

Are economic goals and goals of environmental protection compatible? Explaining paths to a sustainable economy

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Abstract

Using Leontief's input/output theory the article explains that there exist different paths to a sustainable economy in the future with compatibility of economic and environmental goals if and only if special balances of costs and returns of environmental activities are satisfied. The article explains approach, result, political implementation and control of such a path to a sustainable economy.

Keywords: Sustainable economy, environmental protection, input/output analysis

Remarks to the subject

Subject is to explain approach, result and political implications of an economic analysis by Maier (1997) within the present discussion about environmental problems and the necessity to find paths to a sustainable development of economic activities in the future. Subject of this previous analysis was to describe the conflict between goals of environmental protection and merely economic goals, to look for solutions of this conflict, and to provide political hints for paths to a sustainable economy in future. Base of this analysis is the static input/output theory of W. Leontief (1966). The analysis was part of an international research project between 1993 and 1996 at Technical University Berlin, entitled "Development of an integrated control mechanism for soil protection in the European Union", and supported by the German Volkswagen Stiftung (Bückmann, 1995, and Dreißigacker, 1997).

As for the definition of economic goals, this analysis refers to the economic goals of Federal Republic of Germany, laid down in the "Law on the German council of economic experts (Gesetz über die Bildung eines Sachverständigenrates)" (1963, 1967, 1983/84) which defines four goals: steady growth of economics, high rate of employment, stability of prices, and external balance. The analysis considers the first three of them. As for the definition of goals of environmental protection, the analysis refers to Wicke et.al. (1991), and Maier (1976). Roughly spoken, the goals of environmental protection are to avoid environmental damages (pollution of soil, water, air, etc.) by human and economic activities, or at least to keep them under control. The paper considers these goals by a special sector of economic activities called environmental sector. Due to Leontief's theory, the physical implementation of these goals by the environmental sector is out of scope.

Approach

The analysis starts with an open-ended and static Leontief model with n sectors of economy, n bigger than one. For the notation see Allen (1971). The equilibrium of the transactions is given by the equations

$$\underline{X} = A \underline{X} + \underline{x} \quad \text{or} \quad \underline{X} = (I - A)^{-1} \underline{x}$$

\underline{X} denotes the vector of the production output of a national economy, \underline{x} the vector of

final use of goods in this economy, I the unity matrix, A the matrix of the production (input) coefficients, $(I-A)$ the matrix of the technological coefficients, and the symbol $(I-A)^{-1}$ stands for the matrix of the inverse coefficients (Leontief inverse).

The equilibrium of returns from the outputs and costs of the inputs (balance of prices) in each sector is given by the equations

$$\underline{p} = A^* \underline{p} + w \underline{b} \quad \text{or} \quad \underline{p} = (I - A^*)^{-1} w \underline{b}$$

Here \underline{p} denotes the vector of the prices per unit of the various goods of the different sectors of economy, \underline{b} the vector with the production coefficients of the primary inputs (in this context equal to the reciprocal productivity coefficients of labour), w the wage rate in the different sectors of economy, w is assumed to be a constant, A^* the transposed matrix to the matrix of the production coefficients A , and I denotes the unity matrix.

Open ended means that \underline{x} , \underline{b} and w are exogenous variables. Static means that all symbols of variables refer to the same time interval, hence there is no need for a special index to denote the time. Imagine this model describes (roughly) an economic system of the present.

In this model a sector in addition with index o (zero) and with name environmental sector is introduced. It is assumed that this extended economic system will work in a future status according the same balances of transactions and prices as noted above. And it is required that in the future system economic goals and goals of environmental protection are compatible. Impact of this construction is a disturbance within the n sectors of the present economic system. This disturbance is focused and analysed. This disturbance can be described by a linear equation system with parameters of the environmental sector in the future economic system as disturbance variables. The analysis focuses solutions, which describe paths from the present to the future economic system under the strong conditions: stability of production, of wage rate, of final use, of prices of products, and of (reciprocal) productivity coefficients of the existing n sectors from present to future. These solutions exist in this model (passing mathematical details) if and only if one of the two equivalent conditions of compatibility is satisfied. If one holds, the other holds as well.

$$p_o (\underline{a}_{oV} \cdot \underline{X}) = X_o (\underline{a}_{Vo} \cdot \underline{p}) \quad \text{or} \quad p_o x_o = w b_o X_o$$

Here is p_o the price of one unit of the production, X_o the total production, x_o the final use of production, and b_o the reciprocal productivity coefficient of the sector environment, w is the constant wage rate. The vectors \underline{a}_{oV} and \underline{a}_{Vo} represent intermediate output and input coefficients of the environmental sector to and from different sectors $v = 1, 2, \dots, n$ within the future system, they are subsets of the future matrix of input coefficients. All symbols with index o refer to variables of the future system the different symbols without an index o refer to the present. The point “ \cdot ” between vectors denotes the scalar product of these vectors. Both conditions refer to balances of the environmental sector. The left condition can be identified as the balance between (from left to right) the returns from the intermediate outputs and the costs for intermediate inputs of the environmental sector in the future system. The right condition can be identified as the balance between (from left to right) the returns from final use of production and the costs for primary inputs of the environmental sector in the future system. As for the proof as well as a numerical example for the existence of solutions, which satisfy the non-negative conditions for prices, sets and input coefficients, see Maier (1997). It is noted that only the cases “no solution” or “many solutions” occur, and not the case “a single solution”. Thus there are different paths to a sustainable economy in the future or no path. The larger n is the grater is the variety of these paths. Going such a path is (mathematically) equivalent to a series of

