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ОПТИМИЗАЦИОННАЯ МОДЕЛЬ ДВУХСТАВОЧНОГО ТАРИФА

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OPTIMIZATION MODEL OF A TWO-PART TARIFF

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Аннотация
В работе рассмотрены оптимизационные модели двухставочного тарифа на продукцию и услуги естественных монополий. В модели оптимизации тарифа учитываются нижний и верхний пределы тарифа. В работе также рассматривается задача нахождения максимума функции общественного благосостояния при условии безубыточности фирмы, неотрицательности цены и неотрицательности средней прибыли фирмы.
Abstract
The paper considers optimization models of a two-part tariff for products and services of natural monopolies. In the tariff optimization model, the lower and upper limits of the tariff are taken into account. The paper also considers the problem of finding the maximum of the social welfare function under the condition that the firm breaks even, the price is non-negative, and the average profit of the firm is non-negative.
Ключевые слова: тариф, фирма, модель, оптимизация, продукт.
Keywords: tariff, firm, model, optimization, product.

1. Введение

В работе рассматривается задача нахождения максимума функции общественного благосостояния при условии безубыточности фирмы, неотрицательности цены и неотрицательности средней прибыли фирмы.

В отличие от известных работ, в статье учтены условия неотрицательности цены и неотрицательности средней прибыли фирмы и исследована модель оптимизации тарифов. В работе также рассматриваются обобщения модели тарифной оптимизации, которые изучаются в [1]-[3]. Модели тарифной оптимизации также рассматриваются в [4]-[7]. Обычно становятся известной нижняя и верхняя граница тарифа в экономике. Поэтому в работе рассмотрен случай $P \in [a_1, b_1]$ и $\varepsilon \in [a_2, b_2]$, где $b_1 > a_1 \ge 0$ и $b_2 > a_2 \ge 0$, $b_1, b_2 \in R$.

Работа является продолжением работы автора [7].

При одноставочном тарифе расходы потребителя представляют собой линейную функцию от объема потребления $R(Q) = P \times Q$, поэтому одноставочные тарифы называют также линейными тарифами. Общие затраты покупателя при линейных тарифах пропорциональны количеству купленной продукции. Цены Рамсея являются линейными ценами, максимизирующими функцию общественного благосостояния при условии безубыточности естественной монополии.

Многоставочные тарифы включают в себя плату за подключение к сети (или плату за право пользования услугой) и последовательность ставок, зависящих от объема потребления.

Наиболее простым нелинейным тарифом является двухставочный тариф, включающий в себя плату за подключение ε и ставку (предельную цену) P за каждую единицу приобретенного продукта. Впервые двухставочный тариф был предложен Коузом (см. [3, с.72]). Предельная цена P в тарифе Коуза равна предельным издержкам, а плата за подключение устанавливается на уровне, достаточном для покрытия постоянных издержек и определяется делением величины постоянных издержек F на общее число потребителей N:

$$P(Q) = \begin{cases} \frac{F}{N} : Q = 0, \\ MC : Q > 0, \end{cases}$$

где MC - функция предельных издержек. Идея такого тарифа проста: гарантировать потребление продукции естественной монополии в эффективном объёме. Плата за подключение к сети, внесенная один раз, не влияет на решение потребителей об объеме покупки в дальнейшем, и покупатели приобретут то же количество продукта, что и при линейной цене, равной предельным издержкам. Может показаться, что двухставочный тариф Коуза дает простое решение проблемы максимизации общественного благосостояния при условии безубыточности естественной монополии. Действвительно, если все потребители при таком тарифе получают неотрицательный излишек, то тариф Коуза будет оптимальным тарифом, обеспечивающим безубыточность фирмы. При нем достигается тот же уровень совокупного излишка, что и при ценообразовании по принципу равенства цен предельным издержкам. Эффект входной платы состоит только в передаче величины излишка, равного постоянным издержкам F от потребителей к фирме. Двухставочный тариф Коуза будет близок к эффективному в случаях, когда рынок участия не эластичен по плате за подключение к сети. Принято считать, что рынки электро-, водо-, газоснабжения являются такими рынками. Если же плата за подключение к сети заставит кого-то из потребителей покинуть рынок, то двухставочный тариф Коуза перестает быть оптимальным. В этом случае, возможно, лучше установить цену $P > MC$ и взимать меньшую плату за подключение, чем потерять часть потребителей.

Вопрос об оптимальном двухставочном тарифе в этом случае должен решаться как задача об определении оптимальной цены на двух рынках: рынке участия и рынке потребления с учётом отрицательной перекрестной эластичности между этими двумя рынками. Действительно, рост предельной цены P не только сокращает общее потребление, но и подталкивает некоторых покупателей отказаться от потребления услуги, что сокращает число участников рынка. Рост входной платы ε заставит некоторых потенциальных потребителей отказаться от выхода на рынок, что приведет к сокращению общего потребления. Если участие не эластично по цене, что характерно, например, для рынка коммунальных услуг, то оптимальный двухставочный тариф имеет высокую входную плату ε и низкую предельную цену P, близкую к предельным издержкам. Если участие имеет высокую эластичность по цене, то входная плата ε относительно низка, чтобы увеличить число участников рынка, а предельная цена P довольно высока, чтобы покрыть общие издержки.

Работа состоит из четырех пунктов. В пункте 1 дано краткое изложение работы. В пункте 2 рассмотрена функция общественного благосостояния и критерий оптимизации. В пункте 3 изучается оптимизационная модель двухставочного тарифа (частный случай). В пункте 4 исследована общая модель оптимизации двухставочного тарифа.

2. Функция общественного благосостояния и критерий оптимизации

Рассмотрим обобщения модели тарифной оптимизации, которые изучаются в [1]-[3].

Предположим, что спрос потребителей на продукт естественной монополии зависит не только от цены на данный продукт, но и от параметра θ, позволяющего различать потребителей по их приверженности к данному продукту. На практике таким параметром может быть доход потребителей. Поэтому в дальнейшем параметр θ будем называть доходом. Обозначим через $Q = Q(p, \theta)$ функцию спроса потребителей с доходом θ. Причем, функция спроса удовлетворяет условию сильной монотонности по θ: если $\theta_1 > \theta_2$, то $Q(p, \theta_1) > Q(p, \theta_2)$ для любой цены p. Условие сильной монотонности означает, что потребитель с большим значением параметра θ купит большее количество продукта при любой цене p.

Доход будем рассматривать как случайную величину с известной функцией распределения $G(x)$ и плотностью распределения $g(x)$. Тогда доля потребителей, имеющих доход меньше, чем x равна $G(x)$, а доля потребителей, имеющих доход в интервале $[x, x + \Delta x]$, приблизительно равна $g(x) \times \Delta x$.

Предположим, что потребителям предложен двухставочный тариф с платой за подключение ε и предельной ценой P. Максимизируя свой излишек, потребитель со значением дохода θ приобретет $Q = Q(P, \theta)$ единиц товара. Пусть $\rho(q, \theta)$ – обратная функция спроса. Значение функции $\rho(Q, \theta)$ представляет собой цену, которую покупатель с доходом θ готов заплатить за Q единиц товара. Для вычисления излишка этого покупателя проинтегрируем разность между его готовностью платить за q единиц товара $\rho(q, \theta)$ и реально уплаченной ценой P по всем единицам приобретенного товара. Далее вычтем из полученной величины входную плату ε. Получим излишек покупателя (см. [3, с.76]):

$$S(P, \varepsilon, \theta) = \int_0^{Q(P,\theta)} (\rho(q, \theta) - P)dq - \varepsilon = \int_0^{Q(P,\theta)} \rho(q, \theta)dq - PQ(P, \theta) - \varepsilon.$$

Вычислим средний излишек покупателей при двухставочном тарифе (P, ε). Обозначим через $\theta_0 = \theta_0(P, \varepsilon)$ значение дохода, при котором покупатель получает нулевой излишек при тарифе $(P, \varepsilon): S(P, \varepsilon, \theta_0) = 0$, т.е $S(P, \varepsilon, \theta_0(P, \varepsilon)) = 0$. Все покупатели со значением дохода $\theta < \theta_0(P, \varepsilon)$ не будут совершать покупку при тарифе (P, ε), так как их излишек при этом тарифе отрицателен. Будем называть доход $\theta_0(P, \varepsilon)$ предельным доходом. Через θ_{max} обозначим наибольшее из возможных значений дохода θ. Проинтегрируем излишки потребителей со всеми возможными значениями дохода θ (от $\theta_0(P, \varepsilon)$ до θ_{max}) с весами, равными плотностям вероятности для этих значений.

Получим средний потребительский излишек при двухставочном тарифе (P, ε):

$$S(P, \varepsilon) = \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} S(P, \varepsilon, x)g(x)dx .$$

Чем многочисленнее группа потребителей с некоторым значением дохода q, тем с большим весом входит излишек этой группы потребителей в общий потребительский излишек. Предположим, что функция издержек естественной монополии (ЕМ) линейна: $C(Q) = F + cQ$, где F - постоянные издержки, c - предельные издержки. Тогда излишек производителя, полученный естественной монополией при обслуживании потребителя со значением дохода $\theta > \theta_0(P,\varepsilon)$, равен

$$\Pi(P,\varepsilon,\theta) = PQ(P,\theta) + \varepsilon - c \cdot Q(P,\theta) = (P-c)Q(P,\theta) + \varepsilon .$$

Тогда средняя прибыль фирмы при двухставочном тарифе (P,ε) составит величину (см. [3, с.77]):

$$\Pi(P,\varepsilon) = \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx - F .$$

Рассмотрим задачу нахождения максимума функции общественного благосостояния $W(P,\varepsilon) = S(P,\varepsilon) + \Pi(P,\varepsilon)$ при условии безубыточности фирмы, неотрицательности цены и неотрицательности средней прибыли фирмы:

$$\begin{cases} \max\limits_{P\ge 0,\varepsilon\ge 0} W(P,\varepsilon), \\ \Pi(P,\varepsilon) \ge 0. \end{cases}$$

Рассмотрим эквивалетную задачу

$$\begin{gathered} \min_{P\ge 0,\varepsilon\ge 0} (F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} S(P,\varepsilon,x)g(x)dx), \\ F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx \le 0. \end{gathered} \qquad (2.1)$$

Так как $S(P,\varepsilon,\theta) = \int_0^{Q(P,\theta)} \rho(q,\theta)dq - PQ(P,\theta) - \varepsilon$ и $\Pi(P,\varepsilon,\theta) = (P-c)Q(P,\theta) + \varepsilon$, то задача (2.1) имеет вид:

$$\begin{gathered} \min_{P\ge 0,\varepsilon\ge 0} \{F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} ((P-c)Q(P,x)+\varepsilon)g(x)dx - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} (\int_0^{Q(P,x)} \rho(q,x)dq - PQ(P,x) - \varepsilon)g(x)dx\}, \\ F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} ((P-c)Q(P,x)+\varepsilon)g(x)dx \le 0. \end{gathered}$$

Построим обобщенную функцию Лагранжа для задачи (2.1)

$$L(P,\varepsilon,\lambda_0,\lambda) = \lambda_0(F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} S(P,\varepsilon,x)g(x)dx) + \lambda(F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx), \qquad (2.2)$$

где $\lambda_0 \ge 0$, $\lambda \ge 0$ (см. [8, с.129]). Отметим, что без ограничения общности будем считать $\lambda_0 = 0$ или $\lambda_0 = 1$. Из экономических соображений следует, что можно положить $\lambda_0 = 1$, т.е. предположим, что задача (2.1) является регулярной. Тогда функции Лагранжа (2.2) имеет вид:

$$\begin{aligned} L(P,\varepsilon,\lambda) &= F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} S(P,\varepsilon,x)g(x)dx + \lambda(F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} \Pi(P,\varepsilon,x)g(x)dx) = \\ &= (1+\lambda)(F - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} ((P-c)Q(P,x)+\varepsilon)g(x)dx) - \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} (\int_0^{Q(P,x)} \rho(q,x)dq - PQ(P,x) - \varepsilon)g(x)dx. \end{aligned}$$

Обозначим $\overline{Q}(P,\varepsilon) = \int_{\theta_0(P,\varepsilon)}^{\theta_{max}} Q(P,x)g(x)dx$ -спроса при двухставочном тарифе (P,ε). Средний спрос получается в результате интегрирования спроса различных групп потребителей по всем возможным значениям дохода q, с весами, равными плотности вероятности для этих значений. Чем многочисленнее группа потребителей с некоторым значением дохода q, тем с большим весом входит спрос этой группы потребителей в общий спрос.

