Formation of pollutant emissions trading optimum model at the international market

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Abstract

The eco-economic problems of world economy and policy are analyzed in the paper. The evaluation of possible economic damage to the world economy is given. The effective international pollutant emissions trading impediments are found. The potential threats at the open international market are shown. The emissions trading optimum model between developed and developing countries is developed on the basis of Coase theorem for these potential threats prevention.

Key words: KYOTO PROTOCOL, CLIMATE CONTROL, OPTIMUM MODEL, INDUSTRIAL INTEREST GROUPS, EMISSION TRADING, ECONOMIC DAMAGE, EFFICIENT MARKET.

The problem of world climate global changes passed long ago from the narrowly-specialized scientific questions into a rank of one of the most burning issues of world economy and policy. [7]

In the public, considerable interest is caused by an economic evaluation of damage from the world climatic changes. The sounded estimates are contradictory. According to W. Nordhaus model, the damage of the world GDP by 1 – 1.5% is possible when warming-up by 1-2°C, while the insignificant increase in GDP is predicted in the well-known Mendelssohn model for similar warming. The temperature growth by 5–6 °C threatens the world with the minimum decrease in world GDP according to R. Mendelssohn model, its reduction by 6–11% according to W. Nordhaus model and fall by catastrophic 14–15% according to N. Stern model. To a great extent, such distinctions are related to various discount rates. [5; 20]

Some other authors estimate also the possible economic damage from climate change. In the well-known R. Mendelssohn paper, the calculations for consequences evaluation of climate change for the USA agriculture were conducted. In the future, the group of authors conducted the calculations of possible economic damage for the whole world. [5; 14]

R. Tol made an interesting attempt of consequences evaluation not only for real sector of economy, but also for the social sphere, first of all, for the health of the population. [21]

In "Stern report", the model covering damage from increase of natural disasters, and also various indirect effects (losses from social and political instability) is suggested. [5; 20]

The need of the global environmental problems solution by the world community put a principle on question of efforts distribution between the countries. Complexity consists in that the information, in the conditions of which the countries obligations are determined, is characterized by essential incompleteness. It is supposed that the market mechanism will allow overcoming of this complexity: the countries, which received more quantity of more than effective emissions, will sell the surplus to the countries, which received quantity of less than effective emissions.

Data on the countries emission of one million ton of CO_2 are presented in Table 1. [22; 23] The majority of the developed countries reduced the number of emission of carbon dioxide in 2009 in comparison

with 1990. At the same time, developing countries increased emissions considerably and do not want to undertake any obligations for their reduction.

At the moment, 30% of all emissions of CO_2 are carried out by production of the goods traded in the world market. [19] Thus, the growth of consumption of carbon intensive production in one country cannot lead to increase in emissions in this country, however, is conducive to growth of emissions in other countries delivering the carbon intensive production to this country. In 2003, N. Akhmad and A. Vykoff established that the total amount of export of CO_2 emis

sions is comparable, and in many cases, it exceeds the quantity of emissions of the certain countries. Thus, the most part of the developed countries are net importers of emissions, whereas developing countries mainly serve as net exporters. [6]

In Russia, our confirmation of the Kyoto Protocol was met extremely negatively by a number of experts. They claimed that it will cause the milliard losses in the country, as during the period 2008-2012, Russia had to exceed the emission level of carbon dioxide of 1990. [4] It is obvious that it did not happen, and is not expected in a short time.

Table 1. CO2 Emissions of one million ton in the world countries

Country	1990	1995	2000	2009	2012
Australia	260,1	285,5	338,8	394,9	386,3
England	549,3	516,6	523,8	465,8	457,5
Germany	950,4	869,4	827,1	750,2	755,3
India	582,3	776,6	972,5	1585,8	No data
Italy	397,4	409,4	426,0	389,3	374,8
Canada	432,3	465,2	532,8	520,7	533,7
China	2 244,1	3 022,1	3 077,2	6 877,2	No data
Russia	2178,8	1574,5	1505,5	1532,6	1659,0
USA	4868,7	5138,7	5698,1	5195,0	5074,1
Ukraine	687,9	392,8	292,0	256,4	281,1
Japan	1064,4	1147,9	1184,0	1092,9	1223,3

Source: CO_2 Emissions from Fuel Combustion. 2011. 2014

As it is known, the international emissions trading became the most discussed part of the Kyoto Protocol (some elements of such trading were allowed previously, for example, within the Montreal Protocol). However, the emphasis is placed on its direct consequences during the protocol action. The question of how effective market of international emissions trading can be created is of the great interest. There have been already appeared the rudiments of the imperfect market. The derivative market of hydrocarbons also functions. Since 2005, the climatic futures trading is opened at the Chicago climatic exchange opened in 2003. B. Chilton claims that the market of "carbon" derivatives will become the world's largest soon.

