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# THE MODELING OF MUTUAL TIES BETWEEN ECONOMY AND ENVIRONMENT PROBLEM

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**Abstract:**
There have been several studies about economy and environmental protection in this work. Through the matrix of equations, it is describing the dynamic depending between ecological system exits. Economic problems are considered in terms of the environment, and environmental problems are considered in terms of economic development requirements. There are detailed studies of ecological linkages and noted the effects of environmental pollution. Taking this into consideration, a static model is constructed and tested with provisional data due to incompleteness of the information. There has been data analysis through tables. Final analysis was completed and marked the growth in gross issuance.

**JEL:** Q57, O13, P18, P28

**Keywords:** environment, ecological system, matrix of direct cost factors for the destruction of pollutants, vector exporting useful results, the amount of contamination

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vector, vector natural purification capacity, vector amount of non-productive consumption of resources

## 1. Introduction

A new phenomenon related to the relationship between economy and the environment, first of all is considered to be the enormous changes that have taken place as a result of rapid development of the world economy and the economies of individual countries: in science and technology. Scientific and technological progress to some extent affected the economies of all countries.

Production growth brought a new ecological situation, which is characterized by the fact that the environment has more active reverse effect on the pace and nature of economic development. In this regard, there is a complicated task of how to combine production growth with environmental protection and easier solution of future problems [1-8].

The new ecological situation is:

- First of all, the sustainable growing influence of economic activity on the environment.
- Secondly, the fact becomes more clear and conscious that the environment and its resources are limited.
- Scarcity of environmental resources in economic activity puts certain limits in terms of its permissible load; the excess can lead to undesirable changes in the environmental balance.
- The role of the environment increases in economic life and the interactions between economy and environment become stronger.

The new situation in which the modern economy is developing, it becomes necessary to consider the environmental requirements in economic problems and consider environmental problems in economic development requirements.

It is mentioned about a class of systems, which is the main component of economy and environment. They can be called as economy-environment and economic-ecological systems. These systems can be local, regional and global, depending on whether which part of their interaction becomes the object of scientific analysis.

Human understanding of the environment, as a complex dynamic ecological system, is in need of some adjustment provisions, relating to the effective functioning of the system management and development.

In macroeconomic level, it is primarily associated with the production and distribution of the proportions of methodological grounds.

One of the most effective tools studying nature and public relations is mathematical modeling method.

## 2. Ecological mutual ties in problem modeling

Let's do more study on the graph of ecological interactions 1. Production / $P$ / is the process of creating material values and to use natural resources /$R$/:

The result of the production is the GDP (gross domestic production) /$W$/, which is composed of two proportional flows: useful data output results /$X$/ and side result flows /$V$/, which is due to the peculiarities of modern production technology.

They are either being destroyed or dumped into the environment, polluting it. In the chart, we have /$Q$/ which designs certain cyber filter that separates contaminants usage of production /$V$/ and of end-use sector /$G$/. Filter output is generated by two flows. They are useful resources /$S$/, which are derived from recycling process of waste and contaminants / $Z$/, which flow into the surrounding environment. A certain amount of pollutants discharged into the environment /$\bar{Y}$/ is absorbed, dissolved, or is thrown out of the study of the ecosystem, and the other part of the final product /$\hat{Z}$/ is accumulated, negatively impacted on natural, technical and human resources. The cost of destruction of pollutants is formed in industrial consumption /$e$/ and antipollution activities and costs are related to the expansion of productions assets at the expense of their use /$\bar{f}$/.

Overall, the effects of environmental pollution can be seen as a reverse phenomenon of the consequences that occur in the production growth. The following, particularly are provided in /$f$/ flow, which corresponds to the accumulation process in the chart, meaning the expansion of production at the expense of growth of production assets. In more meaningful terms, they are gross capital investments that support the development of the economic system.

Part of the final outcome / $C$ /, which remains as aggregate investment of capital as well as credit balances after deduction of exports and imports, is not merely the end result of industrial consumption /$\hat{C}$/ the current material production through the final consumption sector. Here, too, residues are formed /$G$/, which should be subject to reprocessing. We will note that the net result is the final outcome of the basic economic system, which is opposed to the side discharge pollutants.