Пусть функция $\theta_0(P,\varepsilon)$ непрерывно дифференцируема при $P \ge 0, \varepsilon \ge 0$, частная производная $\frac{\partial}{\partial P}Q(P,x)$ непрерывна при $P \ge 0$ и $x \in [0,\theta_{max}]$, $Q(P,x)$, $\rho(q,x)$ и $g(x)$ непрерывные функции при $P \ge 0$, $q \ge 0$ и $x \in [0,\theta_{max}]$. Считаем, что $0 \le \theta_0(P,\varepsilon) \le \theta_{max}$ при $P \ge 0$, $\varepsilon \ge 0$.

Вычислим частные производные функции Лагранжа:

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)=(1+\lambda)(((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-$$
$$-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}(Q(P,x)+(P-c)\frac{\partial}{\partial P}Q(P,x))g(x)dx)-$$
$$-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}(\rho(Q(P,x),x)\frac{\partial}{\partial P}Q(P,x)-Q(P,x)-P\frac{\partial}{\partial P}Q(P,x))g(x)dx+$$
$$+(\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)=$$
$$=(1+\lambda)(((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}(Q(P,x)+(P-c)\frac{\partial}{\partial P}Q(P,x))g(x)dx)+$$
$$+\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}Q(P,x)g(x)dx+(\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)=$$
$$=(1+\lambda)[((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}(P-c)\frac{\partial}{\partial P}Q(P,x)g(x)dx]-$$
$$-\lambda\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}Q(P,x)g(x)dx+(\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon).$$

Отметим, что $\rho(Q(P,x),x)=P$, где $\rho(Q,x)$ - обратная функция спроса. Так как

$$S(P,\varepsilon,\theta_0(P,\varepsilon))=\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon=0,$$

то имеем

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)=(1+\lambda)[((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-(P-c)\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\frac{\partial}{\partial P}Q(P,x)g(x)dx]-\lambda\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}Q(P,x)g(x)dx=$$
$$=(1+\lambda)(((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}[(1+\lambda)(P-c)\frac{\partial}{\partial P}Q(P,x)+\lambda Q(P,x)]g(x)dx.$$

Также ясно, что

$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)=(1+\lambda)[(P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}g(x)dx]+\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}g(x)dx+$$
$$+(\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)=$$
$$=(1+\lambda)((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}g(x)dx.$$

Так как $\Pi(P,\varepsilon,\theta(P,\varepsilon))=(P-c)Q(P,\theta(P,\varepsilon))+\varepsilon$, то обозначив $(1-G(\theta_0(P,\varepsilon)))=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}g(x)dx$,

$\overline{Q}(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}Q(P,x)g(x)dx$ и $\overline{Q}_p(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\frac{\partial}{\partial P}Q(P,x)g(x)dx$ имеем, что

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)=(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)-\lambda\overline{Q}(P,\varepsilon),$$
$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)=(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda(1-G(\theta_0(P,\varepsilon))).$$

Величина $(1-G(\theta_0(P,\varepsilon)))=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}g(x)dx$ представляет собой долю участников данного рынка при двухставочном тарифе (P,ε) по отношению к совокупной численности всех потрибителей.

По теореме 4.2.1 (принцип Лагранжа) и лемме 4.2.1[8, с.130, с.131] имеем, что для решения (P,ε) задачи (2.1) выполняется система:

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)\begin{cases}=0:P>0,\\ \geq 0:P=0,\end{cases} \quad (2.3)$$

$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)\begin{cases}=0:\varepsilon>0,\\ \geq 0:\varepsilon=0\end{cases} \tag{2.4}$$

и выполняется равенство

$$\lambda(F-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}((P-c)Q(P,x)+\varepsilon)g(x)dx)=0.$$

Теперь, вообще говоря, необходимо составить четыре систем путем попарного комбинирования соотношений из (2.3), (2.4). Затем требуется найти решения каждой такой системы и каким-то образом исследовать их на оптимальность.

Пусть $P>0$ и $\varepsilon>0$ решение задачи (2.1). Из соотношения (2.3), (2.4) следует, что если $P>0$ и $\varepsilon>0$ решение задачи (2.1), то (P,ε) является решением системы

$$(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\tfrac{\partial}{\partial P}\theta_0(P,\varepsilon)-(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)-\lambda\overline{Q}(P,\varepsilon)=0, \tag{2.5}$$

$$(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\tfrac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda(1-G(\theta_0(P,\varepsilon)))=0 \tag{2.6}$$

и выполняется равенство

$$\lambda(F-\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}((P-c)Q(P,x)+\varepsilon)g(x)dx)=0.$$

Если $g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)\neq 0$, то из соотношения (2.6) получим, что

$$\Pi(P,\varepsilon,\theta_0(P,\varepsilon))=\tfrac{\lambda}{(1+\lambda)}\,\frac{(1-G(\theta_0(P,\varepsilon))).}{g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}. \tag{2.7}$$

Используя соотношение (2.7), уравнение (2.5) можно переписать в виде

$$(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)+\lambda\overline{Q}(P,\varepsilon)=\lambda(1-G(\theta_0(P,\varepsilon))).\frac{\frac{\partial}{\partial P}\theta_0(P,\varepsilon)}{\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}. \tag{2.8}$$

Величину $\frac{\frac{\partial}{\partial P}\theta_0(P,\varepsilon)}{\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}$ найдем из уравнения (см. [3, с.80])

$$S(P,\varepsilon,\theta_0(P,\varepsilon))=\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon=0.$$

Отсюда следует, что

$$\tfrac{\partial S}{\partial P}+\tfrac{\partial S}{\partial\theta_0}.\tfrac{\partial\theta_0}{\partial P}=0 \quad \text{и} \quad \tfrac{\partial S}{\partial\varepsilon}+\tfrac{\partial S}{\partial\theta_0}.\tfrac{\partial\theta_0}{\partial\varepsilon}=0.$$

Поэтому

$$\frac{\frac{\partial}{\partial P}\theta_0(P,\varepsilon)}{\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}=\frac{\frac{\partial S}{\partial P}}{\frac{\partial S}{\partial\theta_0}}:\frac{\frac{\partial S}{\partial\varepsilon}}{\frac{\partial S}{\partial\theta_0}}=\frac{\frac{\partial S}{\partial P}}{\frac{\partial S}{\partial\varepsilon}}=\frac{P\frac{\partial}{\partial P}Q(P,\theta_0(P,\varepsilon))-Q(P,\theta_0(P,\varepsilon))-P\frac{\partial}{\partial P}Q(P,\theta_0(P,\varepsilon))}{-1}=Q(P,\theta_0(P,\varepsilon)).$$

Тогда уравнение (2.8) можно переписать в виде

$$(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)+\lambda\overline{Q}(P,\varepsilon)=\lambda(1-G(\theta_0(P,\varepsilon))).Q(P,\theta_0(P,\varepsilon)).$$

Если $\overline{Q}(P,\varepsilon)\neq 0$, то отсюда следует, что

$$(P-c)=\frac{\lambda}{1+\lambda}\frac{(1-G(\theta_0(P,\varepsilon))).Q(P,\theta_0(P,\varepsilon))-\overline{Q}(P,\varepsilon)}{\overline{Q}_p(P,\varepsilon)}$$

или

$$\frac{P-c}{P}=-\frac{\lambda}{1+\lambda}\frac{\overline{Q}(P,\varepsilon)}{P\overline{Q}_P(P,\varepsilon)}(1-\frac{(1-G(\theta_0(P,\varepsilon))).Q(P,\theta_0(P,\varepsilon))}{\overline{Q}}).$$

Так как $\Pi(P,\varepsilon,\theta)=(P-c)Q(P,\theta)+\varepsilon$, то из соотношения (2.7) имеем, что

$$(P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon=\tfrac{\lambda}{(1+\lambda)}\,\frac{(1-G(\theta_0(P,\varepsilon))).}{g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}.$$

Таким образом, если $P>0$, $\varepsilon>0$ и $\lambda>0$, то из системы

$$\frac{P-c}{P}=-\frac{\lambda}{1+\lambda}\frac{\overline{Q}(P,\varepsilon)}{P\overline{Q}_P(P,\varepsilon)}(1-\frac{(1-G(\theta_0(P,\varepsilon))).Q(P,\theta_0(P,\varepsilon))}{\overline{Q}(P,\varepsilon)}),$$

$$(P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon=\tfrac{\lambda}{(1+\lambda)}\,\frac{(1-G(\theta_0(P,\varepsilon))).}{g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}, \tag{2.9}$$

$$\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}((P-c)Q(P,x)+\varepsilon)g(x)dx=F$$

можно найти оптимальный двухставочный тариф (P,ε) и λ.

Преобразуем систему (2.9) с использованием экономических величин (см. [3, с.81]).

Определим эластичность участия по входной цене ε как

$$E_\varepsilon(N) = \frac{\partial(1-G(\theta_0(P,\varepsilon)))}{\partial\varepsilon}\cdot\frac{\varepsilon}{1-G(\theta_0(P,\varepsilon))}.$$

Так как $(1-G(\theta_0(P,\varepsilon)) = \int\limits_{\theta_0(P,\varepsilon)}^{\theta_{max}} g(x)dx$, то имеем, что $\frac{\partial(1-G(\theta_0(P,\varepsilon)))}{\partial\varepsilon} = -g(\theta_0(P,\varepsilon))\frac{\partial\theta_0(P,\varepsilon)}{\partial\varepsilon}$. Поэтому

$$E_\varepsilon(N) = -g(\theta_0(P,\varepsilon))\frac{\partial\theta_0(P,\varepsilon)}{\partial\varepsilon}\cdot\frac{\varepsilon}{1-G(\theta_0(P,\varepsilon))}.$$

Эластичность участия по входной цене показывает на сколько процентов уменьшится доля участников рынка при увеличении платы за подключение на 1%.

Определим эластичность среднего спроса по плате за подключение как

$$E_\varepsilon(\overline{Q}) = \frac{\partial\overline{Q}(P,\varepsilon)}{\partial\varepsilon}\cdot\frac{\varepsilon}{\overline{Q}(P,\varepsilon)}.$$

Так как $\overline{Q}(P,\varepsilon) = \int\limits_{\theta_0(P,\varepsilon)}^{\theta_{max}} Q(P,x)g(x)dx$, то имеем, что $\frac{\partial\overline{Q}(P,\varepsilon)}{\partial\varepsilon} = -Q(P,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial\theta_0(P,\varepsilon)}{\partial\varepsilon}$. Поэтому

$$E_\varepsilon(\overline{Q}(P,\varepsilon)) = -Q(P,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial\theta_0(P,\varepsilon)}{\partial\varepsilon}\cdot\frac{\varepsilon}{\overline{Q}(P,\varepsilon)}.$$

Эта величина показывает на сколько процентов сократится средний спрос при увеличении платы за подключение на 1%.

Определим эластичность среднего спроса по предельной цене как

$$E_P(\overline{Q}(P,\varepsilon)) = \overline{Q}_P(P,\varepsilon)\frac{P}{\overline{Q}(P,\varepsilon)}.$$

Так как $\overline{Q}_p(P,\varepsilon) = \int\limits_{\theta_0(P,\varepsilon)}^{\theta_{max}} \frac{\partial}{\partial P}Q(P,x)g(x)dx$, то имеем, что

$$E_P(\overline{Q}(P,\varepsilon)) = \overline{Q}_P(P,\varepsilon)\frac{P}{\overline{Q}(P,\varepsilon)} = \int\limits_{\theta_0(P,\varepsilon)}^{\theta_{max}} \frac{\partial}{\partial P}Q(P,x)g(x)dx\,\frac{P}{\overline{Q}(P,\varepsilon)}.$$

Эта величина показывает на сколько процентов сократится средний спрос при увеличении предельной цены на 1%.

Используя эластичности среднего спроса по предельной цене и по плате за подключение, а также эластичность участия по плате за подключение, системы (2.9) можно переписать в виде

$$\frac{P-c}{P} = -\frac{\lambda}{1+\lambda}\frac{1}{E_P(\overline{Q}(P,\varepsilon))}\left(1-\frac{E_\varepsilon(\overline{Q}(P,\varepsilon))}{E_\varepsilon(N)}\right), \tag{2.10}$$

$$\frac{(P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon}{\varepsilon} = -\frac{\lambda}{(1+\lambda)}\frac{1}{E_\varepsilon(N)}, \tag{2.11}$$

$$\int\limits_{\theta_0(P,\varepsilon)}^{\theta_{max}} ((P-c)Q(P,x)+\varepsilon)g(x)dx = F. \tag{2.12}$$

Тариф (P,ε), удовлетворяющий уравнениями (2.10)-(2.12), называется оптимальным двухставочным тарифом.

