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Cost Benefit Analysis of Community Relocation Project

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Abstract

There have been a variety of needs for community relocation project. The community relocation project is that all households in a community must leave their present location and reside in a new location. Since relocating households in the project are not few but many, the impacts at the spatial economy are significant. We find the needs for community relocation in many policy programs like Disaster prevention program, Marginal Area Development, Slum clearance, and Large scale infrastructure project. Since a public sector spends its budget for a community relocation project, we should apply the cost benefit analysis to the project as well as other public policies. Although the community relocation project is often implemented in practice, theoretical foundation of cost benefit analysis for the project has not been clarified. This paper provides a clear theoretical foundation of cost benefit analysis applied to a community relocation project. Based on the model, the paper then defines the social benefit of the community relocation and decomposes it to items to be measured in practice.

Keywords
Community Relocation, Cost Benefit Analysis, Benefit Incidence Analysis

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1 Introduction

There have been a variety of needs for community relocation project. The community relocation project is that all households in a community must leave their present location and reside in a new location. Since relocating households in the project are not few but many, the impacts at the spatial economy are significant. We find the needs for community relocation in many policy programs.

Disaster prevention program
In order to protect a community from risks like river flood or landslide, the community relocation is a dominant option to protect the community.

Marginal Area
A small village called a marginal area in a peripheral region, where population is aging and decreasing, can not keep providing public services and maintaining community activities. If the community in the marginal area relocates to be merged with a large community, it can still keep them.

Slum clearance
A metropolitan area in a developing country has a slum area where workers of an informal sector are residing in bad environment. The slum is cleared by making a community at the area to relocate.

Large scale infrastructure project
A large scale infrastructure project needs a community relocation from a construction site. It is often the case that a dam construction makes communities at its site or water area to leave their locations.

Since a public sector spends its budget for a community relocation project, we should apply the cost benefit analysis to the project as well as other public policies. Although the community relocation project is often implemented in practice, theoretical foundation of cost benefit analysis for the project has not been clarified.

This paper aims at providing a clear theoretical foundation of cost benefit analysis applied to a community relocation project. The paper first builds a simple spatial economic model which describes location choice behavior of households among two regions and demand-supply balancing in land market for each region　Based on the model, the paper then defines the social benefit of the community relocation and decomposes it to items to be measured in practice. The paper finally discusses a variety of cases to which the cost benefit analysis is applied and concludes with some remarks.

2 Model

2.1 Basic assumptions

A simple spatial economic model in this paper is built with the following assumptions.
a) There is an economy which consists of two regions labeled by $i \in \mathbf{I} = \{1,2\}$.　The region labeled by $i = 1$ is the original location of community, and the other region labeled by $i = 2$ is the destination of relocation.
b) A number of households or population in each region in a case without implementation of relocation project is denoted by $N_i, i \in \mathbf{I} = \{1,2\}$.
c) Utility level of a household V_i $i \in \mathbf{I} = \{1,2\}$ is a quasi linear function of income y_i, land rent R_i and residential environment Q_i. The function is then written as $V_i = y_i + v(R_i, Q_i)$.
d) There are two representative absentee landowners each of which owns a volume of land denoted by L_i for $i \in \mathbf{I} = \{1,2\}$.
e) A government which is to implement a relocation project pays subsidy S_R to each relocated household, and also S_L to the landowner of the region $i = 1$ (the origin of relocation). Each locating household has to burden the relocation cost C_R which includes mental or psychological resistance for relocation like a loss of love for a hometown.

2.2 Market clearing conditions for land market

The equilibrium in land market is stated as the following Non-linear Complementarity Problem.

$$(L_i - N_i q(R_i, Q_i)) R_i = 0 \tag{1.a}$$

$$L_i - N_i q(R_i, Q_i) \geq 0 \tag{1.b}$$

$$R_i \geq 0 \qquad \text{for all } i \in \mathbf{I} = \{1,2\} \tag{1.c}$$

where $q(R,Q) = -\dfrac{\partial v(R,Q)}{\partial R}$, which is obtained by Roy's identity (See Varian(1992)).