The dependence on ecosystem dynamics between exits matrix can be described by equations [2,3]:

$$X_t = AX_t + \overline{A}Y_t + K\frac{\partial X}{\partial t} + \overline{K}\frac{\partial Y}{\partial t} + F_t - U_t + \hat{C}_t \quad (1)$$

$$\hat{Z}_t = EX_t + G_t - Y_t - \hat{Y}_t \quad (2)$$

$$R_t + \widetilde{A}Y_t = \widetilde{R}X_t + \overline{R}_t \quad (3)$$

Where:

$X_{t(n)}$ - Vector of the aggregate amount,

$Y_{t(m)}$ - Vector destruction of hazardous waste.

$R_{t(e)}$ - Vector volumes of natural resources.

$A = (a_{ij})_{n\times n}$ - Coefficient matrix of useful results of direct production costs.

$\overline{A} = (\overline{a}_{iq})_{n\times m}$ - Coefficient destruction matrix of pollutants of direct costs.

$K = (k_{ij})_{n\times n}$ -Coefficient matrix of Production gains.

$\overline{K} = (\overline{k}_{iq})_{n\times m}$ - Coefficient matrix to increase the destruction of pollutants.

$F_{t(n)}$ - Export vector in useful results.

$U_{t(n)}$ - The vector of importing useful results.

$\hat{C}_{t(n)}$ - The vector of final results (non-productive consumption).

$\hat{Z}_{t(m)}$ - The vector of allowed sectors in pollution.

$E = (e_{qj})_{m\times n}$ - The coefficient matrix to exit harmful productions in environment.

$G_{t(m)}$ -The vector of pollution volume in end-use sectors level.

$\hat{Y}_{t(m)}$ - The vector of natural purification capacity.

$\widetilde{A} = (\widetilde{a}_{eq})_{l\times m}$ - The coefficient matrix of output useful resources.

$\widetilde{R} = (\widetilde{r}_{ej})_{l\times n}$ - The coefficient matrix of consumption of production resources.

$\overline{R}_{t(e)}$ - The vector of the used volume of non-production resources.

System solution will determine the sectorial structure of production, taking into account the level of environmental pollution, which corresponds to the maximum permissible concentrations and volumes of pollutants, as well as the demands and destruction of natural resources. This model differs from existing models because it considers the contamination of final consumption, as well as the use of resources.

Let's implement mathematical model description.

We have the equation of (2):

$$Y_t = EX_t + G_t - \hat{Z}_t - \hat{Y}_t \quad (2')$$

$$\frac{\partial Y}{\partial t} = E \cdot \frac{\partial X}{\partial t} + \frac{\partial G}{\partial t} - \frac{\partial \hat{Z}}{\partial t} - \frac{\partial \hat{Y}}{\partial t} : \quad (2'')$$

Inserting (2′) and (2″) in (1), we will get:

$$X_t = AX_t + \overline{A}EX_t + \overline{A}\left(G_t - \hat{Z}_t - \hat{Y}_t\right) + K\frac{\partial X}{\partial t} + \overline{K}E\frac{\partial X}{\partial t} + \overline{K}\left(\frac{\partial G}{\partial t} - \frac{\partial \hat{Z}}{\partial t} - \frac{\partial \hat{Y}}{\partial t}\right) + F_t - U_t + \hat{C}_t ,$$

$$\frac{\partial X}{\partial t} = \left(K + \overline{K}E\right)^{-1}\left(I - A - \overline{A}E\right)X_t - \left(K + \overline{K}E\right)^{-1}\left[\overline{A}\left(G_t - \hat{Y}_t - \hat{Z}_t\right)\right] +$$
$$+ \overline{K}\left(\frac{\partial G}{\partial t} - \frac{\partial \hat{Z}}{\partial t} - \frac{\partial \hat{Y}}{\partial t}\right) + \left(F_t - U_t + \hat{C}_t\right),$$
$$X_0 = \left\lfloor X_{i(0)} \right\rfloor : \quad (1')$$