Из условия (2.10) следует, что, как и в случае ценообразования Рамсея, относительное отклонение цены от предельных издержек должно быть тем выше, чем ниже эластичность среднего спроса по предельной цене P. Отличие от обычной формулы Рамсея состоит в присутствии корректирующего множителя $1-\frac{E_\varepsilon(\overline{Q}(P,\varepsilon))}{E_\varepsilon(N)}$, учитывающего эластичность среднего спроса и эластичность участия по плате за подключение.

Если функция спроса, возрастающая функция по параметру θ, то из [3, с.82] следует, что корректирующий множитель удовлетворяет условию $0<1-\frac{E_\varepsilon(\overline{Q}(P,\varepsilon))}{E_\varepsilon(N)}<1$ для любого двухставочного тарифа (P,ε). Из формулы (2.10), следует, что предельная цена будет превосходить предельные издержки.

Если $E_\varepsilon(\overline{Q}(P,\varepsilon)) = 0$, то есть размер платы за подключение не влияет на величину среднего спроса, то предельная цена будет вычисляться по тому же правилу, что и цена Рамсея:

$$\frac{P-c}{P} = -\frac{\lambda}{1+\lambda}\frac{1}{E_P(\overline{Q}(P,\varepsilon))}.$$

Величина $(P-c).Q(P,\theta_0(P,\varepsilon))+\varepsilon$ в формуле (2.11) представляет собой прибыль, полученную фирмой от потребителя с предельным доходом $\theta_0(P,\varepsilon)$. Другие потребители, участвующие на данном рынке, имеют значение дохода $\theta > \theta_0(P,\varepsilon)$ и, соответственно, спрос $Q(P,\theta) > Q(P,\theta_0(P,\varepsilon))$. Следовательно, фирма получит от них прибыль, не меньшую, чем $(P-c).Q(P,\theta_0(P,\varepsilon)) + \varepsilon$. Из формулы (2.11) следует, что чем ниже эластичность участия по плате за подключение $E_\varepsilon(N)$, тем выше должна быть эта плата, и тем в большей степени издержки фирмы должны покрываться за счет высокой платы за подключение. Если участие имеет высокую эластичность по плате за подключение $E_\varepsilon(N)$, то издержки фирмы должны покрываться в основном за счет высокой предельной цены P, а плата за подключение ε должна быть относительно низка.

Если $P > 0$ и $\varepsilon > 0$ решение задачи (2.1) и $\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}} ((P-c)Q(P,x)+\varepsilon)g(x)dx > F$, то получим, что $\lambda = 0$. Тогда из (2.10), (2.11) следует, что

$$(P-c) = 0, \quad (P-c)Q(P,\theta_0(P,\varepsilon)) + \varepsilon = 0.$$

Отсюда следует, система несовместима. Поэтому если $P > 0$, $\varepsilon > 0$, то $\lambda > 0$ и λ определяется из системы (2.10)-(2.12).

Если $P > 0$, $\varepsilon = 0$ решение задачи (2.1) и $\lambda > 0$, то из системы

$$(1+\lambda)(P-c)Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial P}\theta_0(P,0) - (1+\lambda)(P-c)\overline{Q}_p(P,0) - \lambda\overline{Q}(P,0) = 0,$$

$$(1+\lambda)(P-c)Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial \varepsilon}\theta_0(P,0) - \lambda(1-G(\theta_0(P,0))) \geq 0,$$

$$\int_{\theta_0(P,0)}^{\theta_{\max}} (P-c)Q(P,x)g(x)dx = F$$

определяется оптимальный тариф P. Если $Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial P}\theta_0(P,0) - \overline{Q}_p(P,0) \neq 0$, то отсюда следует, что

$$P-c = \frac{\lambda}{1+\lambda}\cdot\frac{\overline{Q}(P,0)}{Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial P}\theta_0(P,0) - \overline{Q}_p(P,0)}.$$

Если $P > 0$, $\varepsilon = 0$ решение задачи (2.1) и $\int_{\theta_0(P,0)}^{\theta_{\max}} (P-c)Q(P,x)g(x)dx > F$, то получим, что $\lambda = 0$. Поэтому из соотношения

$$(P-c)Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial P}\theta_0(P,0) - (P-c)\overline{Q}_p(P,0) = 0,$$

$$(P-c)Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial \varepsilon}\theta_0(P,0) \geq 0$$

можно найти оптимальный тариф P. Если $Q(P,\theta_0(P,0))g(\theta_0(P,0))\tfrac{\partial}{\partial P}\theta_0(P,0) - \overline{Q}_p(P,0) \neq 0$, то отсюда имеем, что $P = c$.

Если $P = 0$, $\varepsilon > 0$ решение задачи (2.1) и $\lambda > 0$, то из системы

$$(1+\lambda)(\varepsilon - cQ(0,\theta_0(0,\varepsilon)))g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial P}\theta_0(0,\varepsilon) + (1+\lambda)c\cdot\overline{Q}_p(0,\varepsilon) - \lambda\overline{Q}(0,\varepsilon) \geq 0,$$

$$(1+\lambda)(\varepsilon - cQ(0,\theta_0(0,\varepsilon)))g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial \varepsilon}\theta_0(0,\varepsilon) - \lambda(1-G(\theta_0(0,\varepsilon))) = 0,$$

$$\int_{\theta_0(0,\varepsilon)}^{\theta_{\max}} (-c\cdot Q(0,x)+\varepsilon)g(x)dx = F$$

можно найти оптимальный тариф ε. Если $g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial \varepsilon}\theta_0(0,\varepsilon) \neq 0,$ то отсюда имеем, что

$$\varepsilon - cQ(0,\theta_0(0,\varepsilon)) = \frac{\lambda}{1+\lambda}\,\frac{(1-G(\theta_0(0,\varepsilon)))}{g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial \varepsilon}\theta_0(0,\varepsilon)}.$$

Пусть $P = 0$, $\varepsilon > 0$ решение задачи (2.1). Если $\int_{\theta_0(0,\varepsilon)}^{\theta_{\max}} (-c\cdot Q(0,x)+\varepsilon)g(x)dx > F$, то получим, что $\lambda = 0$. Поэтому из соотношения

$$(\varepsilon - c\cdot Q(0,\theta_0(0,\varepsilon)))g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial P}\theta_0(0,\varepsilon) + c\cdot\overline{Q}_p(0,\varepsilon) \geq 0,$$

$$(\varepsilon - cQ(0,\theta_0(0,\varepsilon)))g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial \varepsilon}\theta_0(0,\varepsilon) = 0,$$

можно найти оптимальный тариф ε. Если $g(\theta_0(0,\varepsilon))\tfrac{\partial}{\partial \varepsilon}\theta_0(0,\varepsilon) \neq 0,$ то $\varepsilon = cQ(0,\theta_0(0,\varepsilon))$.

Случай $P = 0$, $\varepsilon = 0$ тривиален.

3. Оптимизационная модель двухставочного тарифа (частный случай).

Пусть $\theta_0 = \theta_0(P,\varepsilon)$ постоянное неотрицательное число, т.е. $\theta_0 = \theta_0(P,\varepsilon)$ не зависить от переменной (P,ε), $R = (-\infty,+\infty)$. Предположим, что средний потребительский излишек при двухставочном тарифе (P,ε) имеет вид:

$$S(P,\varepsilon) = \int_{\theta_0}^{\theta_{\max}} S(P,\varepsilon,x)g(x)dx\,,$$

где $S(P,\varepsilon,x)$ излишек покупателя, $S: R\times R\times[\theta_0,\theta_{\max}]\to R$ - заданная функция.

Предположим, что средняя прибыль фирмы при двухставочном тарифе (P,ε) составит величину (см. [3, с.77]):

$$\Pi(P,\varepsilon) = \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx - F\,,$$

где $\Pi(P,\varepsilon,x)$ излишек производителя, полученный естественной монополией при обслуживании потребителя со значением дохода $\theta > \theta_0$, $\Pi: R\times R\times[\theta_0,\theta_{\max}]\to R$ - заданная функция.

Рассмотрим задачу нахождения максимума функции общественного благосостояния $W(P,\varepsilon) = S(P,\varepsilon) + \Pi(P,\varepsilon)$ при условии безубыточности фирмы, неотрицательности цены и неотрицательности средней прибыли фирмы:

$$\begin{cases} \max\limits_{P\ge 0,\varepsilon\ge 0} W(P,\varepsilon), \\ \Pi(P,\varepsilon)\ge 0. \end{cases}$$

Рассмотрим эквивалетную задачу

$$\begin{aligned} &\min_{P\ge 0,\varepsilon\ge 0}(F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0}^{\theta_{\max}} S(P,\varepsilon,x)g(x)dx), \\ &F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx \le 0. \end{aligned} \tag{3.1}$$

Построим обобщенную функцию Лагранжа для задачи (3.1)

$$L(P,\varepsilon,\lambda_0,\lambda) = \lambda_0(F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0}^{\theta_{\max}} S(P,\varepsilon,x)g(x)dx) + \lambda(F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx)\,. \tag{3.2}$$

где $\lambda_0 \ge 0, \lambda \ge 0$ (см. [8, с.129]). Отметим, что без ограничения общности будем считать $\lambda_0 = 0$ или $\lambda_0 = 1$. Из экономических соображений следует, что можно положить $\lambda_0 = 1$. Тогда функции Лагранжа (3.2) имеет вид:

$$\begin{aligned} L(P,\varepsilon,\lambda) &= F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0}^{\theta_{\max}} S(P,\varepsilon,x)g(x)dx + \lambda(F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx) = \\ &= (1+\lambda)(F - \int_{\theta_0}^{\theta_{\max}} \Pi(P,\varepsilon,x)g(x)dx) - \int_{\theta_0}^{\theta_{\max}} S(P,\varepsilon,x)g(x)dx. \end{aligned}$$

Пусть функции $S(P,\varepsilon,x)$, $\frac{\partial}{\partial P}S(P,\varepsilon,x)$, $\frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)$, $\Pi(P,\varepsilon,x)$, $\frac{\partial}{\partial P}\Pi(P,\varepsilon,x)$ и $\frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)$ непрерывные при $P\ge 0$, $\varepsilon \ge 0$ и $x\in[\theta_0,\theta_{\max}]$. Вычислим частные производные функции Лагранжа:

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda) = -(1+\lambda)\int_{\theta_0}^{\theta_{\max}} \frac{\partial}{\partial P}\Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0}^{\theta_{\max}} \frac{\partial}{\partial P}S(P,\varepsilon,x)g(x)dx\,,$$

$$\frac{\partial}{\partial \varepsilon}L(P,\varepsilon,\lambda) = -(1+\lambda)\int_{\theta_0}^{\theta_{\max}} \frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)g(x)dx - \int_{\theta_0}^{\theta_{\max}} \frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)g(x)dx\,.$$

По теореме 4.2.1 (принцип Лагранжа) и лемме 4.2.1[8, с.130, с.131] имеем, что для решения (P,ε) задачи (3.1) выполняется система:

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)\begin{cases} = 0 : P > 0, \\ \ge 0 : P = 0, \end{cases} \tag{3.3}$$

$$\frac{\partial}{\partial \varepsilon}L(P,\varepsilon,\lambda)\begin{cases} = 0 : \varepsilon > 0, \\ \ge 0 : \varepsilon = 0 \end{cases} \tag{3.4}$$

и выполняется равенство

$$\lambda(F-\int_{\theta_0}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx)=0.$$

Теперь, вообще говоря, необходимо составить четыре систем путем попарного комбинирования соотношений из (3.3), (3.4). Затем требуется найти решения каждой такой системы и каким-то образом исследовать их на оптимальность.

Пусть $P>0$ и $\varepsilon>0$. Из соотношения (3.3), (3.4) следует, что если $P>0$ и $\varepsilon>0$ решение задачи (3.1), то (P,ε) является решением системы

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(P,\varepsilon,x)g(x)dx=0,$$

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)g(x)dx=0$$

и выполняется равенство $\lambda(F-\int_{\theta_0}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx)=0$.