2.3 Comparison of social surplus between with and without relocation

Cases are labeled by a,b for with and without respectively. Social surplus (SS) in each case is written as,

Without)

$$SS = N_1(y_1^a + v(R_1^a, Q_1^a)) + R_1^a L_1 + N_2(y_2^a + v(R_2^a, Q_2^a)) + R_2^a L_2 \tag{2.a}$$

With)

$$\begin{aligned} SS &= N_1(y_2^b + S_R - C_R + v(R_2^b, Q_2^b)) + R_1^b L_1 + S_L + N_2(y_2^b + v(R_2^b, Q_2^b)) + R_2^b L_2 - N_1 S_R - S_L \\ &= N_1(y_2^b - C_R + v(R_2^b, Q_2^b)) + R_1^b L_1 + N_2(y_2^b + v(R_2^b, Q_2^b)) + R_2^b L_2 \end{aligned} \tag{2.b}$$

3 Social Net Benefit and its Decomposition

3.1 Social Net Benefit as change in social surplus

Social net benefit (SNB) of a project is defined as a difference of social surplus between without-case and the with-case stated in (2.a) and in (2.b) respectively. The SNB is written as,

$$\begin{aligned} SNB = \Delta SS = N_1\{(y_2^b - y_1^a) - C_R + v(R_2^b, Q_2^b) - v(R_1^a, Q_1^a)\} + (R_1^b - R_1^a)L_1 \\ + N_2(y_2^b - y_2^a + v(R_2^b, Q_2^b) - v(R_2^a, Q_2^a)) + (R_2^b - R_2^a)L_2 \end{aligned} \tag{3}$$

3.2 Decomposition of SNB in integral form

The SNB stated in (3) is decomposed into a several items in integral form as,

$$\begin{aligned} SNB = N_1 \int_{y_1^a}^{y_2^b} dy_1 - N_1 C_R + N_1 \oint_{(R_1^a, Q_1^a) \to (R_2^b, Q_2^b)} \left\{ \frac{\partial v(R,Q)}{\partial R} dR + \frac{\partial v(R,Q)}{\partial Q} dQ \right\} + \int_{R_1^a}^{R_1^b} L_1 dR_1 \\ + N_2 \int_{y_2^a}^{y_2^b} dy_2 + N_2 \oint_{(R_2^a, Q_2^a) \to (R_2^b, Q_2^a)} \left\{ \frac{\partial v(R,Q)}{\partial R} dR + \frac{\partial v(R,Q)}{\partial Q} dQ \right\} + \int_{R_2^a}^{R_2^b} L_2 dR_2 \end{aligned} . \tag{4}$$

By dividing the path of line integral into two segments, we can obtain

$$\begin{aligned} &\oint_{(R_1^a, Q_1^a) \to (R_2^b, Q_2^b)} \left\{ \frac{\partial v(R,Q)}{\partial R} dR + \frac{\partial v(R,Q)}{\partial Q} dQ \right\} \\ &= \oint_{(R_1^a, Q_1^a) \to (R_2^a, Q_2^a)} \left\{ \frac{\partial v(R,Q)}{\partial R} dR + \frac{\partial v(R,Q)}{\partial Q} dQ \right\} + \oint_{(R_2^a, Q_2^a) \to (R_2^b, Q_2^b)} \left\{ \frac{\partial v(R,Q)}{\partial R} dR + \frac{\partial v(R,Q)}{\partial Q} dQ \right\} \end{aligned} . \tag{5}$$

Inserting (5) into (4), the SNB is decomposed as,

$$
\begin{aligned}
SNB &= N_1\int_{y_1^a}^{y_2^a} dy_1 + N_1\int_{y_2^a}^{y_2^b} dy_1 - N_1 C_R \\
&+ N_1\left[\oint_{(R_1^a,Q_1^a)\to(R_2^a,Q_2^a)}\left\{\tfrac{\partial v(R,Q)}{\partial R}dR + \tfrac{\partial v(R,Q)}{\partial Q}dQ\right\} + \oint_{(R_2^a,Q_2^a)\to(R_2^b,Q_2^b)}\left\{\tfrac{\partial v(R,Q)}{\partial R}dR + \tfrac{\partial v(R,Q)}{\partial Q}dQ\right\}\right] \\
&+ \int_{R_1^a}^{R_1^b} L_1 dR_1 \\
&+ N_2\int_{y_2^a}^{y_2^b} dy_2 \\
&+ N_2\oint_{(R_2^a,Q_2^a)\to(R_2^b,Q_2^a)}\left\{\tfrac{\partial v(R,Q)}{\partial R}dR + \tfrac{\partial v(R,Q)}{\partial Q}dQ\right\} \\
&+ \int_{R_2^a}^{R_2^b} L_2 dR_2
\end{aligned} \quad . \tag{6}
$$

3.3 Cancel-out of terms

Some terms in the decomposed form may be canceled out with others (Morisugi and Ohno(1992)). We introduce a parameter $\sigma \in [a,b]$ which denotes a point on the path of line integral so that we can examine terms to be canceled out.

Distribution of households is indicated, for without-case and with-case respectively, in what follows.

