

Two Intensities Analysis of London Accord

Hiroshige TANAKA

Professor of Faculty of Economics, Chuo University, Higashinakano
742-1, Hachioji-city, Tokyo 192-0393, JAPAN.

abstract

London Accord is constructed by the two intensities on low carbon communities in theoretical framework. This article makes clear the characteristics of the two indexes approach. We analyze the property of the two indexes approach in the dynamical adjustment procedure and equilibrium situation. We make the first step to clarify the theoretical framework of London Accord.

1. Introduction

Globalizing economic activities and decentralization of government might appear commonly in many advanced countries. Many environmental and social problems require betterment with voluntary contributions of many agents of government, firms, residents and NPO. Global environmental problems seem to require the global public policy to be effective for each stakeholder¹. For the problems new effective methods or technologies are possibly developed by supporting funds and efforts of these agents. Sustainable development of communities could be achieved by a cooperation and improved or voluntary participation of multi stakeholders². By effective cooperation of stakeholders corporations or non-profit organizations could achieve sustainable management and contribute to improve social welfare³. Since many stakeholders seek self interests,

¹ Meadows et al(2005) and Gleeson and Low(2001) review global sustainability systems.

² Nyssens (2006) indicates problems on multi-goal and multi-stakeholder organizations.

³ Hirshland(2006) considers the reason why the CSR are promoted globally since 2002.

probably contributions of many stakeholders are deficient and out of balanced to promote sustainability⁴. We must investigate incentives of voluntary contributions and devise a sustainable scheme to foster and to facilitate them⁵.

Price mechanism in market economy is vital role in the resource allocation. The indexes to substitute or complement the price are investigated in the external market economy. In this essay, we consider the mechanism which sends stakeholders signals toward low carbon emission communities. We consider the properties of energy intensity and carbon intensity in the framework of London Accord 2007.

2. Model

We are obliged to convert the way of life and production system in our society into more energy efficient system to achieve the sustainability at a global scale. Many new technologies or policies are developed or proposed to attain the energy efficient society. Probably each method seems to contain merits and demerits at the same time and shows various benefits and costs to be determined. Some innovations might proceed in a series of progresses and mature for long time consequently. We should take strategic approach to accelerate the innovation process. Evaluating the relative advantage of each method, we should select the best mix of the policies. It is largely possible that each measure or technology shows environmental advantage with the costs of decrease of consumption and production in the economy. Sometimes we are targeting to construct conflicting goals for the economy and the environment. The goals for sustainability could be guided by arranging synthetic social indexes which satisfy some proper characteristics. London Accord focuses on the functions of a couple of indexes the energy intensity and the carbon intensity⁶. Considering the two indexes, we explain some notations as follows. The quantity of energy J is measured by Joule. The

⁴ Marshall(2005) considers collaborative solutions for environmental management.

⁵ Tanaka(2004),(2005),(2007a)(2007b) develops the theory of corporate governance(Tirole(2001)) and formulation of Altruism(Tanaka(1998) for the decision process in multi stakeholder communities.

⁶ Krapivin and Varotsos(2007) review the theoretical analysis of globalization and sustainability. Bosetti ,Garraro and Galeotti(2006) consider dynamical properties of carbon and energy intensity.

scale of national product Y is denoted by GDP. It is a desirable target for climate change that we achieve higher Y with lower consumption of J. We should design a clear signal challenging the climate change as price mechanism in market economy plays the role on achieving efficient resource allocations.

We must employ more efforts or resources to increase efficiency of Y regarding to J. The developments of new production technologies or the reform of transformation or distribution system might contribute improvement of the combination Y and J for global environmental problems.