Если $P>0$ и $\varepsilon>0$ решение задачи (3.1) и $\lambda>0$, то получим, что (P,ε) и множитель λ является решением системы

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(P,\varepsilon,x)g(x)dx=0,$$

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)g(x)dx=0,$$

$$F-\int_{\theta_0}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx=0.$$

Если $P>0$ и $\varepsilon>0$ решение задачи (3.1) и $\int_{\theta_0}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx>F$, то получим, что $\lambda=0$. Поэтому (P,ε) является решением системы

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(P,\varepsilon,x)g(x)dx=0,$$

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)g(x)dx=0.$$

Если $P>0$, $\varepsilon=0$ решение задачи (3.1) и $\lambda>0$, то из системы

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(P,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(P,0,x)g(x)dx=0,$$

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(P,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(P,0,x)g(x)dx\geq 0,$$

$$F-\int_{\theta_0}^{\theta_{max}}\Pi(P,0,x)g(x)dx=0$$

определяется оптимальный тариф P и λ.

Если $P>0$, $\varepsilon=0$ решение задачи (3.1) и $\int_{\theta_0(P,0)}^{\theta_{max}}\Pi(P,0,x)g(x)dx>F$, то получим, что $\lambda=0$. Поэтому из соотношения

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(P,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(P,0,x)g(x)dx=0,$$

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(P,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(P,0,x)g(x)dx\geq 0$$

определяется оптимальный тариф P.

Если $P=0$, $\varepsilon>0$ решение задачи (3.1) и $\lambda>0$, то из системы

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(0,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(0,\varepsilon,x)g(x)dx\ge 0,$$

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(0,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(0,\varepsilon,x)g(x)dx=0,$$

$$F-\int_{\theta_0}^{\theta_{max}}\Pi(0,\varepsilon,x)g(x)dx=0$$

можно найти оптимальный тариф ε и λ.

Пусть $P=0$, $\varepsilon>0$ решение задачи (3.1). Если $\int_{\theta_0}^{\theta_{max}}\Pi(0,\varepsilon,x)g(x)dx>F$, то получим, что $\lambda=0$. Поэтому из соотношения

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(0,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(0,\varepsilon,x)g(x)dx\ge 0,$$

$$-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(0,\varepsilon,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(0,\varepsilon,x)g(x)dx=0$$

можно найти оптимальный тариф ε.

Если $P=0$, $\varepsilon=0$ решение задачи (3.1), то выполняются неравенства

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}\Pi(0,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial P}S(0,0,x)g(x)dx\ge 0,$$

$$-(1+\lambda)\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}\Pi(0,0,x)g(x)dx-\int_{\theta_0}^{\theta_{max}}\frac{\partial}{\partial \varepsilon}S(0,0,x)g(x)dx\ge 0,$$

и выполняется равенство $\lambda(F-\int_{\theta_0}^{\theta_{max}}\Pi(0,0,x)g(x)dx)=0$.

Отметим, что если

$$S(P,\varepsilon,x)=\int_0^{Q(P,x)}\rho(q,x)dq-PQ(P,x)-\varepsilon,\qquad \Pi(P,\varepsilon,x)=(P-c)Q(P,x)+\varepsilon,$$

то

$$\frac{\partial}{\partial P}S(P,\varepsilon,x)=\rho(Q(P,x),x)\frac{\partial}{\partial P}Q(P,x)-Q(P,x)-P\frac{\partial}{\partial P}Q(P,x)=-Q(P,x),\qquad \frac{\partial}{\partial \varepsilon}S(P,\varepsilon,x)=-1,$$

$$\frac{\partial}{\partial P}\Pi(P,\varepsilon,x)=Q(P,x)+(P-c)\frac{\partial}{\partial P}Q(P,x),\qquad \frac{\partial}{\partial \varepsilon}\Pi(P,\varepsilon,x)=1.$$

Поэтому, если $\theta_0=\theta_0(P,\varepsilon)$ не зависить от переменной (P,ε), для решения задачи (2.1) также можно получить необходимое условие оптимальности.

4. Оптимизационная модель двухставочного тарифа

Обычно нижняя и верхняя граница тарифа в экономике становится известной. Поэтому целесообрано изучить случай $P\in[a_1,b_1]$ и $\varepsilon\in[a_2,b_2]$, где $b_1>a_1\ge 0$ и $b_2>a_2\ge 0$, $b_1,b_2\in R$, т.е. рассмотрим задачу

$$\begin{cases}\max\limits_{P\in[a_1,b_1],\varepsilon\in[a_2,b_2]} W(P,\varepsilon),\\ \Pi(P,\varepsilon)\ge 0,\end{cases}$$

где $W(P,\varepsilon)=S(P,\varepsilon)+\Pi(P,\varepsilon)$, $S(P,\varepsilon,\theta)=\int_0^{Q(P,\theta)}\rho(q,\theta)dq-PQ(P,\theta)-\varepsilon,$ $S(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}S(P,\varepsilon,x)g(x)dx$,

$\Pi(P,\varepsilon,\theta)=(P-c)Q(P,\theta)+\varepsilon$, $\Pi(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx-F$ (см. п.2).

Считаем, что $S(P,\varepsilon,\theta_0(P,\varepsilon))=\int_0^{Q(P,\theta_0(P,\varepsilon))}\rho(q,\theta_0(P,\varepsilon))dq-PQ(P,\theta_0(P,\varepsilon))-\varepsilon=0$.

Рассмотрим эквивалетную задачу

$$\min_{P\in[a_1,b_1],\varepsilon\in[a_2,b_2]}(F-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}\Pi(P,\varepsilon,x)g(x)dx-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}S(P,\varepsilon,x)g(x)dx),$$
$$F-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}\Pi(P,\varepsilon,x)g(x)dx\le 0. \quad (4.1)$$

Пусть функция $\theta_0(P,\varepsilon)$ непрерывно дифференцируема при $P\in[a_1,b_1]$ и $\varepsilon\in[a_2,b_2]$, частная производная $\frac{\partial}{\partial P}Q(P,x)$ непрерывна при $P\in[a_1,b_1]$ и $x\in[0,\theta_{\max}]$, $Q(P,x)$, $\rho(q,x)$ и $g(x)$ непрерывные функции при $P\in[a_1,b_1]$, $\varepsilon\in[a_2,b_2]$, $q\ge 0$, и $x\in[0,\theta_{\max}]$. Считаем, что $0\le\theta_0(P,\varepsilon)\le\theta_{\max}$ при $P\in[a_1,b_1]$, $\varepsilon\in[a_2,b_2]$.

Функция Лагранжа не меняется (см. п.2), поэтому частные производные функции Лагранжа не меняется. Поэтому

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)=(1+\lambda)(((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}[(1+\lambda)(P-c)\frac{\partial}{\partial P}Q(P,x)+\lambda Q(P,x)]g(x)dx,$$

$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)=(1+\lambda)((P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon)g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}g(x)dx.$$

Так как $\Pi(P,\varepsilon,\theta)=(P-c)Q(P,\theta)+\varepsilon$, то обозначив $(1-G(\theta_0(P,\varepsilon)))=\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}g(x)dx$, $\overline{Q}(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}Q(P,x)g(x)dx$ и $\overline{Q}_p(P,\varepsilon)=\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}\frac{\partial}{\partial P}Q(P,x)g(x)dx$ имеем, что

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)=(1+\lambda)(\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)-\lambda\overline{Q}(P,\varepsilon),$$

$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)=(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda(1-G(\theta_0(P,\varepsilon))).$$

По теореме 4.2.1 (принцип Лагранжа) и лемме 4.2.1[8, с.130, с.131] имеем, что для решения (P,ε) задачи (4.1) выполняется система:

$$\frac{\partial}{\partial P}L(P,\varepsilon,\lambda)\begin{cases}=0: P\in(a_1,b_1),\\ \ge 0: \quad P=a_1,\\ \le 0: \quad P=b_1\end{cases} \quad (4.2)$$

$$\frac{\partial}{\partial\varepsilon}L(P,\varepsilon,\lambda)\begin{cases}=0: \varepsilon\in(a_2,b_2),\\ \ge 0: \quad \varepsilon=a_2,\\ \le 0: \quad \varepsilon=b_2\end{cases} \quad (4.3)$$

и выполняется равенство

$$\lambda(F-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}\Pi(P,\varepsilon,x)g(x)dx)=0.$$

Теперь, вообще говоря, необходимо составить девить систем путем попарного комбинирования соотношений из (4.2), (4.3). Затем требуется найти решения каждой такой системы и каким-то образом исследовать их на оптимальность.

Пусть $P\in(a_1,b_1)$ и $\varepsilon\in(a_2,b_2)$. Из соотношения (4.2), (4.3) следует, что если $P\in(a_1,b_1)$ и $\varepsilon\in(a_2,b_2)$ решение задачи (4.1), то (P,ε) является решением системы

$$(1+\lambda)(\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial P}\theta_0(P,\varepsilon)-(1+\lambda)(P-c)\overline{Q}_p(P,\varepsilon)-\lambda\overline{Q}(P,\varepsilon)=0 \quad (4.4)$$

$$(1+\lambda)\Pi(P,\varepsilon,\theta_0(P,\varepsilon))g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)-\lambda(1-G(\theta_0(P,\varepsilon)))=0 \quad (4.5)$$

и выполняется равенство

$$\lambda(F-\int_{\theta_0(P,\varepsilon)}^{\theta_{\max}}((P-c)Q(P,x)+\varepsilon)g(x)dx)=0.$$

Если $\overline{Q}_p(P,\varepsilon)\ne 0$ и $g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)\ne 0$, то аналогично п.2 имеем, что если $P\in(a_1,b_1)$ и $\varepsilon\in(a_2,b_2)$ и $\lambda>0$, то из системы

$$(P-c)=\frac{\lambda}{1+\lambda}\frac{(1-G(\theta_0(P,\varepsilon))).Q(P,\theta_0(P,\varepsilon))-\overline{Q}(P,\varepsilon)}{\overline{Q}_p(P,\varepsilon)},$$

$$(P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon=\frac{\lambda}{(1+\lambda)}\frac{(1-G(\theta_0(P,\varepsilon))).}{g(\theta_0(P,\varepsilon))\frac{\partial}{\partial\varepsilon}\theta_0(P,\varepsilon)}, \qquad (4.6)$$

$$\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx)=F$$

можно найти оптимальный двухставочный тариф (P,ε) и λ.

Если $P\in(a_1,b_1)$ и $\varepsilon\in(a_2,b_2)$ решение задачи (4.1) и $\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\Pi(P,\varepsilon,x)g(x)dx)>F$, то получим, что $\lambda=0$. Тогда

$$(P-c)=0,\quad (P-c)Q(P,\theta_0(P,\varepsilon))+\varepsilon=0.$$

Поэтому $P=c$ и $\varepsilon=0$. Тогда если $a_2>0$, то отсюда следует, что система несовместима.

Ясно, что если $P\in(a_1,b_1)$, $\varepsilon\in(a_2,b_2)$ решение задачи (4.1) и $a_2>0$, то $\lambda>0$ и λ определяется из системы (4.6).

Если $P\in(a_1,b_1)$, $\varepsilon=a_2$ и $\lambda>0$, то из системы

$$(1+\lambda)((P-c)Q(P,\theta_0(P,a_2))+a_2)g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-(1+\lambda)(P-c)\overline{Q}_p(P,a_2)-\lambda\overline{Q}(P,a_2)=0,$$

$$(1+\lambda)((P-c)Q(P,\theta_0(P,a_2))+a_2)g(\theta_0(P,a_2))\frac{\partial}{\partial\varepsilon}\theta_0(P,a_2)-\lambda(1-G(\theta_0(P,a_2)))\geq 0,$$

$$\int_{\theta_0(P,a_2)}^{\theta_{max}}\Pi(P,a_2,x)g(x)dx=F$$

определяется оптимальный тариф P. Если $Q(P,\theta_0(P,a_2))g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-\overline{Q}_p(P,a_2)\neq 0$, то отсюда получим, что

$$P-c=\frac{\lambda\overline{Q}(P,a_2)-(1+\lambda)a_2g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)}{(1+\lambda)[Q(P,\theta_0(P,a_2))g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-\overline{Q}_p(P,a_2)]}.$$

Если $P\in(a_1,b_1)$, $\varepsilon=a_2$ решение задачи (4.1) и $\int_{\theta_0(P,a_2)}^{\theta_{max}}\Pi(P,a_2,x)g(x)dx)>F$, то получим, что $\lambda=0$. Поэтому

$$((P-c)Q(P,\theta_0(P,a_2))+a_2)g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-(P-c)\overline{Q}_p(P,a_2)=0,$$

$$((P-c)Q(P,\theta_0(P,a_2))+a_2)g(\theta_0(P,a_2))\frac{\partial}{\partial\varepsilon}\theta_0(P,a_2))\geq 0$$

и отсюда определяется оптимальный тариф P.

