Microeconomic Implications of Environmental Tax

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***Abstract* - The devastation of the environment occurs mainly as a result of intensive economic development. The study of its consequences is a subject of interest of experts from various professional orientations. Economic theorists, ecologists and all those involved in the creation of solutions in the field of environmental policy, product designers and new technological procedures constantly point to the need for alignment of economic development goals and the environmental consequences that economic progress causes. Excluding natural disasters, external diseconomies in production are the most powerful cause of environmental degradation, regardless of whether they occur in the form of hydro, aero or lithium pollution.**

The aim of this paper is to show how the introduction of pollution taxes affects the behavior of market players, the amount of pollution and the magnitude of social well-being. In most cases, the market mechanism cannot adequately address the problem of negative externalities in production. But, on the other hand, this state, because of limited information on the consequences of environmental damage or for other reasons, through its intervention in the market, can produce an outcome worse than that created by the uncontrolled market.

***Keywords* - negative externalities, environmental damage, environmental tax, social well-being, pollution, market inefficiency**

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1. Introduction

The question of the effect of the addition of environmental tax with the goal of regulating the amount of pollution is tight regarding the role of the state in a modern economy. Economic science no longer pursues the question of whether economic life should be regulated only by the market or only the state, but rather to what extent the state should influence economic life and in what areas. The problem comes down to determining the optimum between market and state regulations. Numerous schools of economic thought (physiocratic direction and the classical school of economic liberalism) argued that the role of the state in economic life should be minimized and most economic activity left to the market mechanism, pointing to very serious defects in rigid state interventionism. The view that the market mechanism is a much better form of social coordination instead of the state is also represented by F. Hayek, one of the most significant representatives of modern liberalism. It is not disputed that the market performs its allocative function extremely well in most cases. However, in certain situations, the market mechanism cannot solve many economic problems. Almost more than a century ago, English economist Alfred Marshall (1842-1924) pointed to the inability of the market to solve the problem of externalities. Arthur Pigou (1877-1959) believed that the existence of such effects hindered the normal economic processes, reduced the efficiency of the market mechanism and narrowed the possibility of national income growth [13].

There are many examples of inefficiencies in the market mechanism. The appearance of externalities, that is, the situation when the behavior of market participants in accordance with their own private interests do not lead to realization of social interests, represents only a drastic form of market failure. Although externalities in their character can be positive and negative, the subject of this paper covers only negative externalities, that is, external diseconomies. Since negative externalities in production have a detrimental effect on long entrants and degrade the quality of the environment, the question is how can their impact be mitigated or eliminated? How can the inefficiencies of the market mechanism in the case of external diseconomies in production be corrected? Negative externalities, especially those related to environmental pollution, are regulated by various measures of state policy [15]. Ignoring the importance and role of other forms of state regulation, in this manifesto, our research will focus only on the analysis of the effects of the introduction of environmental tax. This type of tax is also called by many economists a Pigou tax (by the great economist Pigou, who was among the first to advocate its introduction). By introducing it to reduce external diseconomies, the state not only provides itself with tax revenue, but also affects the amount of pollution and the well-being of market players.

2. External Diseconomies in Production as an Expression of Market Inefficiency

Externalities may arise among manufacturers, consumers or consumers and manufacturers. They can be negative when the action of one party creates costs to the other or positive when the action of one party benefits the other [12].

Of all the externalities, the greatest theoretical challenge in economic science is negative externalities in production, that is, external diseconomies and finding the modalities for solving them.

External diseconomies in production occur when one manufacturer generates costs to other producers or consumers and does not compensate them in any way. A typical example of these diseconomies is the negative effects on different forms of air, water and soil pollution caused by factory plants and dirty technologies.

Take, for example, a company whose plants release a certain amount of smoke into the atmosphere or a certain amount of waste fluid. If we show the market demand curve and the market supply curve in a diagram (Figure 1.), we see that the equilibrium is established at the point of their intersection. The private benefit curve shows the value of the good to the customers, while the private cost curve shows the cost of production, which does not include the costs that others suffer from pollution [6]. In other words, curve *S* does not contain the pollution costs borne by society because of the external diseconomy in the production of a particular product.