It leads to certain challenges and menace to the world economy. The propositions on trading optimization in this market are necessary. The emissions trading established by Kyoto Protocol, seemed considerably new idea. [1] It is not consistent with the reality, the idea origin can be observed in R. Coase's works. [8] Coase's ideas gained further development. [2; 12; 18]

The main theoretical base for establishment of the emissions market was brought by the Canadian economist J. Dulles for the water environment, and the American economist Crocker for the atmosphere. Then such scientists as W. Baumol and D. Montgomery made the essential contribution to development of emissions trading idea. [1; 9; 10; 15]

In our assumptions, we rely on the Coase theorem, according to which, the competitive market will lead to Pareto-optimal production of the polluting emissions at a complete definition of ownership rights of pollution objects and zero transaction costs. Therefore, the problem of creation of the international trading effective mechanism can be divided into three components: the correspondence of participants incentives to the market-based ones, definition of the property rights, availability of transaction costs. Besides that, due to the fact that world community acts on behalf of the planet population, its actions cannot be concentrated on the question Pareto-efficiency only, but must suppose prosperity maximization of a world population, and also consider plea for justice. [2]

Do the participants incentives of international emissions trading correspond to the incentives of the market of perfect competition? Although, the Kyoto Protocol allows participation in the enterprises emissions trading, the main persons are national government. Certainly, the government motivation is

non-market, and we face all the problems typical for bureaucracy economy. These problems include two levels: acceptance of obligations of emissions reduction and distribution of quotas between the enterprises. [13]

Abstracting from imperfection of available information, let us consider, whether the states will seek to undertake the emissions reduction obligation, which is optimum from the standpoint of their economy functioning. The answer to this question will depend on a number of factors. First of all, the more obligations will be undertaken by the country, the more finances are required to be accumulated within the country for these obligations implementation. These finances get into the order of executive power, and the utility obtained by the corresponding office holders depends on the amount of these finances. But the emotions quantity, which can be sold, also means additional cash inflow. Secondly, decisions will be influenced by groups of interests. First of all, they are presented to "industrial lobbies". The obligations decrease supporting is expected (its pressure forced USA not to ratify the Kyoto Protocol and Canada to leave this Protocol). Though, there can be situations when producers of a certain country anticipate the foreign producers in ecological parameters. In that case, introduction of the additional standards related to the excess obligations can be a basis for the murky protectionism, and be supported by the industry. Thirdly, the population behavior can be different. As a rule, the population has no sufficient ideas of which obligations are optimum and what consequences of their acceptance. The support will depend on confidence in the government, the relative degree of fears of unemployment and "ecological" fears to a great extent.

Let us try to combine these observations in the simplified model, which is developed together with Vinokurov S.S. [2] Let us suppose that the production consists of two technologically unconnected branches A and B, at that, the branch A produces harmful emissions, and the branch B produces the negligible quantity of them. Consumers can replace products of these branches in the basket with constant elasticity γ, so:

$$U = \left[q_A^{\frac{\gamma-1}{\gamma}} + q_B^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}},$$

where U – usefulness of the representative individual; q – the quantity of the consumed production of the relevant branch.

Let the markets of both products be competitive. At equilibrium, the products price is equal to margin-

al costs; and the proportions of consumption are established so that the equation $\dfrac{q_A}{q_B} = \left(\dfrac{p_B}{p_A} \right)^{\gamma}$ is carried out.

Thus, consumers possess the fixed budget $X = p_A q_A + p_B q_B$. It is possible to see that in these conditions, the price of production of branch A will be established as follows

$$p_A = \frac{X}{q_A + q_B^{\frac{\gamma-1}{\gamma}} q_A^{\frac{1}{\gamma}}}.$$

The fact whether the products of branches A and B are substitute goods or complements is of significant importance. Let us note that in our case, on the one hand, the point at issue is about certain nature of environmental impact (in the form of harmful emissions), and on the other hand, about consumer goods. Most likely, the branch A will pose the industrial production, and branch B will be traditional, mainly agricultural production. These branches production will be interchangeable to small degree. It should be expected that from positions of our problematics, the products of branches A and B are complementary to each other, and $\gamma < 1$.