Если $Q(P,\theta_0(P,a_2))g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-\overline{Q}_p(P,a_2)\neq 0$, то отсюда получим, что

$$P-c=-\frac{a_2g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)}{Q(P,\theta_0(P,a_2))g(\theta_0(P,a_2))\frac{\partial}{\partial P}\theta_0(P,a_2)-\overline{Q}_p(P,a_2)}.$$

Если $P\in(a_1,b_1)$, $\varepsilon=b_2$ решение задачи (4.1) и $\lambda>0$, то из системы

$$(1+\lambda)((P-c)Q(P,\theta_0(P,b_2))+b_2)g(\theta_0(P,b_2))\frac{\partial}{\partial P}\theta_0(P,b_2)-(1+\lambda)(P-c)\overline{Q}_p(P,b_2)-\lambda\overline{Q}(P,b_2)=0,$$

$$(1+\lambda)\Pi(P,b_2,\theta_0(P,b_2))g(\theta_0(P,b_2))\frac{\partial}{\partial\varepsilon}\theta_0(P,b_2)-\lambda(1-G(\theta_0(P,b_2)))\leq 0,$$

$$\int_{\theta_0(P,\varepsilon)}^{\theta_{max}}\Pi(P,b_2,x)g(x)dx=F$$

определяются оптимальный тариф P и λ. Если $Q(P,\theta_0(P,b_2))g(\theta_0(P,b_2))\frac{\partial}{\partial P}\theta_0(P,b_2)-\overline{Q}_p(P,b_2)\neq 0$, то отсюда получим, что

$$P-c=\frac{\lambda\overline{Q}(P,b_2)-(1+\lambda)b_2g(\theta_0(P,b_2))\frac{\partial}{\partial P}\theta_0(P,b_2)}{(1+\lambda)[Q(P,\theta_0(P,b_2))g(\theta_0(P,b_2))\frac{\partial}{\partial P}\theta_0(P,b_2)-\overline{Q}_p(P,b_2)]}.$$

Если $P\in(a_1,b_1)$, $\varepsilon=b_2$ решение задачи (4.1) и $\int_{\theta_0(P,b_2)}^{\theta_{max}}\Pi(P,b_2,x)g(x)dx)>F$, то получим, что $\lambda=0$.

Тогда

$$((P-c)Q(P,\theta_0(P,b_2))+b_2)g(\theta_0(P,b_2))\tfrac{\partial}{\partial P}\theta_0(P,b_2)-(P-c)\overline{Q}_p(P,b_2)=0\,,$$

$$\Pi(P,b_2,\theta_0(P,b_2))g(\theta_0(P,b_2))\tfrac{\partial}{\partial \varepsilon}\theta_0(P,b_2)\le 0\,.$$

Если $Q(P,\theta_0(P,b_2))g(\theta_0(P,b_2))\tfrac{\partial}{\partial P}\theta_0(P,b_2)-\overline{Q}_p(P,b_2)\ne 0$, то отсюда получим, что

$$P-c=-\frac{b_2 g(\theta_0(P,b_2))\tfrac{\partial}{\partial P}\theta_0(P,b_2)}{Q(P,\theta_0(P,b_2))g(\theta_0(P,b_2))\tfrac{\partial}{\partial P}\theta_0(P,b_2)-\overline{Q}_p(P,b_2)}\,.$$

Аналогично можно рассмотреть случаи $P=a_1$ и $\varepsilon\in(a_2,b_2)$; $P=b_1$ и $\varepsilon\in(a_2,b_2)$; $P=a_1$ и $\varepsilon=a_2$; $P=a_1$ и $\varepsilon=b_2$; $P=b_1$ и $\varepsilon=a_2$; $P=b_1$ и $\varepsilon=b_2$.

Список литературы

1. Богачкова Л.Ю. Совершенствование управления отраслями Российской энергетики: теоретические предпосылки**,** практика**,** моделирование. - Волгоградское научное издательство, 2007.- 421 с.
2. Зайцева Ю. В. Оптимизационные модели ценообразования в естественной монополии. // Автореферат диссертации на соискание ученой степени кандидата экономических наук. Москва, 2003.- 26с.
3. Зайцева Ю.В. Математические модели ценообразования в естественной монополии. - Волгоград: Изд-во ВолГУ, 2006. - 117 с.
4. Чернавский С.Я. Реформы регулируемых отраслей российской энергетики. - М. : Нестор-История, 2013. - 328 с.
5. Тироль Ж. Рынки и рыночная власть: Теория организации промышленности. - Экономическая школа, 1996.- 745 с.
6. Brown, S., Sibley D. The theory of public utility pricing. // Cambridge University Press, USA, 1986. P. 39-44.
7. Садыгов И.М. Об оптимизации тарифов на электроэнергию. // Annali d′ Italia, 2023, №46, C.11-23.
8. Сухарев А.Г., Тимохов А.Ф., Федоров В.В. Курс методов оптимизации. - М.: Наука, 1986.- 326 с.

JURIDICAL SCIENCES

ATMOSPHERIC AIR LEGAL PROTECTION IN THE PRE-WAR ECONOMY OF UKRAINE

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Abstract

Article proposed are presented study's results of the problem of atmospheric air legal protection from negative anthropogenic and economic impact in pre-war Ukraine. The problems at the level of energy, coal and mining industries, as well as metallurgy were researched. Viewpoint on the protection of atmospheric air in the context of the fiscal policy of the state is presented. Attention was paid to international cooperation on the essence of the problem.

The author's recommendations for reforming the regulatory framework in the area under study are given.

Keywords: atmospheric air, legal protection, economic impact, international cooperation, pre-war Ukraine.

The main text.

Introduction. The current status of the atmospheric air protection problem in the conditions of military entrepreneurship undoubtedly leads us to the need of comparative analysis with a similar problem of the pre-war period. In respect to these circumstances, the term of "protection" should be considered as a comprehensive, interdisciplinary measure; therein legal regulation measures have a primary importance. The relevance of the study in this case is evidently, since the problem of coexistence of a healthy environment and economic progress is a key not only for law, but also for the political economy.

At different times, separate issues of atmospheric air pollution were devoted to the study of E. Guida, O. Obushchak, S. Obushchak, K. Mudrik, V. Petrov, O. Sarkisov, V. Rybachek, A. Chugay, E. Gusev, D. Kukuy, O. Ilyin, S. Bogolyubov, I. Kolosov and many others.

With all respect to the scientific heritage of presented and other authors [13, p.107], the problems of pre-war industrial-related air pollution, in the context of a full-scale invasion of the russian federation in Ukraine, are given insufficient research attention.

The purpose of these papers is to evaluate the level of atmospheric air legal protection in the context of pre-war economic activities in the fields of energy, metallurgical and mining industry, on the one hand, and fiscal policy, on the other hand, and a review of foreign doctrine in aforesaid field, both: from the viewpoint of peaceful reforms and partially - wartime assistance.

Materials and Methods. Presented survey has done with assistance of formal and compares methods as special and ontology, deduction, analysis ad synthesis as common, which led to obtain a new data and background for discussion and further investigations from contemporary scientific viewpoint. Thereof, research methodology is based on general scientific methods such as analysis, synthesis, induction, deduction, analogy and empirical methods - observation, comparison and statistical ones.

Methodological basis of the survey, undoubtedly, is a dialectical method, the introduction of which provides an opportunity to study the object and subject of research in their gnoseological unity, as well as the nature of medical law development and their impact, as cause and effect.

Results and Discussion. Pehchevski, considering atmospheric pollution as one of the strategic problems of the country's development, pays attention to the fact that in the pre-war period in Ukraine air emissions mainly consisted of nitrogen oxides, carbon dioxide, sulfur dioxide and dust, but there were also high concentrations of polycyclic aromatic hydrocarbons and heavy metals in industrially developed cities [2].

At the same time, author emphasizes that stationary sources of air pollution make up more than 60% emissions. Approximately 90% of them fall on the mining (~ 30%) and processing (~ 20%) industries, as well as power generation (~ 40%). Non-stationary sources are mainly associated with road transport, which accounts for about 35% of atmospheric pollution [14].

The scientist refers to the fact that the key regulatory act designed to protect the quality of atmospheric air in Ukraine is the Law on the Protection of Ambient Air, structure is prescribed quality standards, MPC of emissions from stationary sources, measures to protect atmospheric air, public and private obligations with respect to air quality, air quality monitoring and responsiveness measures. The law correlates with EU Air Quality Directive, but most of the details such as MPC, monitoring provisions and short/long term air quality improvement action plans are subject to regulatory bylaws [11].

In 2018, thermal power plants released 474,598 tons of SO_2, 92,140 tons of nitrogen oxides and 148,047 tons of dust into the atmosphere. The largest air pollutant with sulfur dioxide was the Uglegorskaya TPP (85,561 tons), then the Zaporizhzhya TPP (74,519 tons). Zaporizhzhya TPP also recorded the highest emissions of nitrogen oxides: 23,222 tons, Luhansk TPP - 9,670 tons. Dust emissions from the Pridneprovskaya TPP turned out to be the highest today: 43,712 tons [1].

In 2019, the highest source of SO_2 emissions was the Burshtynskaya TPP (123,519 tons). Zaporizhzhya TPP remained the highest emitter of nitrogen oxides - 21,830 tons, and Kurakhovskaya TPP - 30,244 tons [16].

In respect to these circumstances, Pehchevski, as recommendations for pre-war Ukraine, provides implication to reduce the operating time of factories during peak hours of electricity consumption in order to reduce the level of emissions of thermal power plants; cancellation of government plans for the construction of new thermal power plants; the development of a long-term national concept of carbon-free energy, and so on and so forth [2].

Havrankova et al. constituted that system of environmental supervision in pre-war Ukraine has been repeatedly criticized for a number of reasons: corruption, inefficiency, unmotivation of employees, insufficient funding, outdated material and technical base, lack of uniform electronic logs of natural resources [3, p. 30]. Author emphasizes three key problems of aforesaid system: insufficiency of institutional organization of the environmental control; due to permanent reorganization with subsequent staff reductions, the regional structure of the Specialized Environmental Inspectorate (SEI) was significantly weakened. Communication between SEI, public authorities and local governments is weak and ineffective, there is practically no cooperation between them; SEI does not have any authority to monitor the environment [4;5;7].

As ways to resolve the presented problems, the scientist proposed to develop an electronic system of environmental reporting and monitoring; entitle the power of the SEI in accordance with the EU 2001/331/EC Recommendations; provide a new control entity with the authority to assess the effectiveness of environmental protection measures funded from state and local budgets [10;12;15].

Kolosov I.V. studying the problem of atmospheric air pollution with metallurgical waste, pays attention to the fact that the waste of Nikopol Ferroalloys Plant, JSC. solely is enough to cover every square kilometer of the Ukrainian with a layer of dust weighing approximately 280 tons. In order to prevent such devastating pollution of the environment, author proposes to regulate the requirements for closed storages of metallurgical waste by the type of spent nuclear fuel storages at the regulatory Acts' level [8, p. 227-229].

Kurylo et al. considering the problem of fiscal measures as tools to prevent atmospheric pollution argued that the economic welfare of the state is inevitably reflected on natural resources, increases the influence of the anthropogenic factor on the world around us. Processes of globalization and social transformation have increased priority protecting the environment, striving to achieve a fair balance and ensure sustainable development of the country. For a long time, the economic development of Ukraine was accompanied by unbalanced the use of natural resources, a low level of priority for environmental protection over economic values, which led to a significant environmental problems. Insufficient financing of environmental protection measures led to an increase in the technogenic burden on the environment. Understanding the significance of the rational consumption and production in the country requires the development and implementation of rational environmental policies and measures to ensure proper environmental governance with adequate funding to do so.

The scientist insists that the tools and mechanisms of the legal, economic, regulatory system, etc. in Ukraine in most cases only partially comply with established approaches and developed standards for environmental activities of EU countries. Domestic legislation on the protection of atmospheric air should be agreed in accordance with EU standards to be implemented in three directions: legislative, regulatory, technological, etc. Taking into account the existing data and issues affecting air quality, Ukraine should timely outline a strategy for the future to ensure clean air for future generations, implement measures to reduce air pollution, which can significantly improve the overall air quality with positive results [9, p. 315,316,323].