The vertical spacing of the curve *S'* from *S* denotes the external cost per unit caused by the manufacturers and the consequences are borne by the third party. Clearly, if externalities didn't exist, the production quantity of x* and the price of p* would be economically efficient. The area below the private benefit curve and above the private cost curve to level x* represent the magnitude of social well-being or total surplus. As manufacturers pollute the environment and cause environmental damage of *e* monetary units, measuring total well-being needs to include the environmental damage whose consequences are borne by a third party [1]. Total well-being in volume x* and market price p* equals the sum of the consumer and manufacturer's excess minus height environmental damage.

The magnitude of ecological damage at volume x* is obtained by multiplying the ecological damage per unit by the number of products produced and is equal to the area of the respective quadrilateral.

In the case of negative externalities, allocative efficiency requires that polluting companies determine their production levels so that prices cover not only marginal private costs but also marginal external costs, that is, they cover total marginal costs [10].

The competitive equilibrium does not take into account the damage that pollutants cause. Such allocation of resources would be optimal provided that there are no external diseconomies.

Total well-being in the presence of negative externalities is equal to the sum of the consumer's (triangle area p*EC) and manufacturer's surplus (triangle area p*ED), minus the amount of ecological damage at circumference x* (area of the hatched quadrilateral DEFL).

A competitive equilibrium cannot be the optimal solution if it is possible to increase this defined social well-being (the sum of consumer and producer surplus minus the amount of external costs). The figure below illustrates the intersection of the curve of private benefits and social costs at point E'. If manufacturers force themselves to reduce production to the level of x*', they can only sell that quantity at the price of p*'. The sum of the consumer and producer surplus will be reduced by the area of the square LDEE' and will be equal to the area of the triangle LE'C.

External costs relative to the competitive equilibrium will be reduced by the amount given to the area of HEFE' quadrilateral and equal to the area of DHE'L quadrilateral.

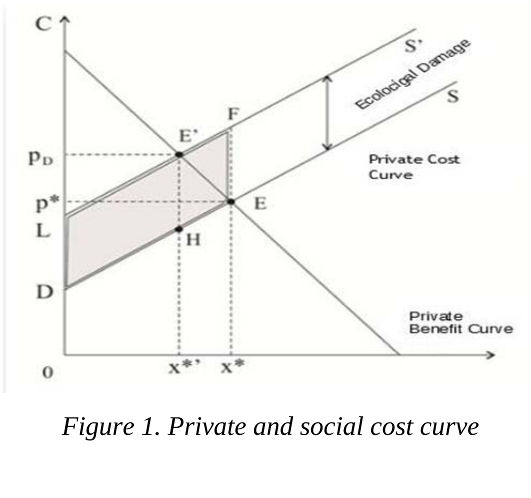

Figure 1. Private and social cost curve

What quantity would be optimal from a social point of view? Clearly, this would be the amount at which the social cost and private use curves intersect (point E'). Below this level of production, the value of output for consumers is greater than the social cost of producing it, so it pays to increase production and sales. The same applies to the output levels to the right of the intersection point [4].

At these levels, the social cost is greater than the private benefit, so from a social point of view it is justified to reduce production.

3. Effects of Environmental Tax on Market Equilibrium

The introduction of an environmental tax represents the best public policy measure aimed at reducing pollution and remedying the effects of environmental damage. By introducing a tax and determining its amount, the amount of pollution can be directly affected.

In terms of effects on overall well-being, environmental tax differs substantially from other types of tax, in particular sales tax (unit tax and ad valorem tax) [7].

While sales tax disrupts incentives for participants in sales transactions by moving resource allocation away from the social optimum, the environmental tax is the opposite, introducing it encourages buyers and sellers to get closer to the social optimum.

In ordinary tax, social welfare is measured by the sum of the consumer's and producer's surplus and decreases its introduction more than the state's revenue from the collected tax increases, which ultimately results in the appearance of a “dead burden” [8].

In contrast, when negative externalities are present, by introducing an environmental tax, the state not only cares about the well-being of direct market participants, but also about the well-being of those affected by the negative effects of environmental damage.

