punishing negative externalities. The technology that allows us to offer the appropriate solution is blockchain.

According to the Pigou model, economic agents producing negative externalities should be punished with taxes and fines, but in this case it is necessary to have a mechanism for quantifying externalities, which is not always possible. In Coase's model of externalities, external effects appear as a result of ownership unresolved issues, which led to market failures requiring government intervention. However, blockchain can be used to evaluate both positive and negative externalities, both Pigou externalities and Coase externalities.

For Pigou externalities, blockchain can be used as a platform for storing and recording data from objective monitoring systems, for example, various sensors and analysers that use the Internet of Things (IoT) technology [7]. According to this technology, numerous sensors continuously analyse the operation parameters of enterprises, for example, the volume of harmful emissions, the level of noise produced, etc. According to the IoT protocol, they are recorded on-line in blockchain, which ensures their reliable storage, the inability to manipulate data and open access to data, including for the public. According to estimates, the number of "smart objects" interacting with each other without human intervention will exceed 25 billion in 2020, and would be 100 billion by 2050, which is already an acute problem of storing all this data. As studies show, it is possible to solve this problem on the basis of the blockchain platform [2].

Various sensors can act as elements for assessing quantitative indicators of external influences, which, according to the Internet of Things (IoT) protocol, write these indicators to the blockchain, which guarantees their safety and immutability (CO2 content in the air, water pollution, number of museum visitors, etc.).

By definition, Coase externalities are mainly of a qualitative nature and cannot be recorded by objective control systems; therefore, we should talk about a qualitative assessment of external effects, which can also be done on the basis of a blockchain platform, where estimates made by members of society is under the direct influence of the given external effects (positive or negative) will be recorded. In fact, this is a kind of public voting system, which assesses how active are economic actors in striving to reduce negative Coase externalities and increase positive Coase externalities. Such achievement of social harmony will be carried out on the principles of "digital democracy" [6].

Note that a similar mechanism of economic consent was proposed for a final solution to the problem of taking into account externalities and related market failures and government interference in market mechanisms [1].

It is proposed to make the collected data on the size evaluation of externalities the subject of economic exchange between economic entities and the state, or between economic entities themselves according to the principles of B2B or B2G. In

essence, it is about creating a cryptocurrency exchange at which economic agents acquire specific assets: tax breaks, grants, investment resources, which are purposefully provided by the state in exchange for a decrease in negative externalities and an increase in positive externalities. At the same time, emitted tokens can be called EBC tokens (Externality-Backed Coin) by analogy with ABC tokens (Asset-Backed Coin).

It is appropriate to give an example of Norilsk Nickel, which launched a digital platform for the issuance and circulation of hybrid tokens secured by various exchange commodities, the creation of which was approved by the Central Bank of Russia. In the case of EBC tokens, the state defines a set of assets to be exchanged for EBC tokens by a special regulatory act [3].

A key element of this system is the subsystem for supporting the process and the procedure for recording changes that occur in the magnitude of externalities (positive or negative) and their subsequent tokenization, i.e. EBC token emissions.

The indicated subsystem includes the following elements: (a) collection of data that directly or indirectly estimate the value of externalities, (b) safe and reliable storage of data unchanged, (c) verification of data and ensuring open access to them, (d) emission of EBC tokens, (e) exchange of EBC tokens for appropriate forms of remuneration, (f) system for managing tokenization of externalities, (g) exchange of tokens between different external accounting circuits. Let us consider in more detail these elements of the blockchain platform, within which they are implemented most effectively.

(a) Data collection allowing directly or indirectly to estimate the magnitude of changes in positive and negative externalities, is carried out using the "Internet of Things" IoT, which, according to the definition of IIC (Industrial Internet Consortium) is a system that connects and integrates industrial control systems with control systems, business systems and analytical systems. Since not all types of externalities can be taken into account by objective control systems, they are supplemented by a specialized social network through which the population can evaluate Coase's externalities, acting as a kind of social control system. Upon that, the data stream is recorded in the blockchain.

(b) Lossless data storage is provided by blockchain technology based on cryptographic protection and distributed storage of all received information.

(c) Data verification is achieved as part of the blockchain based on the cryptographic protection mechanism, which provides both immutability and information verification. In addition, a system of social control in the form of "digital democracy" provides an additional verification loop: open access to the database for all users allows the population to assess how much correctly control systems reflect the size of externalities.

(d) EBC tokens are issued on the basis of the same mechanisms for issuing cryptocurrencies, but unlike, for example, bitcoins, EBC tokens will be provided with financing by the state funds within the framework of relevant programs and projects. The larger the volumes of decrease in negative externalities and increase in positive externalities, the greater the volume of EBC tokens issued.

(e) The EBC tokens are converted in certain types of financial and investment resources in accordance with the rules established by the state. Those types can be tax breaks, investments, and grants. The corresponding proportions of exchange can be "floating" depending on the ratio of supply and demand on the part of economic entities.

(f) The system of managing the tokenization of externalities should include a set of state bodies of the federal and republican levels responsible for certain types of economic activities that generate the corresponding externalities. These bodies should set thresholds for the magnitude of externalities, methods for measuring and evaluating them, and also make proposals for the exchange rate of EBC tokens for financial resources.

(g) The exchange of tokens between different accounting systems must be envisaged to ensure the ability of economic entities to exchange some types of EBC tokens for others. For example, EBC tokens issued to reduce the environmental burden could be exchanged to EBC tokens issued to improve the quality of cultural leisure of the population.

IV. SUMMARY

The application of this model for the tokenization of externalities can be implemented for starters as a pilot project within the framework of the national environmental program, for example, the "Ecology" national project being implemented in the Russian Federation. This national project provides for a qualitative reduction of externalities associated with a load on the natural environment by 2024. It includes a package of 11 projects aimed at improving the quality of water, air, forest conservation, and waste management [10]. An analysis of the activities included in the national project shows that it combines indicators that can be attributed to Pigou-externalities, that is, they have quantitative measurability, and Coase-externalities related to qualitative factors.

It should also be noted that, as is shown by the MSW disposal system reform process, which is being carried out in a number of pilot regions [5], the city population is the construction wary of waste recycling plants, fearing the occurrence of negative externalities, for example, environmental degradation near such plants, unpleasant odours, noise, and increased emissions CO2, etc. Using the described externalities tokenization model allows us to make the implementation of such projects transparent to the public, and to make them full participants in the expert community, which evaluates the level of externalities and their minimization based on the token economy

V. CONCLUSIONS

The mechanism of internalizing the externalities based on the blockchain platform proposed within the framework of this paper allows determining the value of Pigou-externalities or

Coase-externalities. However, this mechanism must be supplemented by a system of stimulating economic entities to reduce their negative output and increase positive externalities. As practice shows, the use of taxation, fines, and other traditional tools is not effective enough. Sometimes it is easier for an economic entity to pay a fine for a negative impact on the environment than to take actions to reduce the level of this impact. In our opinion, it is also possible to propose such a mechanism for stimulating economic entities based on blockchain technology.

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