Indiana University McKinney School of Law's Professor Catherine Beck was getting ready to teach her Ukrainian law students at Chernivtsi University about US law when she read the headline "Heavy missile strikes by Russian forces on Ukrainian infrastructure." Meaning, once again, Catherine had to check her email before class to see if any of her students would be able to get on Zoom during the next hour. Beck, a Professor of Legal English at Indiana University McKinney School of Law, volunteered her during the Fall 2022 semester to teach an online legal English course to graduate law students in Ukraine. This course was part of a larger collaborative initiative between Ukrainian law schools and the international law school community, an initiative which grew out of relationships formed over the past decade thanks to seeds planted by groups such as the Legal Writing Institute's Global Legal Writing Skills Committee and the Global Legal Skills Conference community. The purpose was to foster cultural exchange, and the result was the Global Legal Skills Virtual Workshop Series, made possible with support from the US Agency for International Development (USAID)’s Justice for All Activity. The workshop’s three short webinars, held over the summer of 2022, brought together law faculty from Ukraine, the United States, and the European Union in an exchange of ideas on how to best support Ukrainian law schools, faculty, and students following Russia’s full-scale invasion of Ukraine. The primary needs identified during these sessions included Legal English courses, guest lectures on a range of topics, and support for Ukrainian legal academics to edit and publish their work in English-language law journals. One effective collaboration was between Zaporizhzhia National University and Professor Robin Juni of GW Law, who gave a guest lecture on environmental law. Faculty and students of the Yuriy Fedkovych Chernivtsi National University and Vasyl’ Stus Donetsk National University also joined this lecture. “Prof. Juni’s lectures inspire [one] to study more deeply progressive practices of environmental law implementation, in particular in the area of atmospheric air protection from pollution,” said Associate Professor Oleksii Makarenkov. Professor Tetyana Kolomoets, Dean of the Zaporizhzhia National University Law Faculty, also expressed gratitude to Juni for teaching a course useful to both teachers and students and noted that Juni's lectures helped re-establish a lecture series with US specialists that had run for many years until Russia's full-scale invasion on February 24, 2022 [6].

Conclusions. The study conducted encourages us to show the following conclusions:

1. The main pollutants of atmospheric air in pre-war Ukraine were enterprises of energy, coal and mining industries, metallurgy. At the same time, the most common pollutants were oxides of sulfur, nitrogen, carbon.
2. To reduce emissions into the atmosphere, we propose to comprehensively diversify and normatively consolidate the predominant use of renewable sources of electricity: solar, wind, etc., as well as establish legislative, including fiscal incentives for the introduction of such sources of electricity instead of traditional ones.
3. Issues of environmental supervision and control require their proper funding, a deployed regional network, the presence of administrative powers to control both the use of funds from environmental funds of state and local budgets, and bringing it in line with the regulatory requirements of the EU and the Council of Europe.
4. Metallurgical enterprises, as one of the largest pollutants of atmospheric air, must be fully equipped with closed storage facilities for production waste. For failure to comply with this requirement, penalties should be introduced, not bind with the tax-free minimum income of citizens or the minimum wage, but focused on the declared income of the enterprise in the calendar period preceding the violation. In our viewpoint, such sanctions should be from 10 to 50% of the total gross income of the enterprise, depending on the scale of potential pollution. Otherwise, a negligible amount of fines will lead to the profitability of their payment in comparison with the fulfillment of the requirements of environmental protection legislation.
5. At the international level, cooperation with USAID-like programs should be encouraged to improve the level of communication on atmospheric air protection and international standards in aforesaid area.
6. At the legislative level, preferences for environmental-oriented investment over exclusively mercantile should be consolidated in order to achieve a fair balance between rational environmental use and effective economic development of Ukraine.

However, the assessment of the harm caused to atmospheric air by the military actions of the russian federation and the methods of jurisdictional compensation for losses caused should be devoted to subsequent scientific research and author's investigations.

References

1. Basic Data. URL: https://cdr.eionet.europa.eu/Converters/run_conversion?file=ua/eu/lcp_ied/envxppjxw/lcp-ied_art72_1.xls&conv=tohtml&source=local (Date of Address is August, 27,2023).
2. Davor Pehchevski. The impacts of Ukraine's energy sector on air quality. URL: https://bankwatch.org/wp-content/uploads/2020/10/2020-10-19_Ukraine-air-quality-mapping_final2.pdf (Date of Address is August, 27,2023).
3. Dirty Skies Above: Regulation of Air Pollution in Ukraine and the EU. Comparative Study of Law, Policy, and Practice. Kyiv-Prague. 2019.
4. EU framework on environmental inspections, available at [https://ec.europa.eu/environment/legal/law/inspections.htm] (Date of Address is August, 27,2023).
5. Yehor Firsov, Екоінспекція. Старт, Українська правда - Блоги, 24 November 2019, available at [https://blogs.pravda.com.ua/authors/firsov/5dda737a55372/]. (Date of Address is August, 27,2023).
6. Global Law School Community Unites to Support Ukrainian Law Schools and Students. URL: https://www.law.gwu.edu/global-law-school-community-unites-support-ukrainian-law-schools-and-students (Date of Address is August, 27,2023).
7. How we monitor compliance, U.S. Environmental Protection Agency, available at [https://www.epa.gov/compliance/ how-we-monitor-compliance] (Date of Address is August, 27,2023).
8. Колосов І.В. ПРОБЛЕМА ЗАБРУДНЕННЯ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ВІДХОДАМИ МЕТАЛУРГІЙНОГО ВИРОБНИЦТВА В УМОВАХ АКТИВНИХ БОЙОВИХ ДІЙ. Актуальні проблеми земельного, аграрного та екологічного права в умовах сучасних викликів і загроз : матеріали круглого столу, присвяч. 100-річчю з дня народження д-ра юрид. наук, проф. Вовка Ю. О. (Хар- ків, 12 трав. 2023 р.) / за заг. ред. А. П. Гетьмана. – Харків : Право, 2023. – 470 с.
9. Kurylo V., Duliba Y., Kurylo I., Mushenok V. Fiscal Policy Measures of Air Protection: Ukrainian Realities and the EU Experience. European Journal of Sustainable Development (2020), 9, 2, 315-324. doi: https://doi.org/10.14207/ejsd.2020.v9n2p315
10. Overview of the Concept of Reforming the System of State Supervision (Control) in the Field of Environmental Protection, available at [https://menr.gov.ua/content/koncepciya-reformuvannya-sistemi-derzhavnogo-naglyadu-kontrolyu-u-sferi-ohoroni-navkolishnogo-seredovishcha-v-ukraini.html].
11. Про охорону атмосферного повітря: Закон України. Відомості Верховної Ради України (ВВР), 1992, № 50, ст.678 (зі зм. та допов.). URL: https://zakon.rada.gov.ua/laws/show/en/2707-12#Text (Date of Address is August, 27,2023).
12. Recommendation of the European Parliament and of the Council of 4 April 2001 providing for minimum criteria for environmental inspections in the Member States, available at [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001H0331&from=EN] (Date of Address is August, 27,2023).
13. Рубцова І. ПОНЯТТЯ Й ОСОБЛИВОСТІ ДЕТЕРМІНАНТИ «ОХОРОНА АТМОСФЕРНОГО ПОВІТРЯ». Підприємництво, господарство і право. 6/2021. С. 107-110. doi: https://doi.org/10.32849/2663-5313/2021.6.17

14. Statistical Yearbook. Environment of Ukraine 2018 / State Statistics Service of Ukraine. URL: https://ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/11/Zb_dovk_2018.pdf (Date of Address is August, 27,2023).

15. The Concept of Reforming the System of State Supervision (Control) in the Field of Environmental Protection, available at [https://zakon.rada.gov.ua/laws/main/616-2017-%D1%80] (Date of Address is August, 27,2023).

16. Ukrainian coal LCPs. URL: https://docs.google.com/spreadsheets/d/1auCrtXy4ELO6GB1gCqhkOY3SMUPCOAxMYLJKeZxDoyY/edit#gid=1427178828 (Date of Address is August, 27,2023).

MEDICAL SCIENCES

PRESEPSIN AS A MARKER FOR RISK STRATIFICATION FOR ACUTE CHOLANGITIS IN SURGERY DEPARTMENT

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Abstract

Acute cholangitis is caused by bacterial infection and has high morbidity and mortality risk. The grade of cholangitis can guide clinical treatment from single antibiotic treatment to biliary drainage. With the introduction of C-reactive protein (CRP), and total bilirubin (T-Bil), procalcytonin into the diagnostic criteria and severity grading for acute cholangitis, the diagnosis rate and grading have significantly improved.

Aim. To evaluate the value of presepsin in patients with acute cholangitis.

Methods. Overall, this study enrolled all patients (age > 18 years) diagnosed with acute cholangitis from January 2018 till December 2022. All patients included in this study met the diagnostic criteria for acute cholangitis according to TG18.

Results. In total, 249 patients were examined, which included 70, 80, and 99 patients classified as having mild, moderate, and severe cholangitis, respectively. WBC count, CRP, PCT, presepsin, T-Bil, direct bilirubin, and sequential organ failure assessment scores of moderate and severe cholangitis patients were higher than those of mild cholangitis patients (P = <0.001). The optimal cutoff value of presepsin for grading moderate acute cholangitis was 1490 pg/mL (sensitivity, 0.84; specificity, 0.56) The optimal cutoff value of presepsin for grading severe acute cholangitis was 2635 pg/mL (sensitivity, 0.64; specificity, 0.78).

Conclusion. Presepsin can help predict the positive blood culture, and is also superior to CRP and PCT in the risk stratification of acute cholangitis. Timely determination of presepsin levels can help clinicians identify the severity of patients with acute cholangitis early.

Keywords: Acute cholangitis, procalcitonin, presepsin, diagnostic.

Introduction. Acute cholangitis is a systemic infectious disease characterized by biliary obstruction and bile bacterial growth that cause acute inflammation and infection of the bile duct. Acute cholangitis was first described by Charcot as 'hepatic fever' in 1877; therefore, the typical signs and symptoms of acute cholangitis (intermittent fever with chills, right-upper-quadrant pain and jaundice) are known as Charcot's triad [1.2].

The prevalence of cholelithiasis varies from race to race. Of the many patients hospitalized for gallstones, 6% to 9% are diagnosed with acute cholangitis [3]. Men and women are affected equally and the average age of patients with acute cholangitis is between 50 and 60 years old. If acute cholangitis is not properly treated, it rapidly develops into systemic inflammatory response syndrome, sepsis and mortality. In the 1990s, the mortality rate for severe acute cholangitis was between 11% and 27% [4].

Presepsin (sCD14-subtype [sCD14-ST]) was discovered in 2002 by Endo et al. [4] When monocytes and granulocytes phagocytose bacteria, CD14 is taken up into the cell together with the bacteria. CD14 that is digested and cleaved by intracellular digestive enzymes is otherwise named presepsin [5,6]. Increased presepsin is considered specific for bacterial infections and useful for early diagnosis of bacterial infections [7]. Presepsin can be used as a biomarker in the emergency room and intensive care unit (ICU) settings since only 17 min are required for its measurement [8].

Therefore, this prospective study aimed to compare levels of presepsin against traditional biomarkers in patients with acute cholangitis on admission to evaluate the role of presepsin in the early risk stratification of acute cholangitis.

Material and methods: Overall, this study enrolled all patients (age > 18 years) diagnosed with acute cholangitis from January 2018 till December 2022.

All patients included in this study met the diagnostic criteria for acute cholangitis according to TG18. The diagnostic criteria were as follows: (1) Systemic inflammation (fever/chills, abnormal WBC count, or elevated CRP level); (2) cholestasis (T-Bil levels ≥ 34.2 μmol/mL or liver enzyme levels > 1.5 times that of the normal upper limit); and (3) supporting imaging findings (evidence of biliary dilatation, such as benign or malignant stenosis, stone, and/or stent). The severity was stratified as mild, moderate, and severe according to TG18[12].

A chemiluminescent enzyme immunoassay was used to test presepsin concentration by a PATHFAST analyzer (Mitsubishi Chemical Medience Corporation, Tokyo, Japan). The detection range was 20 pg/mL to 200000 pg/mL. Information regarding conventional inflammatory biomarkers procalcitonin, C-reactive protein and other indicators were obtained from the clinical laboratory data.

Results: The surveyed patients with acute cholangitis who took part in this study were 249. All patients with acute cholangitis at admission were divided into mild, moderate and severe groups based on the TG18 score. The number of patients in the above three groups was 70 (28.1%), 80 (32.1%) and 99 (39.8%), respectively.