We indicate the level of resources invested or consumed to improve Y as e_y .

e_j denotes the volume of effort to improve energy efficiency J. e_y and e_j are traded in markets by the price of the unit. London Accord argues the properties of the five capitals; natural capital, human capital, social capital, manufactured capital and financial capital⁷. Resources are invested or poured into some capitals intensively according to relative advantage of them. In other words, resources are arranged among feasible targets for climate changes. If the total resource newly available to polices for constructing the sustainable society is given by E, the fund G to improve environment and poverty problems is expected to enlarge resource restriction in the area of challenging global environmental problems. The condition is expressed by

$$e_y + e_j = E + G. \quad (1)$$

The new technologies to improve energy efficiency possibly increase national products but deplete J for the economy. In some case, the new technologies to improve efficiency of solar energy replace a part of fossil energy but possibly decrease J for the total energy generation. In other case, the advanced equipment in power station requires great investment but is able to generate higher level of J. Although we can suppose both possibilities, it is appropriate to consider the former case mainly. It is assumed that Y and J are the monotone increasing and decreasing functions of e_y and e_j as

⁷ Forum for the Future(2007) pp.7-15.

$Y(e_y)$ and $J(e_j)$. It is assumed that the inequalities $Y'(e_y) > 0$ and $J'(e_j) < 0$ are satisfied⁸. We refer this assumption as negative prospect by distinguishing from the positive prospect. C is the total amount of carbon emitted in a nation. The growth of Y is a main factor to increase carbon emission. Joule consumption by burning coal or oil increases Carbon emission largely but the renewable energy is possibly assumed to affect carbon emission in a limited way. The relation between carbon emission and Joule depends on the energy sources determined by energy policies. Carbon function is expressed by

$$C = F(Y, J). \quad (2)$$

The shape of the carbon function is transformed by technologies, methods and policies for the global warming. The energy intensity is defined by

$$EI \equiv \frac{J(e_j)}{Y(e_y)}. \text{ Similarly, the carbon intensity is defined by } CI \equiv \frac{F(Y(e_y), J(e_j))}{J(e_j)}.$$

It is assumed that the inequalities $\frac{\partial F}{\partial Y} > 0$ and $\frac{\partial F}{\partial J} > 0$ are satisfied.

3. Methods of indication for minimizing carbon emission

In this section, we consider implications of index approach in climate change by employing a model analysis. The policies for minimizing carbon emission are derived by solving the first order conditions of the following Lagrange function (3). λ is a Lagrange multiplier. Differentiating

$$F(Y, J) + \lambda(e_y + e_j - E - G) \quad (3)$$

with regard to e_y and e_j , we derive the following conditions

$$\frac{\partial F}{\partial Y} \frac{dY}{de_y} + \lambda = 0,$$

$$\frac{\partial F}{\partial J} \frac{dJ}{de_j} + \lambda = 0.$$

It is certain that the inequality

⁸ This assumption is reflected by negative prospect. Some technologies intend to increase J by additional investment of e_j . The positive prospect $J'(e_j) > 0$ is discussed later.

$$-\frac{dJ}{dY} = \frac{\frac{dJ}{de_j}}{\frac{dY}{de_y}} < 0 \quad (4)$$

holds. Considering (4), we can suppose that J and Y satisfy a positive correlation⁹. That is, (4) expresses the increment of J required by one unit enlargement of Y in the most efficient carbon emission. In order to construct low carbon emission communities, the depletion of energy efficiency is obtained by a expense of decreasing GDP. (4) implies that the depletion of J required by the growth of GDP to achieve low carbon communities decreases to lower in lower marginal depletion effect of energy $\frac{dJ}{de_j}$ or higher marginal

national product $\frac{dY}{de_y}$. That is, the economic or shadow price should be

determined by the rate of the two marginal effects of energy and product. The rate will be set up as a targeting index for market oriented solution for climate change. In this essay, policies based on (4) is named by direct or single index approach.

