THE RELATIONSHIP BETWEEN GREENSPACE AGREEMENT, EXTERNAL DISECONOMY AND RESIDENTS' RISK ASSESMENT

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Abstract

The greenspace agreement is an effective method to promote the conservation and creation of greenspace. In this paper, the mechanism of the formation of the greenspace agreement is analysed using the coalition game. As a result, it was identified that the greenspace agreement requires a certain level of supporters in order to be formed and the most desirable situation is when there is a universal agreement. It also identified the possibility of the existence of free riders which could prevent a unanimous support of the greenspace agreement. The number of supporters of the greenspace agreement and number of free riders are dependent on the size of the external diseconomy caused by the lack of consideration for greenspace, the government's enforceability of taxes on the diseconomy and the decline in land prices due to the external diseconomies from the neglect of greenspace. Furthermore, it was found that it was also influenced by the residents and stakeholder's risk assessment based on their view towards the government's enforceability of taxes and the rate of decline in land prices.

Keywords: Greenspace agreement, coalition game, free rider, external diseconomy
JEL classification: H2, Q5, R0

1. Introduction

Urban greenspace provides environmental and social services such as wind block, fire protection, prevention of soil erosion, dust control, sound insulation, air purification, climate balance, conservation of biodiversity, environmental protection function such as the formation of resource-circulating society and amenity functions such as scenery, space and comfort (e.g. Hoyano and Hagiwara, 1983; McPherson, 1992; Minemura et al., 2002; Tabata, 2011). Recent studies on the health benefits of greenspace is especially active (Ambrey, 2016; Willis et. al, 2015; Gilbert, 2016). However, with the emphasis on economic development, liberal building policy and unified national approach towards development, Japan has neglected consideration for greenspace (Ministry of Land, Infrastructure, Transport and Tourism/ Ministry of Agriculture, Forestry and Fisheries/Ministry of the Environment, 2004). As global endeavours towards sustainable development such as the Rio Summit has progressed, Japan's interest in greenspace has risen (Ministry of Land, Infrastructure, Transport and Tourism, 2014).

This has led to the establishment and amendments to the Urban Green Space Conservation Act and the encouragement of developing with greenspace and afforestation consideration (In the 1973 Urban Green Space Conservation Act, the greenspace agreement focused on increasing greenspace, whereas in the 1995 amendment, the concept of greenspace consideration was added.). Included in Article 45 is the concept of a universal agreement concerning the conservation and formation of greenspace and as an effective method, the greenspace agreement is introduced. Article 54 includes the concept of a one person agreement as one type of agreement. However, this paper focuses on an agreement with a certain number of participants, so will limit the analysis to the coverage of Article 45. Since its introduction, the number of universal green space agreement has grown to 521 in 2014 (Ministry of Land, Infrastructure, Transport and Tourism, 2014). A greenspace agreement supported by the land owners and stakeholders of a City Planning Area or an area of land along a considerable sized Quasi-City Planning Area, road or river, enables the establishment of developed and detailed standards concerning greenspace conservation and creation. In this way, through a greenspace agreement, residents are actively able to establish greenspace regulations and take part in an important role in the conservation and creation of greenspace.

This paper focuses on the mechanism of the formation of a greenspace agreement, which is a tool used to maintain greenspace and applies the coalition game for the analysis. According to the Broken Windows Theory (Wilson and Kelling, 1982), the deterioration of the environment can lead to increased crime and decline in sanitation levels leading to further deterioration of the environment. There are past studies on the influence of urban greenspace in crime preventions (e.g. Branas et al., 2011; Kuo and Sullivan, 2001). Hence, it will be necessary to consider the introduction of taxes to cover the cost of addressing the negative externalities from the neglect in greenspace. Moreover, such decline in the environment has the potential to reduce land prices and there are studies which support the positive impact greenspace has on land and housing value (e.g. Conway et al. 2010, Jim and Chen, 2006). Taking these points into consideration, since the negligence of greenspace may cause external diseconomy and affect the decline in land prices, the model takes into consideration the incurrence of such related cost.