By acting in this way, environmental taxes move the allocation of resources closer to the social optimum.

Environmental tax is an essential determinant of market equilibrium. If producers are obliged to pay taxes, its variables, and thus marginal costs, rise.

Geometrically, the introduction of environmental taxes shifts the marginal cost curve to the left. If market demand remained the same, the introduction of taxes would, by reducing supply, increase the equilibrium price and reduce the equilibrium quantity.

Consider the effect of introducing an environmental tax in the event that the bidder is required to pay the tax. Let the market demand and supply curves be linear and let them take the form before the introduction of taxes: [9].

$$p_d = a - bx \qquad (1)$$

$$p_s = c + dx \qquad (2)$$

in which p_d indicates the price buyers are willing to pay for the quantity x and p_s is the price that sellers are willing to accept for the quantity x. Parameter a indicates the amount of the price at zero demanded quantity, and parameter b indicates how much the price will decrease if the demanded quantity increases by one [15].

Parameter c specifies the intersection of the supply curve with the ordinate axis, while d shows how much the price will increase if the quantity offered is increased by one. By equalizing the right sides of expressions (1) and (2) and solving by x, we obtain an equilibrium quantity.

$$x^* = \frac{a - c}{b + d} \qquad (3)$$

We will obtain the equilibrium price by replacing x* in the expression (1) or (2):

$$p_d = p_s = \frac{ad + bc}{b + d} \qquad (4)$$

Before the introduction of taxes, the whole amount of the price paid by the buyer is received by the seller. We will assume that sellers are taxpayers and that the unit tax is t. The price received by the seller (p_s) is equal to the difference between the price paid by the buyer p_d and the amount given to the state for tax purposes, namely:

$$p_s = p_d - t \qquad (5)$$

The quantity demanded is a function of the price the buyer pays, so the demand function will retain its initial form given by expression (1), while the quantity offered depends on the price the buyer pays minus the tax amount, that is:

$$p_d - t = c + dx \qquad (6)$$

Solving the system of equations (1) and (6) by x, we get the equilibrium quantity after the introduction of taxes:

$$x^{*'} = \frac{a - c}{b + d} - \frac{t}{b + d} \qquad (7)$$

The price that customers pay p_d is obtained by replacing x*' in expression (1) or (6) and solving them by p_d, namely:

$$p_d = \frac{ad + bc}{b + d} + \frac{bt}{b + d} \qquad (8)$$

and we will get the offer price when we deduct the tax from the price paid by the buyer, that is:

$$p_s = \frac{ad + bc}{b + d} - \frac{dt}{b + d} \quad (9)$$

3.1. The impact of Ecological Wellbeing Tax

With a demand curve that goes from left to right and a supply curve that goes from left to right, the introduction of taxes reduces the price the seller receives while increasing the price paid by the buyer [10].

The sum of the price increase for the buyer and the price decrease for the seller is equal to the amount of tax imposed. It is clear that for these reasons they are losing both market participants to the size of the tax burden they bear. But there is another type of loss for buyers and bidders [6].

This is a reduced equilibrium quantity, resulting from the introduction of taxes. Lost output is the social cost of taxes. On the other hand, the introduction of taxes benefits the state, it generates revenues from which its expenditures are financed.

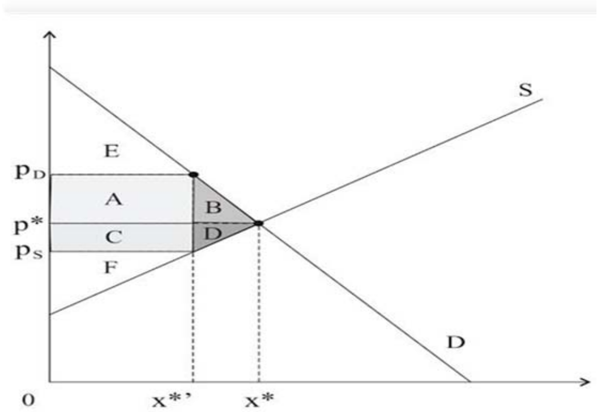

Figure 2. Effects of taxes on consumer and producer surplus

At first glance, it may seem like there is a balance of harms and benefits to introducing taxes, that what one participant loses (buyers and sellers), others (the state) receive in the same amount [5].