The features and outcomes of 249 patients with acute cholangitis are shown in Table1. There were 156 men and 93 women, and the median age was 71 years. Age, WBC counts, CRP, PCT, presepsin, T-Bilirubin and direct bilirubin, of moderate and severe cholangitis patients were higher than those of mild cholangitis patients.

Table 1

Diagnostic criteria and severity of acute cholangitis

	Severity of acute cholangitis			
Features	Mild (n=70)	Moderate (n=80)	Severe (n=99)	p-value
Age	67	83	75	0.000
Male/Female	55/15	57/23	44/55	0.780
Temperature (ºC)	38.1 (37.7-38.4)	38.7 (38.1-39.2)	38.9 (38.4-39.4)	0.017
Laboratory tests				
WBCs ($\times 10^9$/L)	8.90 (6.35-10.95)	14.25 (9.98-17.05)	10.95 (7.75-16.35)	<0.001
CRP (mg/L)	52.29 (25.87-115.50)	88.95 (57.90-150.58)	120.65 (66.75-180.58)	<0.001
PCT (ng/mL)	4.28 (1.03-11.28)	10.34 (1.64-31.75)	25.55 (5.75-48.56)	<0.001
Presepsin (pg/mL)	1429.00 (825.00-1875.00)	2225.00 (1689.00-2704.00)	3215.00 (2185.00-3915.00)	<0.001
T-Bil (μmol/L)	62.58 (45.30-103.58)	113.4 (85.45-157.45)	99.98 (59.78-150.02)	<0.001
D-Bil (μmol/L)	40.55 (29.55-76.82)	77.50 (59.45-99.54)	69.77 (42.37-97.34)	<0.001

After comparing the three groups, WBC counts, CRP, PCT, presepsin and T-Bilirubin of patients with moderate and severe cholangitis were found to be higher than those of patients with mild cholangitis (P = <0.001; Table1). Multiple comparison analysis was used to check the differences between particular pairs of groups. Presepsin had the lowest P-value in patients with mild-to-moderate and moderate-to-severe acute cholangitis (P = <0.001) The optimal cutoff value of presepsin for grading moderate acute cholangitis was 1490 pg/mL (sensitivity, 0.84; specificity, 0.56) The optimal cutoff value of presepsin for grading severe acute cholangitis was 2635 pg/mL (sensitivity, 0.64; specificity, 0.78).

Compared with the mild group, presepsin, procalcitonin, and CRP levels were significantly higher in patients with moderate and severe acute cholangitis (P <0.001). Dependence of number of microorganisms and grades of acute cholangitis Table 2.

Table 2

Dependence of number of microorganisms and grades of acute cholangitis

	Severity of acute cholangitis			
Features	Mild (n=70)	Moderate (n=80)	Severe (n=99)	p-value
Blood culture	65 (	72	89	0.315
Positive blood culture	19	29	38	0.147
G^- bacteria	15	22	32	0.328
G^+ bacteria	0	2	5	
Other bacteria	2	3	3	0.548

WBC counts, PCT, and presepsin levels in the positive blood culture group were greater than those in the negative blood culture group ($P < 0.01$); however, CRP and T-Bil levels did not show significant differences between the groups ($P > 0.05$).

Discussion: For a long time, acute cholangitis has been diagnosed based on Charcot's triad; however, its misdiagnosis rate can be as high as 30%–80%[]. With the introduction of WBC count, CRP, and T-Bilirubin the diagnosis rate and grading have improved notably[9.10]. However, early risk stratification assessments are difficult according to WBC count, CRP, T-Bilirubin, vital signs in the surgery department. PCT has been recommended as a biomarker for predicting severe acute cholangitis; however, PCT levels are often higher in patients with burns [11], and are falsely negative in patients with atypical bacterial infections [12]. Early grading of acute cholangitis is still an important clinical challenge in the surgery department. Presepsin is a promising biomarker of bacterial infectious disease discovered in recent years, and its sensitivity and accuracy are better than those of PCT, WBC count, and CRP[13.14]. Based on the aforementioned findings, we demonstrated that presepsin had a higher sensitivity and specificity in risk stratification of acute cholangitis and had a better positive rate in predicting bacterial blood culture.

Blood cultures are the gold standard for diagnosing bloodstream infections, especially when a serious infection is suspected; however, blood cultures are often negative, and the results usually arrive after several days[15.16]. In this study, presepsin was as effective as PCT in predicting positive bacterial cultures. Presepsin levels can be determined much sooner than blood culture, facilitating early risk stratification and treatment to some extent.

Conclusion: Presepsin can help predict the positive blood culture, and is also superior to CRP and PCT in the risk stratification of acute cholangitis. Timely determination of presepsin levels can help clinicians identify the severity of patients with acute cholangitis early.

References

1. Merritt JL 2nd, Norris M, Kanungo S. Fatty acid oxidation disorders. Ann Transl Med. 2018;6:473. [PubMed] [DOI]

2. Singer M. The role of mitochondrial dysfunction in sepsis-induced multi-organ failure. Virulence. 2014;5:66-72. [PubMed] [DOI] [Cited in This Article:

3. Eckerle M, Ambroggio L, Puskarich MA, Winston B, Jones AE, Standiford TJ, Stringer KA. Metabolomics as a Driver in Advancing Precision Medicine in Sepsis. Pharmacotherapy. 2017;37:1023-1032. [PubMed] [DOI]

4. Ferrario M, Cambiaghi A, Brunelli L, Giordano S, Caironi P, Guatteri L, Raimondi F, Gattinoni L, Latini R, Masson S, Ristagno G, Pastorelli R. Mortality prediction in patients with severe septic shock: a pilot study using a target metabolomics approach. Sci Rep. 2016;6:20391. [PubMed] [DOI]

5. Rogers AJ, McGeachie M, Baron RM, Gazourian L, Haspel JA, Nakahira K, Fredenburgh LE, Hunninghake GM, Raby BA, Matthay MA, Otero RM, Fowler VG, Rivers EP, Woods CW, Kingsmore S, Langley RJ, Choi AM. Metabolomic derangements are associated with mortality in critically ill adult patients. PLoS One. 2014;9:e87538. [PubMed] [DOI]

6. Gravito-Soares E, Gravito-Soares M, Gomes D, Almeida N, Tomé L. Clinical applicability of Tokyo guidelines 2018/2013 in diagnosis and severity evaluation of acute cholangitis and determination of a new severity model. Scand J Gastroenterol. 2018;53:329–334. [Abstract] [Google Scholar]

7. Benoist JF, Mimoz O, Assicot M. [Procalcitonin in severe trauma] Ann Biol Clin (Paris) 1998;56:571–574. [Abstract] [Google Scholar]

8. Hatherill M, Jones G, Lim E, Tibby SM, Murdoch IA. Procalcitonin aids diagnosis of adrenocortical failure. Lancet. 1997;350:1749–1750.

9. Baumgartner A, Schuetz P. [Laboratory results in clinical practice: importance of interpretation in the clinical context] Ther Umsch. 2015;72:119–123. [Google Scholar]

10. Zhao J, Tan Y, Wang L, Shi Y. Discriminatory ability and prognostic evaluation of presepsin for sepsis-related acute respiratory distress syndrome. Sci Rep. 2020;10:9114. [Europe PMC free article] [Google Scholar]

11. Venugopalan DP, Pillai G, Krishnan S. Diagnostic Value and Prognostic Use of Presepsin Versus Procalcitonin in Sepsis. Cureus. 2019;11:e5151. [Europe PMC free article] [Google Scholar]

12. Unuma K, Makino Y, Sasaki Y, Iwase H, Uemura K. Presepsin: A potential superior diagnostic biomarker for the postmortem differentiation of sepsis based on the Sepsis-3 criteria. Forensic Sci Int. 2019;299:17–20. [Google Scholar]

13. Aliu-Bejta A, Atelj A, Kurshumliu M, Dreshaj S, Baršić B. Presepsin values as markers of severity of sepsis. Int J Infect Dis. 2020;95:1–7. [Google Scholar]

14. Yao S, Kaido T, Uozumi R, Hirata M, Iwamura S, Miyachi Y, Macshut M, Sharshar M, Yagi S, Uemoto S. Diagnostic potential of presepsin in bacterial infection following hepato-biliary-pancreatic surgery: A prospective observational study. J Hepatobiliary Pancreat Sci. 2020;27:756–766. [Google Scholar]

15. Scott-Conner CE, Grogan JB. The pathophysiology of biliary obstruction and its effect on phagocytic and immune function. J Surg Res. 1994;57:316–336. [Google Scholar]

16. Chenevier-Gobeaux C, Borderie D, Weiss N, Mallet-Coste T, Claessens YE. Presepsin (sCD14-ST), an innate immune response marker in sepsis. Clin Chim Acta. 2015;450:97–103. [Google Scholar]

PHILOSOPHICAL SCIENCES

ON THE PHILOSOPHICAL ANALYSIS OF "WORLDVIEW" PHENOMENON: METHODOLOGICAL ACCENTS

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Abstract

The article characterizes worldview phenomenon (Weltunschauung – German) from ontological and methodological points of view. Understanding essential nature of worldview as the integrity of "spiritual" (mental-cognitive) and "practical" of existence, the author explains specific character of its manifestation in the realities "human being", "the present" and "education". Turning to the origins of the formation of "worldview" concept and its evolution in the history of philosophical thought, the author analyses transformations and "changes" of the meanings of the worldview concept and the limited nature of the methodological "myth of worldview absence"; the author justifies the advantages of the phenomenological approach to the worldview concept. From the point of view of phenomenological method, the author fixes a new approach to substantiation of nature, origin mechanisms and interaction of variety of "worldview forms" and "functionals" in the ontologically determined worldview integrity; notes the historical contribution of Western European philosophical thought to clarifying the essence of the concept of "worldview". And focuses their attention on the methodological potential of the Russian culture, the Russian language and Russian philosophy in the study of existential meanings of the ontological integrity of the phenomenon of "worldview".

Keywords: methodology, worldview, history of philosophy, phenomenological approach, history of philosophy, ontos of man, "Russian idea", "all-human".

A number of factors of modern civilizational self–development, determine actuality of the philosophical study of the worldview phenomenon, first of all it is existing crisis worldview occurrences in the life of a European civilization man. They are fixed by a various forms of the gap between spiritual and practical components of the man's life activity and loss of connection of his worldview with ethical self-consciousness and moral standards. In the modern society worldview "acquires" less and less treasures of spiritual experience of mankind, accumulated and preserved by science and culture, which narrows the worldview to the forms and conditions originating from the everydayness sphere. Even education cannot cope with this problem. It violates the traditional cultural and historical system integrity of "education-upbringing".

Another factor that determines actuality of worldview philosophical and methodological analysis is that in the modern conditions existing historical worldview types do not satisfy it to full extent. In the sphere of everyday life, stable worldview beliefs are difficult to develop and cease to be its reliable reference points. At the same time, technologies of mental manipulation and the possibility of their direct impact on a person's life experience and value world are gaining strength.

Turning to the philosophical reflection of the worldview phenomenon and the disclosure of the methodological potential of its concept, it is necessary first of all to note the fact that the traditional definition of worldview fixed in the public consciousness as a specific form of spiritual and practical development of the world by a person, a system of views that gives a holistic view of the world, about a person's attitude to the world, about his own place in it, is capacious, but insufficient for deep analysis of this phenomenon. Though this generally accepted formula is evident and "transparent" it looses its completeness and power of the methodological regulator. It makes contradictory understanding grounds possible, meanings indefinite that hinders possible correlations of the concept meanings and the worldview discourse itself. It mainly happens due to misuse of the concept "worldview" in its particular or transformed meanings, in ideology and pseudoscience including and as a result, the status of false consciousness can be assigned to it. And, finally, the worldview concept has its origin in the "classical mind" paradigm and is still under its influence which considerably limits its methodological potential. While the concept's actually capacious and rich potential remains unfulfilled, not fit for the widely used meanings and patterns of its understanding.

The analysis of the worldview proposed by the author in ontological and methodological keys concerns a number of problems and directions of philosophical and methodological research. First of all, it is the evolution of the "worldview" concept meanings in the history of philosophical thought. There are significant stages in it: 1) origin and functioning of the concept as the holistic premised knowledge; 2) the stage of deepening and expanding the epistemological analysis of the worldview and the "disintegration" of its meanings into the characteristics of worldview forms, such as: mythological, religious, philosophical consciousness, myth, ideal, symbol, fairy tale, utopia, legend, worldview, etc. and "functionals" of the worldview, such as: worldview, worldview, worldview, worldview, world transformation, world creation, etc.; 3) the stage of "synthesis" and reconstruction of the worldview concept meaning integrity. Origin and transformation of methodological "worldview absence" myths also may be studied as a peculiar form of the "worldview" concept meanings evolution. Such "anti-metaphysical" methodological positions are most clearly stated by the scientist attitudes of positivism, as well as the concepts of postmodernism and modern transhumanism.

