opera 大阪府立大学 学術情報リポジトリ
Osaka Prefecture University Education and Research Archives

A Note on Economic Approach to Solar Panel

著者	Watanabe Shigeru, Sada Tomohiro
引用	大阪府立大学經濟研究. 2011, 57(1), p.67-71
URL	http://doi.org/10.24729/00001008

A Note on Economic Approach to Solar Panel

Shigeru Watanabe*
Tomohiro Sada**

Abstract: The electric power produced by solar panel is clean energy and important for the environment. In this note, the policy for the clean energy i.e. the electric power produced by the solar panel will be examined.

We get the following result; the policy of decreasing $r = P_B/P_A$; the rate between the price, P_B, of electric power supplied by the electric power company and the price, P_A, of the electric power produced with solar panel and bought by the electric power company from the consumer with solar panel, may rather decrease the latter price, P_A, which implicates the decrease in the supply of electric power produced by the solar panel.

Key Words: Environment, Solar Panel, Clean Energy, Electric Power.

1. Introduction

The electric power produced by solar panel is clean energy and important for the environment[1].

In this note, we will analyze the policy for the clean energy; the electric power produced by the solar panel.

In the next section, a simple model of solar panel will be presented. Concluding remarks will be given in the last section.

2. A Simple Model of Solar Panel

In the following, we will use the following notation.

* Professor of Economics at the Osaka Prefecture College of Economics,
1-1, Gakuencho, Nakaku, Sakai-City, Osaka 599-8531, Japan
** Post graduate student of Economics at Osaka Prefecture University

S_A ; the amount of electric power produced by consumer A with solar panel.

D_A ; the amount of electric power consumed by the consumer A with solar panel.

D_B ; the amount of electric power consumed by the consumer B without solar panel.

P_A ; the price level at which residual electric power produced by the solar panel is sold to the electric company.

$\hat{S}_A \equiv (S_A - D_A)$, is the amount of electric power sold by the consumer A to electric power company.

P_B ; the price level at which electric power is sold by the electric company to consumer B without solar panel.

To make the analysis simple, it is assumed that the demand, D_A, of consumer A for electric power is less than the amount of the electric power, S_A, produced by the consumer A who has solar panel.

The profit, π, of the electric power company is denoted by the following equation (1)

$$\pi = P_B D_B(P_B) - P_A \hat{S}_A(P_A) - cS, \qquad (1)$$

where c is the average cost of producing the electric power and
S is equal to $D_B - \hat{S}_A$.

In the following we assume that the government determines the rate, r, such that

$$r = \frac{P_B}{P_A}. \qquad (2)$$

Using equation (2), the equation (1) is rewritten as

$$\pi = rP_A D(rP_A) - P_A \hat{S}_A(P_A) - c\{D_B(rP_A) - \hat{S}_A(P_A)\}. \qquad (3)$$

Maximizing (2) with respect to P_A yields the following first order condition.

$$\frac{d\pi}{dP_A} = -2\left(\frac{r^2}{n} + \frac{1}{b}\right)P_A + \frac{rm}{n} + \frac{cr}{n} + \frac{c}{b} = 0, \qquad (4)$$

where the supply function for the electric power by A is specified such that

$$\hat{S}_A = bP_A,\ b > 0,$$

and the demand function for the electric power by B is specified such that

$$P_B = m - nD_B. \qquad (5)$$

The equation (5) is rewritten from (2),

$rP_A = m - nD_B$, then

$nD_B = m - rP_A$.

Second order condition is satisfied.

$$\frac{d^2\pi}{dP_A^2} = -2\left(\frac{r^2}{n}+\frac{1}{b}\right) < 0. \qquad (6)$$

From the first order condition the optimal price, P_A^*, of the electric power is derived to be

$$P_A^* = \frac{(m+c)r+\dfrac{cn}{b}}{2\left(r^2+\dfrac{n}{b}\right)}. \qquad (7)$$

Using the equation (7), we can examine the effect of the change in r on the optimal value of P_A.

$$\frac{\partial P_A}{\partial r} = \frac{(m+c)\left(r^2+\dfrac{n}{b}\right)-2\left\{(m+c)r+\dfrac{cn}{b}\right\}r}{2\left(r^2+\dfrac{n}{b}\right)}. \qquad (8)$$

We define r^* such that the numerator of the equation (8) is equal to 0.