The amount of loss due to the introduction of taxes for buyers and bidders is greater than the amount of revenue that the state receives on the basis of the imposed tax.

To prove this claim, we will use our model with linear supply and demand curves and the concept of an economic approach to the problem of consumer and producer surplus [11].

3.2. Effects of an Environmental Tax on the Well-being of Consumers and Producers

At the price p* the equilibrium is established at the equilibrium quantity x* (Figure 2.). For the purchased quantity x*, customers pay x*p*, and were prepared to pay the sum determined by the sum of areas A, B, and E. Therefore, A+B+E denotes the consumer surplus at initial equilibrium. Therefore, in a situation where there is no ecological tax (t = 0), the consumer's surplus is the highest possible and amounts to:

$$P_D V_{(t=0)} = \frac{b}{2}\left(\frac{a - c}{b + d}\right)^2 \quad (10)$$

With the introduction of taxes, consumer surplus will be quantitatively equal to area E and will be:

$$P_D V_{(t > 0)} = \frac{b}{2}\left(\frac{a - c - t}{b + d}\right)^2 \quad (11)$$

The expression (11) gives the dependence of the amount of consumer surplus on the amount of environmental tax. By equating the above expression with zero and solving by t, we get an amount of environmental tax at which the size of the consumer surplus equals zero. Consumer surplus will be zero if the environmental tax is:

$$t = a - c$$

With the introduction of taxes, the price paid by customers from p* rises to p_d, and the size of the consumer surplus will be reduced by the sum of the area of quadrilateral A and triangle B. The area of quadrilateral A is a quantitative measurement of the reduction of consumer surplus because customers in new conditions pay for each unit higher price than before, and the area of triangle B measures the loss of consumer surplus due to the fact that they no longer buy quantities from x*' to x*. Or from another angle, surface A shows the size of the tax burden borne by consumers and surface B a portion of the "dead load" borne by consumers. Total reduction in consumer surplus ($\Delta P_D V$) is:

$$\Delta P_D V = -\left[\left(\frac{a - c - t}{b + d}\right)\left(\frac{bt}{b + d}\right) + \left(\frac{t}{2(b + d)}\right)\left(\frac{bt}{b + d}\right)\right]$$

respectively:

$$\Delta P_D V = -\left[\frac{bt(a - c - t)}{(b + d)^2} + \frac{bt^2}{2(b + d)^2}\right] \quad (12)$$

in which the first collection of the above expression shows a quantitative measurement of the area of quadrilateral A and the second of the surface of triangle B.

What consequences does the environmental tax have for the manufacturer? Obviously, in new circumstances, they get a lower price than before. The price they now receive is given by (9).

Bidding function is defined as the price that bidders are willing to accept in order to sell a certain quantity. If bidders were willing to sell each additional unit at a price determined by the bid function, and were actually selling it at the price p*, that area below the price line p*, above the supply curve, indicates a measure of the manufacturer's surplus. The producer surplus at the price p* is determined by the sum of areas C, D and F. Thus, in a situation where there is no ecological tax (t = 0), the producer surplus is the highest possible and amounts to:

$$P_S V_{(t=0)} = \frac{d}{2}\left(\frac{a-c}{b+d}\right)^2 \qquad (13)$$

With the introduction of taxes, the producer's surplus is reduced to the area F and is:

$$P_S V_{(t>0)} = \frac{d}{2}\left(\frac{a-c-t}{b+d}\right)^2 \qquad (14)$$

If the price received by the bidder after tax is reduced to p_s, the size of the producer's surplus is reduced by the sum of the areas of quadrilateral C and triangle D.