Since there are many factors of uncertainties in society, there is a need to include this in the analysis process. The model takes into consideration such uncertainties as the tax burden to cover the cost to address the external diseconomies from greenspace neglect; the possibility of a decline in land prices from the neglect; and the residents' attitude towards risk.

From this analysis, the results confirmed that in order for a greenspace agreement to be formed, a certain level of supporters is required and the optimal situation is when there is a universal agreement. It also confirmed the possibility of the existence of free riders which can prevent a universal agreement. Furthermore, the number of supporters and the number of free riders are dependent on the size of the external diseconomy caused by greenspace neglect and the ability for the government to enforce taxes. It was also influenced by land prices; the rate of decline in land prices from the external diseconomy from the neglect in green space; and the residents' risk assessment based on their view towards the government's enforceability of taxes and the rate of decline in land prices.

In Section 2, the analysis on landscape agreements using the coalition game is conducted with the consideration of the residents' risk assessment towards the government's ability to enforce taxes on the external diseconomy from the neglect in landscape and the decline in land prices due to the neglect. Section 3 will provide the results and conclusion.

2. Greenspace Agreement and the Coalition Game

We will assume a new development site. A greenspace agreement will be considered by the participants for the conservation and creation of greenspace for this development. When households plan building with consideration for greenspace before the construction starts, the cost per unit area is Y yen for each household. On the other hand, if construction starts without greenspace consideration, cost such as from external diseconomy may be incurred. For example, according to the Broken Windows Theory, the deterioration of the environment can have a number of negative impacts such as increased crime, decline in sanitation levels leading to further deterioration of the environment and a decline in land prices. Therefore, the cost from the external diseconomy will be split in two in the analysis. First, there will be the cost of the burden to each household for the external diseconomy from the neglect in greenspace. This is when a Pigovian tax is imposed on each household. The second will be the cost to each household from the decline in land prices due to greenspace neglect. These costs to the households will be calculated based on per unit area and will be assumed to be $\rho T+\delta L$ yen. Here, T will represent the tax to cover the cost to address the external diseconomy from greenspace neglect and p will be the rate of enforceability by the government concerning this tax and δ will be the rate of decline in land prices effected by greenspace neglect and L will represent the land price. If we assume that x households build without greenspace consideration, the cost to rectify this will be $x(\rho T+\delta L)$ yen per unit area for each household.

Here, the set of players in the coalition game is defined as N. The subset of players within the set will be coalition S and any other coalition will be represented as N-S. In this case, the number of members within coalition S will be s and the number of members in coalition N-S will be n-s.

There is an element of uncertainty concerning the government's capability of the enforcement of the tax to cover the cost of addressing the external diseconomy from

greenspace neglect, as well as uncertainty concerning the decline in land prices due to this neglect. Hence, the residents' subjective assessment may come into play. This is taken into consideration by assuming that there will be a neutral, pessimistic and optimistic view towards the risk of tax enforcement and decline in land prices. Therefore, there will be 9 types of risk assessment and due to limitation of space, we will assume that the risk assessment will be consistent with all of the subject matters. This provides three types of risk assessment towards the tax enforceability for the cost of addressing the external diseconomy from greenspace neglect and the decline in land prices from the neglect. They are (risk neutral, risk neutral), (risk pessimistic, risk pessimistic) and (risk optimistic, risk optimistic).

2.1. Residents with a neutral assessment towards the risk

First, we will examine the case where the residents will have a neutral view towards the risk of the introduction of tax and the decline in land prices from the external diseconomy of the neglect in greenspace. In this case, since there will be no over estimation or under estimation of the government's enforceability of the tax or decline in land prices, they can each be represented as , respectively. Taking this into consideration, the cost function for each case is as described below.