From (8) we obtain the following results ;

$r^* \gtreqless 1$,

according as,

$$\frac{n-b}{n} \gtreqless \frac{2c}{m+c}. \qquad (9)$$

We examine the following three cases.

In case 1, where $\dfrac{n-b}{n} < \dfrac{2c}{m+c}$,

the smaller the m, the higher the possibility of case 1.

In the same way, the larger the b, the higher the possibility of case 1.

In this case, the following relation holds; $r^* < 1$, for any r such that $r \geqq 1$,

$\dfrac{\partial P_A^*}{\partial r} < 0$, hence $\dfrac{\partial P_B^*}{\partial r} = P_A(1-\eta)$, where $\eta \equiv \left|\dfrac{r}{P_A}\dfrac{\partial P_A}{\partial r}\right|$.

Therefore, $\dfrac{\partial P_B^*}{\partial r} \gtreqless 0$ according as $1 \gtreqless \eta$.

In case 2, the equality holds in (9), hence in this case, $r^* = 1$.

If $r = 1$ then

$$\frac{\partial P_A^*}{\partial r} = 0, \text{ hence } \frac{\partial P_B^*}{\partial r} = P_A^* > 0.$$

If $r > 1$ then

$$\frac{\partial P_A^*}{\partial r} < 0, \text{ hence } \frac{\partial P_B^*}{\partial r} = P_A(1-\eta).$$

Therefore, $\frac{\partial P_B^*}{\partial r} \gtreqless 0$ according as $1 \gtreqless \eta$.

In case 3, where $r^* > 1$,

the larger the m, the high the possibility of case 3.

In the same way, the smaller the b, the higher the possibility of case 3.

If $1 \leqq r < r^*$ then

$$\frac{\partial P_A^*}{\partial r} > 0, \text{ hence } \frac{\partial P_B^*}{\partial r} = P_A^* + r\frac{\partial P_A^*}{\partial r} > 0.$$

If $r = r^*$ then

$$\frac{\partial P_A^*}{\partial r} = 0,$$

$$\text{hence } \frac{\partial P_B^*}{\partial r} = P_A^* > 0.$$

If $r^* < r$ then

$$\frac{\partial P_A^*}{\partial r} < 0,$$

$$\text{hence } \frac{\partial P_B^*}{\partial r} = P_A(1-\eta).$$

Therefore, $\frac{\partial P_B^*}{\partial r} \gtreqless 0.$ according as $1 \gtreqless \eta$.

3. Concluding Remarks

We get the following interesting result especially in the case 3.

The larger the m or the smaller the b, the higher the possibility of case 3.

In the case 3, we get the following result; the policy of decreasing $r = P_B/P_A$; the rate between the price, P_B, of electric power supplied by the electric power company and the price, P_A, of the electric power bought by the electric power company from the

consumer with solar panel, may rather decrease the latter price, P_A, which implicates the decrease in the supply of electric power produced by the solar panel.

Notes

1 See, for example, Maruo (2010), Ministry of the Environment (2010). and Watanabe (2009), Watanabe (2010 a), (2010 b).

REFERENCES

N. Maruo, "Stream of Environmental Policy", *Economic Policy for Life, Dec. 2010.*

Ministry of the Environment, *Annual Report on the Environment, the Sound Material-Cycle Society and the Biodiversity in Japan 2010.* Jun. 2010. (http://www.env.go.jp/en/wpaper/)

Shigeru Watanabe, "A Note on Tax Evasion－Environmental Policy in the Presence of Tax Evasion－", *THE JOURNAL OF ECONOMIC STUDIES*, COLLEGE OF ECONOMICS, OSAKA PREFECTURE UNIVERSITY, Vol. 55, No. 2 (No. 228), Sep., 2009.

————————, "A Note on Trade-off between Environment and Tax Evasion", *THE JOURNAL OF ECONOMIC STUDIES*, COLLEGE OF ECONOMICS, OSAKA PREFECTURE UNIVERSITY, Vol. 55, No. 4 (No. 230), March, 2010 a.

————————, "A Note on Policy-Mix for Environment and Production in the Presence of Tax Evasion", *THE JOURNAL OF ECONOMIC STUDIES*, COLLEGE OF ECONOMICS, OSAKA PREFECTURE UNIVERSITY, Vol. 56, No. 1 (No. 231), Jun, 2010 b.