Hereof:

$$X_t = e^{\left(K+\overline{K}E\right)^{-1}\left(I-A-\overline{A}E\right)t} \cdot X_0 - \int e^{\left(K+\overline{K}E\right)^{-1}\left(I-A-\overline{A}E\right)\left(t-\widetilde{C}\right)} \cdot \left(K + \overline{K}E\right)^{-1}\left[\overline{A}\left(G_{\widetilde{C}} - \hat{Y}_{\widetilde{C}} - \hat{Z}_{\widetilde{C}}\right)\right] +$$
$$+ \overline{K}\left(\frac{\partial G}{\partial \widetilde{C}} - \frac{\partial \hat{Z}}{\partial \widetilde{C}} - \frac{\partial \hat{Y}}{\partial \widetilde{C}}\right) + \left(F_{\widetilde{C}} - U_{\widetilde{C}} + \hat{C}_{\widetilde{C}}\right)d\widetilde{C} :$$

Inserting $X_t$ value in (2′), we will get $Y_t$, inserting $X_t$ and $Y_t$ in (3), we will get $R_t$. Let's find out in what conditions (1′) has a non-negative solution to the system of differential equations. The solutions will not be negative, if there is a non-negative matrix $\left(K + \overline{K}E\right)^{-1}\left(I - A - \overline{A}E\right)$ or, if there is an inverse matrix. $\left(K + \overline{K}E\right)^{-1}$.

On the whole, $\left(K + \overline{K}E\right)$ matrix is degenerated and its inverse $\left(K + \overline{K}E\right)^{-1}$ matrix doesn't exist. If we assume that $\left(K + \overline{K}E\right)$ is non-degenerated, it means $X$ vector, in which not negative values can be obtained if $\left(K + \overline{K}E\right)^{-1}\left(I - A - \overline{A}E\right)$ matrix has not negative elements. In all cases both $\left(K + \overline{K}E\right)^{-1}$ and $\left(I - A - \overline{A}E\right)$ matrixes include negative elements, which means $\left(K + \overline{K}E\right)^{-1}\left(I - A - \overline{A}E\right)$ matrix will obtain not negative elements only in the case when $\left(K + \overline{K}E\right)^{-1}$ and $\left(I - A - \overline{A}E\right)$ matrix elements act of absolute values.

If we also consider the complexities arising from the settlement of a class of differential equations, then it becomes clear that the model doesn't find dynamic presentation and is used during practice and theoretical analysis. Figure 1 shows the interconnections of the ecological model.

Let's take a conventional model and test data.

$\overline{A}$ matrix coefficients $G, \hat{Z}, \hat{Y}$ for these vector values, there has been used provisional numbers.

Results analysis / Table 3 / shows that the sector's gross industrial productions are increased by 238 million, 124 million in agriculture, transport by 6 million, other sectors by 4 million.

These mentioned increases are due to the fact that the model takes into consideration the impact of the destruction of pollutants.

| Branches | Industry | Agriculture | Transport | Other branches |
|---|---|---|---|---|
| Industry | 0.4 | 0.1 | 0.3 | 0.1 |
| Agriculture | 0.09 | 0.1 | 0 | 0 |
| Transport | 0.03 | 0 | 0 | 0 |
| Other branches | 0.04 | 0.02 | 0 | 0 |

**Table 1:** Direct costs of production and distribution coefficients

| Branches | Solid particles | Sox | NOx |
|---|---|---|---|
| Industry | 0.08 | 0.05 | 0.01 |
| Agriculture | 0 | 0.03 | 0 |
| Transport | 0.01 | 0.01 | 0.01 |
| Other branches | 0 | 0.01 | 0 |

**Table 2:** Direct cost factors in air pollution

| Branches | Inter branch balance data | Model calculating data |
|---|---|---|
| Industry | 4306 | 4544 |
| Agriculture | 870 | 994 |
| Transport | 129 | 135 |
| Other branches | 1336 | 1340 |

**Table 3:** Gross Production volumes

## 3. Conclusion

The protection of the environment and ecology is an urgent task. Creation of various mathematical models and their testing in real conditions will solve the problem of interaction of ecology and environmental protection in the optimal way.