Area C represents a decrease in the producer's surplus resulting from a decrease in price, and D denotes a decrease in the producer's surplus over those products which now can't sell because of the decrease in the balance quantity. Or from another angle, C shows the magnitude of the tax burden borne by the manufacturers and D the portion of the "dead load" borne by the manufacturers. The total reduction in the manufacturer's surplus ($\Delta P_S V$) is:

$$\Delta P_S V = -\left[\left(\frac{a-c-t}{b+d}\right)\frac{dt}{b+d} + \frac{t}{2(b+d)}\frac{dt}{b+d}\right]$$

respectively:

$$\Delta P_S V = -\left[\frac{dt(a-c-t)}{(b+d)^2} + \frac{dt^2}{2(b+d)^2}\right] \qquad (15)$$

in which the first sum of terms (15) denotes the amount of the producer's surplus decrease due to the decrease in the price of the products still being sold (square area C) and the second decrease of the producer surplus due to the decrease in quantity (triangle area D) [13].

3.3. Effects of Environmental Tax on the Size of "Dead Cargo" and Tax Revenue

The loss of total welfare resulting from the introduction of taxes is quantitatively equal to the sum of areas B and D and is referred to in the economic literature as the "dead weight" (MT) of taxes. It states:

$$MT = \frac{bt^2}{2(b+d)^2} + \frac{dt^2}{2(b+d)^2}$$

respectively:

$$MT = \frac{t^2}{2(b+d)} \qquad (16)$$

On the basis of the above relation, we conclude that the decrease in total welfare, that is, the amount of "dead weight", depends only on the amount of taxes. When there would be no tax in welfare loss and vice versa, a higher tax causes greater welfare loss. It reaches its maximum value "dead load" at a tax rate of $t = a - c$ and would be:

$$MT = \frac{(a-c)^2}{2(b+d)}$$

Based on the expression (16), we conclude that if the amount of tax is doubled, the welfare loss increases by 4 times, if the tax increases three times the welfare loss, i.e. the "dead burden" increases by 9 times, etc.

Tax revenue (T) is obtained by multiplying the quantity of product sold by the amount of tax per unit. In the diagram above, this is the sum of the surfaces A and C, respectively:

$$T = \frac{bt(a-c-t)}{(b+d)^2} + \frac{dt(a-c-t)}{(b+d)^2} \qquad (17)$$

By equating the first derivative of the above function by argument t with zero (a, b, c and d are constants that determine the position of the supply and demand curve in the coordinate system) and solving by t we will get the amount of tax at which the tax revenue reaches its maximum value. This is a tax amount of:

$$t = \frac{a-c}{2}$$

and by equating expression (17) with zero and solving by t, we get a tax amount at which tax revenue equals zero. This is a unit tax amount of:

$$t_1 = 0 \quad \text{i}$$

$$t_2 = (a-c)$$

3.4. Effects of Environmental Tax on the Amount of Environmental Damage

In the unregulated market, the externalities equilibrium is established at the quantity x* and the price p* [2].

This situation is best from the point of view of producers and consumers, but it is least desirable in terms of tax revenues and the amount of total environmental damage. If producers could pollute the environment without any restrictions, the total environmental damage (ED) would be maximized and would be:

$$ED_{(t=0)} = e\left(\frac{a-c}{b+d}\right) \qquad (18)$$

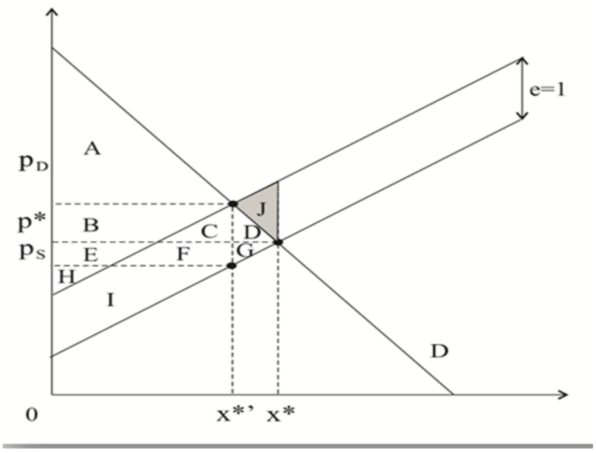

Figure 3. Environmental tax equals environmental damage

The amount of environmental damage in the diagram above is quantitatively summed by the sum of surfaces I, F, G, C, D and J. Although the environmental tax may be less than, equal to, or greater than the amount of environmental damage per unit produced, in the chart above we have illustrated the effects of this tax equal to the amount of environmental damage. [14].