So, $\dfrac{\partial p_A}{\partial q_B} > 0$. I.e. the higher output of branch B

is, the higher the demand schedule for products of branch A will be.

Let us suppose that the countries have identical functions of marginal costs of production of branch A products. The diagrams of marginal external costs will differ owing to that not only own emissions but also the other countries ones will have an impact. Let us consider that output of the branches A of different countries are independent from each other. Then marginal external costs of branch A production can be presented in the form

$MEC = k q_A + f(q_F, r),$

where MEC – marginal external costs; k – constant coefficient; q_F - quantity of branch A production abroad; r – remoteness measure from foreign sources of pollution.

It should be expected that the higher remoteness from foreign sources of pollution is, the lower marginal external costs will be. As in the current situation, industrialized countries are generally concentrated close to each other, it is possible to expect that their marginal external costs are rather high. Carrying out of production to less developed countries will be conductive to their reduction in the developed coun-

tries and increasing in less developed ones. Countries with economy in transition were found in a paradoxical situation: they are close to industrialized countries, but owing to internal problems, possess rather small industrial production, i.e. their marginal external costs are high, but stipulated substantially by transfrontier production.

The general marginal costs of production of branch A (MSC) products are equal to the sum of marginal and marginal external costs of production, i.e.

$$MSC = MC + MEC.$$

In equilibrium situation in the market of branch A production:

$$p_A = MSC.$$

The quota price for additional production of branch A product unit *(t)* will be established in such a way that

$$t = p_A - MC = MEC.$$

Now, let us consider the governmental action when the quotas size determining. In our consideration, it will be sufficient to use the simplified idea of the government purposes: we will assume that their main objective is maximizing the budget (in our case, its ecological component). [16]

The budget replenishment can be performed by two ways: either by quotas selling, or by increase of the taxes, which are necessary for ecological programs carrying out.

Let us consider the first case. As the quota payment is increased with the growth of *MEC,* the state will receive the maximum sum for quotas in domestic market in the case if they obtain equilibrium output. But the countries can perform the emissions trading with each other. Thus, the states with the higher quota equilibrium price (it is the states with the high level of income and/or more developed branch B) will be able to buy a quota from the states with the lower price cheaper, than to sell in domestic market. Thus, it is profitably to carry out the quotas trading by two stages for more developed states. At the first stage, allocation of the optimum quotas size should be achieved, and then, the quotas quantity should be increased due to trading with less developed countries. Therefore, if there are no restrictions to such policy, the developed states will achieve optimum quotas, but carry out excess production of branch A.

Expecting such course of events, it will be profitably for less developed countries to receive excess quantity of quotas and to sell this excess to the developed countries. Thus, less developed countries will achieve excess quotas, and leave their quantity, which is near to optimal, in domestic market.

The aspiration to receive additional resources for financing of ecological programs will act in an opposite direction. It will be profitably for government to fill up the budget in such a way as long as the additional financing sum exceeds losses from reduction of the emission quantity traded in domestic market. The quantity of additional cots, which can be proved, and the marginal costs diagram steepness, from which the losses related to quotas quantity reduction will depend, are important. The higher production environmental compatibility as of the current date is, the less the steepness of this diagram will be. In this view, more developed countries will have more incentives for quotas quantity reduction. At the same time, more developed countries will have wide base for the taxation and great ease in its administration. However, additional financing must be reasonable. On the one hand, the greater development by a component was gained, the more resources by further development are demanded owing to diminishing productivity. On the other hand, it is more difficult to motivate the necessity of further development. Thus, the result is less predictable in this case, than in case of simple emissions trading. From our standpoint, it is necessary to expect that the developed countries will have more incentives to reduction of emission quantity below the optimum.