London Accord adopts two indexes expected to arrange investments for many fields of depleting carbon effectively and efficiently. We assume that the most efficient social system with carbon emission is attained in the condition satisfies the highest level of carbon intensity. To solve the solution the Lagrange function is described as follows.

$$\frac{F(Y(e_y), J(e_j))}{Y(e_y)} + \mu(e_j + e_y - E - G) \quad (5)$$

μ is a Lagrange multiplier. Differentiating (5) with e_j and e_y , the first order conditions of low carbon communities is written by

$$\frac{\frac{\partial F}{\partial J} \frac{dJ}{de_j}}{Y} + \mu = 0,$$

⁹ In the case of positive prospect for energy technologies $J'(e_j) > 0$, (4) is positive. If our society construct by these technologies, the growth of Y can be achieved by depleting J. In this condition, we could attain the growth of Y and depletion of J at the same time. So we could easily find the way to low carbon society.

$$\frac{\frac{\partial F}{\partial Y} \frac{dY}{de_y} - F \frac{dY}{de_y}}{Y^2} + \mu = 0.$$

By arranging the above tow expressions, we ensure that the growth rate of Joule and GDP satisfy

$$\frac{\frac{\frac{\partial F}{\partial Y} - \frac{F}{Y}}{\frac{\partial F}{\partial J}}}{\frac{dJ}{de_y}} = \frac{\frac{dJ}{de_y}}{\frac{dY}{de_y}}. \quad (6)$$

Although we must develop some more investigation, the following result is obtained by comparing (5) and (6). Considering the left side of (6) is transformed into

$$-\frac{\frac{dJ}{dY} \frac{1}{Y} - \frac{\frac{F}{Y}}{\frac{\partial F}{\partial J}}}{\frac{dJ}{de_y}} \quad (7)$$

For the relatively small economy $Y < 1$, (6) is assumed to be larger than negative value of (4). Index approach seems to target greater substitution rate between the energy J and the product Y.

Finally. We consider the energy intensity. Employing the following Lagrange function

$$\frac{J(e_j)}{Y(e_y)} + \alpha(e_j + e_y - E - G) . \quad (8)$$

α is a Lagrange multiplier. The first order conditions of the energy intensity are exhibited by

$$\begin{aligned} \frac{\frac{dJ}{de_j}}{Y} + \alpha &= 0, \\ -\frac{J}{Y^2} \frac{dY}{de_y} + \alpha &= 0. \end{aligned}$$

The above expressions are arranged by

$$\frac{\frac{dJ}{de_j}}{J} + \frac{\frac{dY}{de_y}}{Y} = 0. \quad (9)$$

Consequently, the intensity of energy implies the depletion rate of J and growth rate of Y of the two efforts e_j and e_y equilibrate each other in the low carbon communities. (9) is rewritten by (10). In other words, the rate between J and Y should be equal to rate of marginal effect of two efforts e_j and e_y . Considering the intensity of energy employs average rate $\frac{J}{Y}$ instead of marginal $\frac{dJ}{dY}$ in the case (4), this intensity sends more cautious signal to deplete J than the single index approach.

$$\frac{J}{Y} = -\frac{\frac{dJ}{de_j}}{\frac{dJ}{de_y}} > 0. \quad (10)$$

Noticing that (7) is rewritten by

$$-\frac{1}{Y} \left(\frac{dJ}{dY} + \frac{F}{\frac{\partial F}{\partial J}} \right) \quad (11)$$

two intensities approach adopted by London Accord indicate the larger economy Y more effort to deplete J.

Finally, two intensities approach more sophisticate valuation for policies for climate change in dynamic arrangement process. In a equilibrium, two indexes (7) and (10) turn into the identical value. To simply the expression the elasticity of energy to carbon emission $\frac{\partial F}{\partial J} \frac{J}{F}$ is denoted by ε . Making (10) equal to (11),

$$\frac{dJ}{dY} = J \left(1 - \frac{1}{\varepsilon} \right) \quad (12)$$

is derived. J depletion accompanied by decrease of production Y becomes larger as J or ε increases. That is, the economic or market value of energy depends on the elasticity of energy to carbon emission.

4. Remarks

To achieve low carbon emission we should target to combine the economic or market value to resource allocation between production and energy

efficiency improvements in the direct one index approach. On the other, London Accord is constructed by the two intensities on low carbon communities in theoretical framework. This article makes clear the characteristics of the two indexes approach. Two main results are confirmed. First, the two indexes approach makes many effective signals to moving communities into low carbon system of society in the dynamical adjustment procedure. Second, in the goal the economic or market determine the resource allocation between economy and environment value depend on energy J and the elasticity of energy to carbon emission.

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