Introducing an environmental tax shifts the equilibrium quantity to the level of x*', increasing the price paid by the buyer to p_d, while reducing the price received by the seller to p_s. With the introduction of the environmental tax, the total environmental damage is reduced to the size given by the sum of areas I, F and C. It amounts to:

$$ED_{(t>0)} = e\left(\frac{a-c-t}{b+d}\right) \qquad (19)$$

Subtracting expression (18) from (19), we get the amount of reduction of the total ecological damage resulting from the introduction of the ecological tax:

$$\Delta ED = -\left(\frac{et}{b+d}\right) \qquad (20)$$

as shown in the graph by the sum of surfaces G, D and J.

3.5. Effects of the Environmental Tax on Total Well-being

Given the supply and demand functions, the amount of environmental damage per unit and the amount of environmental tax, the surplus of all participants ($UV_{(t>0)}$) is obtained when the sum of consumer and producer surplus is increased by the amount of tax revenue and the size is reduced environmental damage at a given amount of environmental tax, that is:

$$UV_{(t>0)} = \frac{b}{2}\left(\frac{a-c-t}{b+d}\right)^2 + \frac{d}{2}\left(\frac{a-c-t}{b+d}\right)^2 + t\left(\frac{a-c-t}{b+d}\right) - e\left(\frac{a-c-t}{b+d}\right)$$

respectively:

$$UV_{(t>0)} = \frac{b+d}{2}\left(\frac{a-c-t}{b+d}\right)^2 + (t-e)\left(\frac{a-c-t}{b+d}\right) \qquad (21)$$

On the other hand, in an uncontrolled market (where the state does not intervene by introducing an environmental tax) that produces negative externalities, the amount of total welfare (the sum of producer and consumer surplus plus the amount of tax revenue and minus the value of environmental damage) is:

$$UV_{(t=0)} = \frac{b}{2}\left(\frac{a-c}{b+d}\right)^2 + \frac{d}{2}\left(\frac{a-c}{b+d}\right)^2 - e\left(\frac{a-c}{b+d}\right)$$

respectively:

$$UV_{(t=0)} = \left(\frac{b+d}{2}\right)\left(\frac{a-c}{b+d}\right)^2 - e\left(\frac{a-c}{b+d}\right) \qquad (22)$$

Manufacturers and consumers achieve their maximum well-being at the volume of x*, that is, at the equilibrium price of p*. The consumer surplus is given by the area above the price a and below the demand curve and it is equal to the sum of areas A, B, C and D. The producer surplus is given by the area above the curve of their private costs and below the price, that is, it is given by the sum of areas E, F, G, H and I. Since there is no tax, tax revenue equals zero, and manufacturers will have no incentive to reduce the total amount of pollution. Ecological damage will be maximally possible and equal to the sum of areas I, F, G, C, D and J. Total welfare equals the sum of producer and consumer surplus minus the amount of environmental damage at volume x*. Quantitatively observed, the total welfare will be equal to sum areas A, B, C and H minus the area of triangle J. By treating all the participants together (producers, consumers, the state and the third party that bears the consequences of the environmental pollution), we note that their overall well-being in relation to the case when no tax increases by area J [5].

Table 1. SURPLUS

Category Surplus	Before the introduction of the ecological tax	After the introduction of the ecological tax	Difference
1	2	3	4
Consumer Surplus	(A+B+C+D)	A	-(B+C+D)
Manufacturer's Excess	(E+F+G+H+I)	(H+I)	-(E+F+G)
Environmental Damage	-(I+F+G+C+D+J)	-(I+F+C)	+(G+D+J)
State Revenue	-	(B+C+E+F)	+(B+C+E+F)
TOTAL SURPLUS:	(A+B+E+H-J)	(A+B+E+H)	J

From the difference of expressions (21) and (22), we obtain the effect of introducing an environmental tax on total well-being. He states: [9].
ΔUV = ΔP_D V + ΔP_S V + ΔT + ΔED
respectively:

$$\Delta UV = -\left[\frac{t(a-c-t)}{(b+d)} + \frac{t^2}{2(b+d)}\right] + t\left(\frac{a-c-t}{b+d}\right) + \frac{et}{b+d} \quad (23)$$

in which the term in large brackets denotes a decrease in consumer and producer surplus together, the second collection increases the total surplus due to the emergence of tax revenue, and the third collection net effect of environmental tax on the amount of environmental damage.