The above studies allow the model to be tested in real phenomena. Entering the time factor, you can move from a static model to a dynamic model and perform calculations for a given time interval.

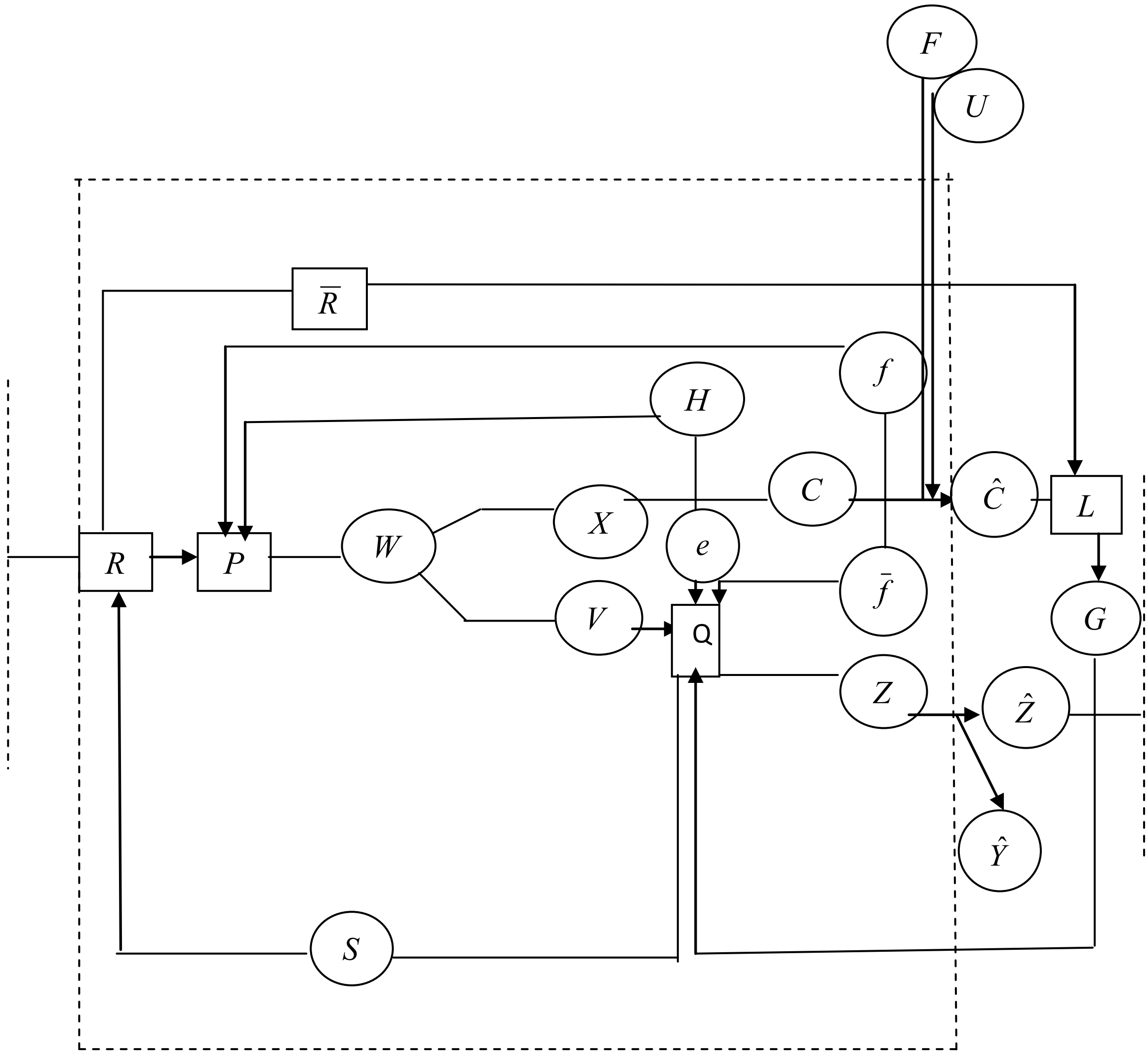


**Figure 1:** The ecological model of mutual relations.

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