steps. Fix the input coefficients b_O , a_{OY} and a_{VO} , which describe working and production conditions in the environmental sector, estimate the (possible) price p_O for a good of the environmental sector, estimate the (possible) production output X_O of the environmental sector, estimate the (necessary) final use x_O of environmental goods, fix values for the free variables in the equation system which describes the disturbance, and hence create a feasible solution of this system with positive values for prices, sets and input coefficients. The (technological) change from an economy without environmental sector to an economy with environmental sector (in future) can be observed and controlled by monitoring the changes within the matrix of the input coefficients (production coefficients). If the compatibility condition is satisfied, there is economic growth and positive impact on labour market (Maier, 1997).

Summary of results from theory

The negative result is: Usually, economic goals are (as expected) not compatible with goals of environmental protection. The positive result is: These goals are compatible if a special condition is satisfied. In this rough model the economic interpretation of this condition is: the cost of the intermediate inputs into the environmental sector from different sectors must be balanced by the returns from the intermediate outputs of the environmental sector. An equivalent formulation of this condition is: the cost for primary inputs (labour) must be balanced by the returns from the final users of products of the environmental sector. In this case is also growth of economics and a positive impact on production output and employment. Moreover if one of this conditions holds there are different paths to a sustainable development of a national economy in future and not only one. But there is a danger: A final use of goods (and services) from the environmental sector of economy, supported only by public programs, may inflate this environmental sector to a degree, which is in opposition to the principle to avoid damage in environment, especially soil and air pollution.

Political implementation and control

In order to explain the implementation of such a path from the present non-sustainable economy to a future sustainable economy according the results of this approach, the author refers to a scenario. Imagine an existing input/output table. As example take the R25 table of the European Union of 1990 (Eurostat, 1997). This table includes 25 sectors of economy. For purpose to take care of goals of environment, imagine, a new sector of economy is created, called environmental sector. In Germany this sector is called waste disposal industry (Abfallwirtschaft). Imagine this sector takes care of waste, polluted soil, air etc., and not different sectors as well. Imagine the technical production conditions in this (new) sector are known. In addition imagine, the potential of the market for the products of this sector is also known. Therefore, the agents of this sector know which industries may use their products as intermediate inputs. But these industries don't use their products. They fear, the use of these products (of environmental sector) as intermediate inputs will raise the prices of their own products, and they might vanish from the market. Imagine on the other hand, by pressure of laws, of decisions of executive bodies on national or international level, the intention to take (more) care of the environmental problems exists. The problem is to use the legal instruments of a state to introduce and implement this new sector environment into the system of the present sectors, and this in a way without violating basic economic goals. These legal instruments include *fiscal instruments* such as taxes, public revenues (from licences, from public charges, etc.), public supports (for special

actions, subsidies, etc.), *non-fiscal instruments*, such as planning procedures (assessment of environmental impact), public conditions, public bids and prohibitions etc., and *market-oriented instruments* such as agreements between public bodies and enterprises, see Wicke (1991), and Bückmann (1995). Imagine these instruments are used to convince the agents of the present sectors of economy to make use of the products of the environmental sector, and to support the final use of these products. The agents of the environmental sector can and will control, whether this sector works efficient in this sense that the costs of its intermediate inputs are covered by the returns of intermediate outputs to different sectors, and in this sense that the costs for labour etc. are covered by the returns from its output to final users. When this control works, one can say that the conflicts between the economic and environmental goals will decrease. This is result of this approach. Why? Firstly, because of the knowledge about production conditions there is a base for calculation of prices of the products of the sector environment. And this sector can estimate the market volume for its total production, which is necessary to balance the costs. Secondly, because of the intermediate outputs to different sectors of economy as well as the final use of its products (can and) will be supported by legal instruments, at least in the beginning period, the total pattern of the technical production will change, step by step. And this change is observable and measurable. The indicators of this production pattern are the input coefficients (production coefficients) of the input/output table referring to the different sectors (not sector environment). Watching these coefficients over time, and these coefficients are for instance future values of the R25 input/output table of European Union, one can observe the technological change from an economy without environmental goals to an economy including these goals. Thirdly, and if there is an imagination of which production coefficients can be adjusted by direct actions to a future status including intermediate products of a environmental sector, this room (or freedom) can be used to accelerate steps on this path to a future status. The theory says this room is a big one. The more developed an economy and hence the more detailed the input/output table is, the bigger is this room. The problem is to bind this room to the fiscal, non-fiscal, and market-oriented instruments of executive bodies on national and international level. In addition, the theory says, there are different possibilities to adjust these production coefficients, hence different paths to a future status of economy with compatibility of economic and environmental goals. To enforce and control this adjustment to a future status is task of public executive bodies. They have to monitor the development of the production coefficients. Fourthly, the opinion that the prices for goods and services of present sectors (not environmental one) will increase is in contradiction to the result of this approach when one of these paths is taken. And finally, to take one of these paths supports the goal of economic growth as well as the goal of high employment. But in supporting this development, one should be aware of an overheating of this environmental sector. The danger of a too big support by public programs etc. can be an inflation of the inputs into this environmental sector. These inputs are, at least partly, pollution, dangerous materials, waste, etc., and hence we get in conflict with the fundamental goal of environmental protection to avoid these negative aspects of production of the present economy.

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