4. Optimal Amount of Environmental Tax

A general approach to sizing environmental taxes involves respecting the interests of all market participants, not just producers who pollute the environment and the consumer.

The interests of the tax collecting state, other producers and individuals who bear the consequences of pollution and organizations dealing with environmental issues must be taken into account [3].

From the point of view of environmentalists, higher taxes reduce pollution and vice versa. There would be no pollution at all if a tax were introduced equal to the vertical distance of the intersection of the supply and demand curve with the vertical axis. In this case, the third party would not bear the negative consequences of pollution, the state would not generate any tax revenues on this basis, the producers and consumers of the given product would not generate any surpluses, because none of the market actors would produce and buy anything at such a high tax. If we consider the problem of the size of the environmental tax only from the perspective of the well-being of consumers and producers, the best solution for them is when there is no ecological tax.

The selfish interests of the state favor an amount of environmental tax that is equal to half the vertical distance of the intersection of the supply and demand curve with the ordinate axis, because at that tax the total tax revenue will be highest [8].

If the state authority is aware of the supply and demand functions of a product that produces adverse effects on the environment, and if the magnitude of these adverse effects per product unit (s) is known, the question arises as to what amount of environmental tax per unit of production the state should determine if its primary goal is to maximize overall well-being [4].

By calculating the first statement of expression (23) by argument t, we obtain

$$\frac{dUV}{dt} = \frac{e}{(b+d)} - \frac{t}{(b+d)} \quad (24)$$

The amount of ecological tax at which total well-being is highest is obtained by equating the above relation with zero and solving it by t. The amount of environmental tax at which maximizing total well-being must be equal to the amount of environmental damage per unit (t = e).

5. Conclusion

If negative externalities in production were not balanced, the point of intersection of the curve of private costs and private benefits would be effective in Pareto's sense. However, due to negative externalities, the total cost of production is higher than the amount of private costs for the amount of damage suffered by other participants due to the negative impact of pollution. For these reasons (at a constant amount of environmental damage per unit of product) the social cost curve must be shifted in parallel with the private cost curve to the left and up. Introduction of pollution tax, i.e. so-called environmental (Piguovian) tax is the most effective public policy measure aimed at reducing pollution levels, remedying the effects of environmental damage and achieving social optimum.

In terms of its effects on overall well-being, environmental taxes differ substantially from sales taxes. While the introduction of sales tax disrupts incentives for participants in sales transactions by moving resource allocation away from the social optimum, with the environmental tax the situation is reversed, its introduction encourages buyers and sellers to approach the social optimum. In the ordinary tax, social welfare as measured by the sum of the consumer and producer surplus decreases more than the state revenue from the collected tax increases, which ultimately results in the appearance of a "dead load". In contrast, by introducing an environmental tax, the state not only cares about the well-being of direct market participants, but also about the well-being of those exposed to the negative effects of environmental damage. By acting in this way, environmental taxes move the allocation of resources closer to the social optimum.

The best solution is achieved if the state determines an amount of environmental tax that is quantitatively equal to the amount of environmental damage per unit of product produced. At a given level of ecological tax, overall well-being is the highest possible. If the tax is less than the amount of environmental damage per unit, the total social well-being is higher than the welfare in the unregulated market, and if the amount of ecological tax is equal to twice the amount of environmental damage per unit, the social welfare at this size of tax equals social welfare in the unregulated market. But if the tax is greater than twice the amount of environmental damage per unit, social well-being at this level of tax is less than social well-being in the unregulated market and is in the essence a typical state failure.

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