The lobbyism from industrialists will have an impact. Its direction will be predetermined not so much by a country development level as by the structure of the industry. If the harmful emissions reduction can be connected with quality of the output, the government will be able to pursue policy of the hidden protectionism by means of the corresponding standards introduction. In that case, lobbyism can be directed on reduction of quotas quantity. If there is not such opportunity, the industrial lobby will work for quotas increase. For example, it is possible to expect that if the mechanical engineering prevails in structure of the industry, the pressure will be towards reduction of quotas quantity. On the contrary, if raw branches, metallurgy, chemistry and petrochemistry prevail, the pressure will be towards the quotas increasing.

As the governments will care also of support from the residents, therefore the public opinion will have impact on their decisions. The public opinion direction depends on the place, which "pure environment" takes in relation to the income in structure of consumption of the representative individual. From our standpoint, it should be expected that these benefits will be complementary. I.e. the income of the individual is higher, the higher usefulness "pure environment" will have and vice versa. In this view, it should

be expected that the public opinion will be turned more likely against ecological programs of the government in less developed countries and for it in the developed countries.

The property rights and transaction costs are the next factors, which can have impact on the government decisions. The fact is that the government, receiving a certain quantity of quotas, must guaranty that in economy, emissions quantity will be exactly as many as quotas quantity they will sell. In other words, the governmental property on harmful emissions is not guaranteed; besides that, it can be in a conflict with public ideas of the person ownership right of the production means, which are a source of external emissions.

Moreover, the state can punish for excess emissions, but cannot prevent them completely. It means that emissions trading is not entered in the existing institutional system, and for the enterprises, it is more profitably to violate the relevant law, than to keep it (because of excess profits, low probability and/or the small amount of punishment), the expected emissions will be higher than the sold quotas quantity. In this case, for the government, it will be profitably "to make secure" and buy the excess quantity of quotas. Besides that, the excess quantity of quotas will reduce their price and will make additional profit for the enterprises; that will reduce their incentives to avoidance of quotas purchase. It should be expected that the above will be more typical for relatively less developed countries, and such countries will leave the excess quotas in domestic market.

Finally, the impact will be had by process of quotas distribution at the UN level. Inasmuch as it will depend not only on efficiency reasons, but also on the justice criterion directed on decrease in a gap between the rich and poor countries of the world, it should be expected that the world rich countries will receive less quotas than poor ones. Besides that, one expects the fulfillment of the incurred obligations in a greater degree by the rich countries as they show a greater negative external effect on one another and violation of obligations can aggravate a situation of the violator noticeably.

Thus, the rich countries are in a game situation with the considerable positive amount in case of quotas distribution due to the nature of formula for *MEC*. Increasing environmental friendliness of the production, thereby, they afford opportunity for one another to increase internal production; that would not be possible if there were no arrangements between them. The rich countries will undertake obligations while the effect from emission abatement by the partner

exceeds the losses due to reduction of own emissions. (However, this refers to the government behavior. I.e. losses will be due to the short-received finances from emissions trading minus the finances received in tax form on financings of ecological programs). On the contrary, the poor countries are found in a situation close to game with the zero amount in case of quotas distribution. Their main profit will consist in quotas sale to the rich countries. At that, actually, there is no rather effective mechanism of their force to fulfillment of the incurred obligations. [2]

Concluding the result, it is possible to claim that there are considerable hindrances of effective international emissions trading. However, even in these conditions, it is impossible to speak of complete nonsense of such trading or that a priori, it brings benefits to the rich countries in the prejudice of the poor ones. [2]

First of all, although a number of factors influence the countries actions and it is difficult to give the single-valued prediction, nevertheless, there are more facts toward that the rich countries will receive the less optimum quotas quantity, and the poor countries will receive more optimum one. Thus, though imperfections of international trading affect these countries diversely, both will reduce their economic efficiency.

Secondly, as a rule, the country poverty is associated with underdevelopment of its industry; however, as we observed, first of all, the main problems arise owing to underdevelopment of traditional branches. Therefore, quota distribution should be connected to this criterion, i.e. industrialized countries should receive their greater quantity. However, it will contradict the principle of justice.

Thirdly, contrary to stereotypes, industrialized countries will have more incentives to fulfill the incurred obligations, than the undeveloped countries.