When both coalition *S* and coalition *N*-S build with greenspace consideration, the cost to coalition *S* is

$$C(S) = sY. \quad (1)$$

When both coalition *S* and coalition *N*-S build with greenspace consideration, the cost to coalition *N-S* is

$$C(N-S) = (n-s)Y. \quad (2)$$

When coalition *S* builds with greenspace consideration and coalition *N-S* does not, the cost to coalition *S* is

$$A(S) = s\{Y + (n-s)(\rho T + \delta L)\}. \quad (3)$$

When coalition *S* builds with greenspace consideration and coalition *N-S* does not, the cost to coalition *N-S* is

$$D(N-S) = (n-s)^2(\rho T + \delta L). \quad (4)$$

When coalition *S* does not build with greenspace consideration and coalition *N-S* does, the cost to coalition *S* is

$$D(S) = s^2(\rho T + \delta L). \quad (5)$$

When coalition *S* does not build with greenspace consideration and coalition *N-S* does, the cost to coalition *N-S* is

$$A(N-S) = (n-s)\{Y + s(\rho T + \delta L)\}. \quad (6)$$

When both coalition *S* and coalition *N*-S do not build with greenspace consideration, the cost to coalition *S* is

$$B(S) = sn(\rho T + \delta L). \quad (7)$$

When both coalition *S* and coalition *N*-S do not build with greenspace consideration, the cost to coalition *N-S* is

$$B(N-S) = (n-s)n(\rho T + \delta L). \quad (8)$$

When the cost to coalition *S* is greater when coalition *S* builds with greenspace consideration and coalition *N-S* does not; than the cost to coalition *S* when both coalition *S* and coalition *N-S* do not build with greenspace consideration, in other words, when $A(S) > B(S)$, from (3) and (7), $s\{Y + (n-s)(\rho T + \delta L)\} > sn(\rho T + \delta L)$ is derived and the following is obtained.

$$s < {}^{Y}/_{(\rho T + \delta L)}. \quad (9)$$

Hence, this suggests that when the number of supporters are less than a certain level, the greenspace agreement is not formed. In further detail, when the number of supporters of the greenspace agreement is less than the ratio of the cost of building with greenspace consideration to the cost of building without, the greenspace agreement is not established.

On the other hand, when the cost to coalition *S* is less when coalition *S* builds with greenspace consideration and coalition *N-S* does not; than the cost to coalition *S* when both coalition *S* and coalition *N-S* do not build with greenspace consideration, in other words, when $A(S) < B(S)$, from (3) and (7), $s\{Y + (n-s)(\rho T + \delta L)\} < sn(\rho T + \delta L)$ and $n \geq s$, obtaining the following.

$$n \geq s > {}^{Y}/_{(\rho T + \delta L)}. \quad (10)$$

Proposition 1

When the number of supporters of the greenspace agreement is greater than the ratio of the cost of building with greenspace consideration to the cost of building without, the greenspace agreement is formed.

This implies that when the number of supporters of the greenspace agreement are over a certain level, the greenspace agreement is formed. It also suggests that the greater the number of supporters of the agreement, the cost to improve the deterioration of the greenspace per household will be less. Thus, it is understood that the best outcome is a unanimous support of the greenspace agreement.

Furthermore, if we observe the relationship between each variable and the number of supporters of the green space agreement in results (10), we learn that the cheaper the cost of supporting the agreement, the agreement is able to be formed with fewer supporters. Moreover, the greater the cost to address the external diseconomy due to green space neglect, the agreement is also formed with fewer supporters. The greater the ability of the government to enforce taxes to address the external diseconomy from green space neglect also enables a greenspace agreement with fewer number of supporters. It was also found that the higher the price of land, the agreement is formed with fewer number of supporters. Finally, it was observed that the greater the decline in land prices, the fewer number of supporters required for a green space agreement to be formed.