In substantiating the philosophical and methodological keys of reflection on the phenomenon of worldview, it is important to focus on its ontology and the analysis of correlations of concepts "related" to the worldview: "man", "education", "culture" and "nature", a stress was put on the necessity of profound study of this phenomenon from three main points of view – the ontology of man, social ontology and the ontology of education. In this regard, the author proceeds from the methodological significance of recognizing a person's worldview as an "ontos" of existence, an integral property of his being in the world.

These lines of worldview analysis are feasible on the basis of the phenomenological method. The phenomenological approach opens up the possibility of studying the intentional nature of the worldview, worldview integralities (manifested by dual bundles: "spiritual – practical", "immanent – transcendent", "finite – infinite", "eternal – transitory", etc.); contextual dependencies, worldview transformations – "transitions", "transfers", "transformations", "substitution", mechanisms of transformation of functioning ideological forms; the study of the architectonics of the worldview, and the identification of its essential structural components – myth and ideal; the study of types and forms of existentials, contexts of the correlation of worldview forms and functionals.

At the same time, it should be noted that the rich potential of the "worldview" concept, quite capacious, but in many ways still "hidden" and not sufficiently realized by current methodology and practice, accumulated in the humanitarian research tradition, reflexively reproduced by the history of philosophical thought. We can talk about the development of the "worldvie" concept in the historical and philosophical tradition" and the possibility of methodological reconstruction the views of thinkers on the worldview in the context of their philosophical concepts. The logic of increasing the meanings of this concept is demonstrated by the diversity and depth of the approaches of I. Kant, F.Schleiermacher, V. Dilthey, E. Huserl, M. Heidegger, K. Jaspers to the reflection of the worldview in the context of their original philosophical systems, as well as the general cultural and historical trend of philosophizing. On the whole historical-philosophical analysis of the concept worldview meanings formation let the author draw a general conclusion about the existing tradition of the worldview phenomenon research, about the formation of the capacious notional potential of this phenomenon, about the wealth of informative motives and how multifaceted its functional purposes are.

Carried out analysis highlighted the perspective line of the reflexive worldview phenomenon analysis that took shape in the history of West-European philosophy and was made on the basis of methodology that overcomes the restrictions of scientism logic and classical rationality in the life philosophy contexts, existential and phenomenological philosophy and "anthropological" turn in philosophy. At the same time there was displayed the general research background of the further analysis of the worldview phenomenon and of possible clarification of the meanings of its notion. The interest to fundamental ontological relation "human being – universe" and to the existential-phenomenological problem of human in a human being has become this very background, in essence it is the interest to the problem of morality ontology and to fundamentally connected with it education ontology problem.

The ontological integrity of the "worldview-education" in human existence finds its existential manifestations. Man is born helpless and completely dependent on his immediate environment. Since his existence is not set exclusively by genetic nature man should educate himself in the environment of other people. He should learn to be in the world, acquire the image of "humaneness", developing in himself potential of active attitude to the world given to him by nature, meanwhile accumulating human potential, human quality of being. Integrity of cognitive, communicative and subject-action forms of activity determines the life of man, ways of his socialization and adaptation. Any integrity is reproduced, kept and transmitted in holistic forms. The most valuable and existentially significant experience is generalized, saved and preserved by culture forms. During the process of its accumulation mechanisms of representation, transformation and transmitting of this experience are modelled in intergenerational continuity. Functioning in the culture context worldview actualizes its most valuable content, modifies existential experience and submerges it in cultural-historical space of the present. Education decodes signs, symbols and culture images and transforming them into worldview forms transfers cultural experience into everydayness context. Through worldview, world understanding and world-attitude man demonstrates measures of actualization and adoption of cultural experience by existence. At that education appears to be the most important and necessary form of manifestation of "entity" of being. It is called upon to keep the essentials of existentia in the worldview and culture perspectives. Worldview brings into education an imperceptible, not grasped mentally a moment of being, that determines the most of man's existentia, which can be called "break through to transcendent" (P. P. Gaidenko). Beyond the worldview paradigm of education "transcenzus" reality is made vapid and taken away from the sphere of education. Having lost it, as the author proves, education looses its spiritual essence.

Nowadays education sphere turned out to be practically deprived of distinctly expressed worldview landmarks, contrary to the logics of being and culture ontology. When answering the question "Why and how could this gap take place and get the status of existential ?" the problem of Man's life path arises, and the research of worldview-education moves into the sphere of existential phenomenology and discourse of "eternal" philosophical themes of being, time, history, contemporaneity and transcendence (I. Kant, K. Jaspers, M. Heidegger). In a new way there arise questions of man’s mind potential, that haven’t been made clear and explained to man by education.

At the same time it is important to emphasize that existentially-phenomenological discourse is becoming more solid and perspective as opposed to universalist metaphysical schemes and intentions of the classical mind logics that take one away from the essence of raising the above mentioned problems. The discourse leads the worldview analysis to clarification of its entity through existential, through clarification of “being- in” reality of many-sided forms of its existence, the sphere of everydayness including. While speculating about the “entity” of being M. Heidegger takes methodological “ontology as phenomenology” point of view and explicates entity in existentia as “care”, “being- in” or “worldliness of the world”. With this approach concern about the education phenomenon as a necessary form of “involvement” into being and self-fulfillment of man who is being in the world appears as one of the key problems of “here-being” and is designated as education paradox in the context of this research. The author calls it worldview paradox of contemporaneity, and the combination “worldview-education”- fundamental ontological relation of man’s being in the world. The existential-phenomenological turn of education study in the worldview contexts lead the worldview analysis to the necessity of understanding of the key existentials of being and eventful modi of human presence in the world.

In conclusion, we note the significant contribution of the Western European philosophical tradition to the development of significant methodological guidelines for the reflexive analysis of the phenomenon of "worldview".

It should be noted, at the same time, and the fact that the most complete and reasoned the humanitarian traditions of Slavic culture, Russian literature, and Russian philosophy are the most fully and argumentatively stated problematic issues and contexts of reflection of the phenomenon of "worldview". Methodological foundations of the integrity of the worldview, which presuppose the harmonization of "spiritual" and "practical" existence in this tradition, are necessarily projected into forms of intercultural communication and dialogue with Russian culture.

The Russian "we are the worldview" (S.L. Frank), the ideas of the "God-human" in man (V. Solovyov, N. Berdyaev), "spirituality", "conciliarity", attributes of freedom and communicative idealism.... symbolically focused by the image of the "all-human", "all-man" in the integrity of the traditional worldview concepts of the "Russian idea". The symbol of the "all-human" of the "Russian idea" is not identified with the Western European lexeme "universal", nor is it identical with the concept of "superman". The symbol of the "all-human" of the Russian idea is not identified with the Western European lexeme "universal", nor is it identical with the concept of "superman". The symbol "all-human" can be understood and disclosed in the context of the integrity of "family-related concepts" (L.Wittgenstein), such as "universal", "universal", "spiritual", "inner man", "all-human spirit", "universal feeling" and turns out to be commensurate with existential reflections on fate and the future of Russia, of the entire human civilization.

Russian thinker S.P. Shevyrev, as research shows, reveals the key importance of this facet of the Russian idea not only by giving the symbol of the "all-man" a deeply religious meaning, but also by the fact that the author of the lexeme "all-man" and the idea of symbolizing the "all-human" is very remarkable and significant from the standpoint of modernity, and it gives it a rich potential for harmonious intercultural, interethnic communication. For the thinker, N. Tsvetkova notes, "... in the life of Russia, the synthesis of the "alien's" and the "own-folk" is important both in science and in art. He believes that "alien's, but humanly beautiful will merge with the Russian spirit," that is, Orthodoxy. Only on a spiritual basis, according to Shevyrev, assimilation of someone else's experience, beautiful and eternal, can occur in Russia, and therefore he characterizes the "Russian spirit" with a number of definitions of "vast", "universal", "Christian", "universal tolerance and universal communication". In this series, - the author concludes, - the synonymous "all-human" is organically present [25 p. 134-135].

Thus, the spiritual tradition of Russian culture and methodological analysis of the phenomenon of worldview, directed to the reflection of the forms of the integrity of being; the "human" in man, the harmonization of the worlds of "spiritual" and "practical" human life activity, undoubtedly, constitutes a significant positive experience of existence, which can be useful in assessing current civilizational strategies and discourses in the choice of landmarks the future self-development of mankind.

References

1. Andryushkov A. A. Formation of Russian identity as a task of education: a worldview that creates the future // Questions of education. 2011. No. 3. pp. 287-301.

2. Arutyunyan M.P. The phenomenon of worldview: historical, philosophical and methodological analysis: monograph. Khabarovsk: KHBNUK Khabarovsk Regional Museum named after N.I. Grodekov, 2016. - 336 p.

3. Arutyunyan M.P. Worldview and education: the formation of a new paradigm // Higher education in Russia. 2004. № 12. 32 - 37.

4. Berdyaev N.A. On the appointment of a person. M.: Republic, 1993. - 383 p.

5. Berdyaev N.A. My philosophical worldview // N.A. Berdyaev on Russian philosophy / comp. B.V. Emelyanov, A.I. Novikov. Part 1. Sverdlovsk: Ural Publishing House. Un-ta, 1991. pp. 19-25.

6. Bim-Bad B.M. Advanced education: Theory and practice // Soviet pedagogy. 1988. No. 2. pp. 51-55.

7. Gurevich P.S. The split of human existence. M. IF RAS, 2009.

8. Zalessky G.E. Psychology of the worldview and beliefs of the individual. -Moscow: Publishing House of Moscow State University. - 144 p.

9. Zenkovsky V.V. Problems of education in the light of Christian anthropology. Moscow: School-Press, 1996. -272 p.

10. Ivanov V. Native and universal. M.: Republic, 1994. - 428 p. - (series "Thinkers of the XX century").

11. Kant I. Criticism of the ability of judgment // Immanuel Kant. Collected works in eight volumes. Vol. 1. "Subcritical works". Moscow: CHORO, 1994. - 414p.

12. Leontiev D.A. Worldview as a myth and worldview as an activity. Tomsk: Tomsk. State University, 2004. - 319 p.

13. Lvov A.A. Competition of worldviews in the field of education //Philosophy of education. History and modernity. Collective monograph / ed. by I. D. Osipov, S. N. Pogodin. St. Petersburg: Publishing House of the Polytechnic University. un-ta, 2019. pp. 46-56.

14. Lviv A.A. Modern concepts of the phenomenon of worldview // Bulletin of the Russian Christian Humanitarian Academy. 2020. Volume 21. Russian Russian Idea: a collection of works by Russian thinkers. M.: Airispress. 2004. Issue 2. pp.11 -23.

15. Russian Idea: a collection of works by Russian thinkers. M.: Airispress. 2004. - 512 p. - (series "Library of History and Culture").

16. Sagatovsky V.N. Philosophy of developing harmony: philosophical foundations of worldview. In 3 h. h. 1. Introduction: philosophy and life. St. Petersburg: Publishing House of the St. Petersburg University, 1997. - 224 p.

17. Frank S.L. Spiritual foundations of the foundations of society. Moscow, 1992.-512 p

18. Frank S.L. Russian worldview. St. Petersburg, 1996. 738 p.

19. Frank S.L. Personality and worldview of Fr. Schleiermacher // Schleiermacher F.D. Speeches about religion to educated people who despise it. Monologues. St. Petersburg: JSC "Aleteya", 1994. pp. 7 - 34.

20. Frank S.L. Russian worldview. St. Petersburg., 1996. 738 p.

21. Heidegger M. Basic concepts of metaphysics // Questions of philosophy. 1989. No. 9. pp. 116 - 163.

22. Scheler M. Philosophical worldview // Selected works. M.: "Gnosis", 1994. p. 3 14.

23. Schleiermacher F.D. Speeches about religion. Monologues. St. Petersburg: "ALETEYA", 1994. 335p.

24. Rybakov N.S. Worldview: facets of meaning // Scientific and educational Center of spiritual and moral education. Educational and methodological recommendations. Pskov, 2023. p. 5 37.

25. Tsvetkova N. "The All-human" and "The All-human": from S.P. Shevyrev to F.M. Dostoevsky // Dostoevsky and world culture. - Philological Journal No. 2, 2018. pp. 127 -150.

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