In view of the last two theses, it is necessary to disagree with standpoint of some scientists about desirability of global emissions trading. [11; 17] On the contrary, the solution of environmental problems of the world is business of the developed countries. In order to avoid distortion, the undeveloped countries or the countries, which industry endures the difficult period, should not be included in this list. Moreover, as the government of the developed countries have incentives to excess obligations, it is necessary to take measures of restriction of such practice in order to avoid erosion of efficiency of their internal economy and the hidden protectionism against import from developing countries. Thus, global reduction of emissions must be incremental and circumspect. In the conditions of the growing economies of these countries, the simple maintenance of emission level

can be more effective, than decision-making on their radical reduction.

References

1. Bukvich R.M., Voronov M.P., Chasovskikh V.P. (2015) Kyoto Protocol and activity of Russia: mechanisms of emissions reduction of greenhouse gases. *Eko-potentsial*. No 2, p.p. 42-54.

2. Vinokurov S.S., Gur'yanov P.A. (2012) Perspectives of formation of the emissions market of the polluting substance. *Ekonomicheskiy analiz: teoriya i praktika*. No 31, p.p. 20-26.

3. Gordienko A. (2011) Why is the Kyoto Protocol attractive to the Russian business? *Obshchestvo i ekonomika*. No 3, p.p. 163-172.

4. Illarionov A., Pivovarova N. (2004) Economic consequences of ratification of the Kyoto Protocol by the Russian Federation. *Voprosy ekonomiki*. No 11, p.p. 34-59.

5. Makarov I.K. (2013) Global climate change as challenge for world economy and economic science. Ekonomicheskiy zhurnal VShE. (Economic journal of HSE). No 3, p.p. 479-496.

6. Makarov I.K., Sokolova A.K. (2014) Assessment of carbon intensity of foreign trade of Russia. Ekonomicheskiy zhurnal VShE. (Economic journal of HSE). No 3, p.p. 477-507.

7. Christoff P. (2006) Post-Kyoto? Post-Bush? Towards an effective climate coalition of the willing. *International Affairs*. Vol. 82, No 5, p.p. 831-860.

8. Coase R.H. (1960) The problem of social cost. *Journal of Law and Economics*. Vol. 3, No 1, p.p. 1–44.

9. Crocker T.D. (1966) The Structure of Atmospheric Pollution Control Systems. *The Economics of Air Pollution*. New York, W.W. Norton and Co., p.p. 61–86.

10. Dales J.H. (1968) Land, water, and ownership. *Canadian Journal of Economics*. Vol. 1, No 4, p.p. 791–804.

11. Ellerman D. (2005) Obstacles to Global CO2 Trading: A Familiar Problem. Climate Change Police and Economic Growth: A Way Forward to Ensure Both. *International Council for Capital Formation*. Institute of Economic Analisys,. pp. 81-89.

12. Hepburn C. (2007) Carbon Trading: A Review of the Kyoto Mechanisms. *Annual Review of Environment and Resources*. Vol. 32, p.p. 375–393.

13. Heyes A., Dijkstra B. (2001/2002) Interest groups and the demand for environmental policy. *The International Yearbook if Environmental and Recourse Economics*. Cheltenham.

14. Mendelsohn R., Morrison W., Schlesinger M., Andronova N. (2008) Country-specific Market Impacts of Climate Change. *Climatic Change*. Vol. 45, No 3–4, p.p. 553–569.

15. Montgomery W.D. (1972) Markets in Licenses and Efficient Pollution Control Programs . *Journal of Economic Theory*. Vol. 5, No 3, p.p. 395–418.

16. Niskanen W. (1975) Bureaucrats and Politicians. *Journal of Law and Economics*. Vol. 13, pp. 617-643.

17. Nordhaus W., Boyer J. (1999) Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol. *Energy Journal, Special Issue on the Kyoto Protocol*. p.p. 93-130.

18. Pearce D. (2002) An Intelectual History of Environmental Economics. *Annual Review of Energy and the Environment*. Vol. 27, p.p. 57–81.

19. Sato M. (2014) Embodied Carbon in Trade: A Survey of the Empirical Literature. *Journal of Economic Surveys*. Vol. 28, No 5, p.p. 831–861.

20. Stern N. et al. (2006) The Economics of Climate Change. *The Stern Review*. Cambridge: Cambridge University Press.

21. Tol R. (2002) Estimates of the Damage Costs of Climate Change – part II: dynamic estimates. *Environmental and Resource Economics*. Vol. 21, No 2, p.p. 135–160.

22. CO_2 Emissions from Fuel Combustion. 2011

23. CO_2 Emissions from Fuel Combustion. 2014