However, it is not a certainty that all residents and stakeholders will participate in the greenspace agreement. Next, we will attempt to examine the situation where a unanimous agreement is reached by all residents and stakeholders within an area.

Here, we will first assume that a coalition *S* was formed and a green space agreement was established and building with green space consideration was conducted based on this. The cost to remaining coalition *N-S* to build with green space consideration and the cost to build without will be (2), (4) respectively. $C(N-S) > D(N-S)$, in other words, when the cost for coalition *N-S* to build without green space consideration is less than to build with consideration, then the following is obtained.

$$(n-s)Y > (n-s)^2(\rho T + \delta L). \quad (11)$$

(11) can be rewritten as follows.

$$n - s < Y/(\rho T + \delta L). \quad (12)$$

Proposition 2

When coalition S, which builds with green space consideration exists and the number of participants in the remaining group N-S is less than the ratio of the cost of greenspace considerate building to the cost of building without greenspace consideration, the remaining group N-S will not form a green space agreement.

From the results above, we learn that there is a case where the cost is cheaper for coalition S to build with greenspace consideration than without and cheaper for coalition N-S to build without. In this case, if the green space considerate building by coalition S has an impact on the external economy to the area and coalition N-S within, coalition N-S can be considered a free rider. Then the dominant strategy for each coalition S and coalition N-S will be (building with greenspace consideration, building without greenspace consideration) and the strategy will be at an equilibrium. In other words, it suggests the possibility of two groups to be formed, the coalition that is proactively considerate of the greenspace and a coalition that is passive about greenspace consideration. This means that the number of members in the group who are active about building with greenspace consideration will not exceed the border of $B/(\rho T + \delta L)$.

Furthermore, if we observe each variable and the number of supporters of the green space agreement in results (12), we learn that the capability to host free riders is greater when the cost from the result of the green space agreement is higher. Moreover, when the cost to address the external diseconomy due to green space neglect is greater, the ability to host free riders is fewer. When the government's ability to enforce these taxes is greater, the capacity to host free riders is fewer. The higher the land prices also limits the free riders as well as the greater the decline in land prices due to green space neglect.

2.2. Residents with a pessimistic assessment towards risk

Next, we will examine the case of the residents with a pessimistic assessment towards risk. Residents with a pessimistic view are inclined to overestimate the government's enforceability of the tax to address the negative externalities from greenspace neglect. Hence, the enforceable tax rate by the government will be estimated as follows.

$$(1 + h_T)\rho \quad (13)$$

Here, h_T represents the rate of overestimation. Moreover, it suggests $0 < h_T < (1-\rho)/\rho$.

Risk pessimistic residents tend to overestimate the rate of decline of land prices due to greenspace neglect. Thus, the rate of land price decline due to greenspace neglect will be estimated as follows.

$$(1 + h_L)\delta \quad (14)$$

Here, h_L represents the rate of overestimation. Moreover, it suggests $0 < h_L < (1-\rho)/\rho$.

The number of participants of the greenspace agreement from (13), (14) with the consideration of the risk pessimistic residents, (10) can be rewritten as follows.

$$n \geq s > {}^{Y}/_{\{(1+h_T)\rho T + (1+h_L)\delta L\}}. \quad (15)$$

Proposition 3

The greater the h_T, the greenspace agreement is able to form with fewer supporters. In the same way, the greater the h_L, the fewer supporters necessary for the greenspace agreement to be established.

In other words, since risk pessimistic types will overestimate the tax enforcement ability of the government to implement taxes to address the negative externalities from greenspace neglect, the greenspace agreement can be established with fewer supporters. Moreover, since they will also overestimate the rate of decline in land prices from greenspace neglect, the greenspace agreement can be formed with fewer supporters.

On the other hand, concerning the capacity to include free riders concerning greenspace consideration, if we consider the risk pessimistic residents from (13) and (14), (12) can be rewritten as follows.

$$n - s < Y/\{(1+h_T)\rho T + (1+h_L)\delta L\}. \quad (16)$$

Proposition 4

The greater the h_T, the capacity to include free riders concerning the greenspace will be less. Similarly, the greater the h_L, the capacity to include free riders will be less.

Hence, since risk pessimistic types will overestimate the tax enforcement ability of the government to implement taxes to address the negative externalities from greenspace neglect, the capacity to include free riders will be fewer. Moreover, since they will also overestimate the rate of decline in land prices from greenspace neglect, in other words have a pessimistic view, the ability to include free riders will be less.

2.3. Residents with an optimistic assessment towards risk

Finally, we will examine the case of residents with an optimistic view towards risk. The risk optimistic residents will tend to underestimate the tax enforcing ability of the government to implement taxes to address the negative externalities from greenspace neglect. Thus, the rate of enforceability by the government for the tax to address the negative externalities from greenspace neglect will be estimated as follows.

$$(1 - l_T)\rho. \quad (17)$$

Here, l_T represents the rate of underestimation. Furthermore, it suggests $1 - (\frac{1}{\delta}) < l_T < 1$.

Risk optimistic residents have a tendency to underestimate the rate of decline in land prices. Hence, the rate of decline of land prices due to greenspace neglect will be as follows.

$$(1 - l_L)\delta. \quad (18)$$

Here, $l_L$represents the rate of underestimation. Moreover, it suggests 1-(1/δ)$< l_L < 1$.

From (17), (18) and consideration for the risk optimistic residents, (10) can be rewritten as follows.

$$n \geq s > {}^{Y}/_{\{(1-l_T)\rho T + (1-l_L)\delta L\}}. \quad (19)$$

Proposition 5

The greater the l_T, the greenspace agreement will require greater number of supporters. In the same way, the greater the l_L, the greater number of supporters necessary for the greenspace agreement to be established.

By way of explanation, since risk optimistic types will underestimate the tax enforcement ability of the government to implement taxes to address the negative externalities from greenspace neglect, the greenspace agreement will require the support of a greater number to be formed. Similarly, since they will also underestimate the rate of decline in land prices from greenspace neglect, the greenspace agreement will require a greater number of supporters.

However, concerning the capacity to include free riders, if we consider the risk optimistic residents from (17) and (18), (12) can be rewritten as follows.

$$n - s < Y/\{(1 - l_T)\rho T + (1 - l_L)\delta L\}. \quad (20)$$

Proposition 6

The greater the l_T, the capacity to include free riders concerning the greenspace will be greater. In the same way, the greater the l_L, the capacity to include free riders will be greater.

In other words, the risk optimistic type of residents will underestimate the tax enforcement ability of the government to implement taxes to address the negative externalities, the capacity to include free riders will be greater. Furthermore, it was identified that these residents will underestimate the rate of decline in land prices from greenspace neglect, in other words have an optimistic view, the ability to include free riders will be greater.

3. Conclusion

With the global focus on sustainable development and Japan's interest in greenspace continues to grow, this paper uses the coalition game to attempt to analyse the mechanism of the formation of a greenspace agreement. The model takes into consideration the cost incurred from the external diseconomy and decline in land prices caused by greenspace neglect. As a result, the greenspace agreement is only possible when a certain level of supporters is gained and the most preferable outcome is when the support is unanimous. On the other hand, the possibility of the existence of free riders was identified which can prevent a unanimous support of the green space agreement. Moreover, the number of supporters of the greenspace agreement and the number of free riders depends on the size of the external diseconomy from greenspace neglect; the enforceability of taxes by the government; land prices; and the rate of decline of land prices from the external diseconomy from the neglect in greenspace. The influence of the residents' assessment of risk based on their view towards the government's enforceability of taxes and the rate of decline in land prices, was also identified.

By taking these observations into consideration, the situation of the support of greenspace agreement and the occurrence of free riders can be understood and may provide insight into future policies concerning greenspace conservation and development.

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