Without) $N_1(a) = N_1 \quad N_2(a) = N_2$ (7.a)

With) $N_1(b) = 0 \quad N_2(b) = N_1 + N_2 = N$ (7.b)

Social surplus at a point on the path of line integral $\sigma \in [a,b]$ is

$$
\begin{aligned}
SS &= N_1(\sigma)(y_1(\sigma) + v(R_1(\sigma),Q_1(\sigma))) + R_1(\sigma)L_1 \\
&\quad + N_2(\sigma)(y_2(\sigma) + v(R_2(\sigma),Q_2(\sigma))) + R_2(\sigma)L_2 - N_1(\sigma)C_R
\end{aligned} \quad . \tag{8}
$$

The Social Net Benefit is given in the following integral form.

$$
SNB = \int_a^b \frac{d}{d\sigma}\{N_1(\sigma)(y_1(\sigma) + v(R_1(\sigma),Q_1(\sigma))) + R_1(\sigma)L_1 + N_2(\sigma)(y_2(\sigma) + v(R_2(\sigma),Q_2(\sigma))) + R_2(\sigma)L_2 - N_1(\sigma)C_R\}d\sigma \, . \tag{9}
$$

The inside of integral in (9) is

$$
\begin{aligned}
&(y_1(\sigma) + v(R_1(\sigma),Q_1(\sigma)))dN_1(\sigma) + L_1 dR_1(\sigma) + (y_2(\sigma) + v(R_2(\sigma),Q_2(\sigma)))dN_2(\sigma) + L_2 dR_2(\sigma) - C_R dN_1(\sigma) \\
&+ N_1(\sigma)(dy_1(\sigma) + dv(R_1(\sigma),Q_1(\sigma))) + N_2(\sigma)(dy_2(\sigma) + dv(R_2(\sigma),Q_2(\sigma)))
\end{aligned} \, . \tag{10}
$$

The change in number of households in each region is rewritten as,

$$N_1(\sigma) = N_1 - n(\sigma) : dN_1(\sigma) = -dn(\sigma) \tag{11.a}$$

$$\text{and} \quad N_2(\sigma) = N_2 + n(\sigma) : dN_2(\sigma) = dn(\sigma)\,. \tag{11.b}$$

By inserting (11.a) and (11.b) into (10) and arranging some terms, we obtain

$$\begin{aligned}&\{(y_2(\sigma) + v(R_2(\sigma), Q_2(\sigma))) - (y_1(\sigma) + v(R_1(\sigma), Q_1(\sigma)))\}dn(\sigma) + L_1 dR_1(\sigma) + L_2 dR_2(\sigma) - C_R dn(\sigma) \\ &+(N_1 - n(\sigma))((dy_1(\sigma) + dv(R_1(\sigma), Q_1(\sigma))) + (N_2 + n(\sigma))(dy_2(\sigma) + dv(R_2(\sigma), Q_2(\sigma)))\end{aligned}. \tag{12}$$

We assume that a community relocation is carried out at a point on time line $\sigma = \sigma'$. The SNB in (9) is divided into the integrals of $\sigma \in [a, \sigma']$ and $\sigma \in (\sigma', b]$ as,

$$\begin{aligned}&SNB \\ &= \int_{n(a)}^{n(\sigma')} \{(y_2(\sigma) + v(R_2(\sigma), Q_2(\sigma))) - (y_1(\sigma) + v(R_1(\sigma), Q_1(\sigma)))dn(\sigma) + \{(y_2(\sigma') + v(R_2(\sigma'), Q_2(\sigma'))) - (y_1(\sigma') + v(R_1(\sigma'), Q_1(\sigma')))\}N_1 \\ &+\int_{n(\sigma')}^{n(b)} \{(y_2(\sigma) + v(R_2(\sigma), Q_2(\sigma))) - (y_1(\sigma) + v(R_1(\sigma), Q_1(\sigma)))dn(\sigma) \\ &+\int_{R_1(a)}^{R_1(\sigma')} L_1 dR_1 + \int_{R_1(\sigma')}^{R_1(b)} L_1 dR_1 + \int_{R_2(a)}^{R_2(\sigma')} L_2 dR_1 + \int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2 - C_R \int_{n(a)}^{n(\sigma')} dn(\sigma) - C_R N_1 - C_R \int_{n(\sigma')}^{n(b)} dn(\sigma) \\ &+(N_1 - n(\sigma))((dy_1(\sigma) + dv(R_1(\sigma), Q_1(\sigma))) + (N_2 + n(\sigma))(dy_2(\sigma) + dv(R_2(\sigma), Q_2(\sigma)))\end{aligned}. \tag{13}$$

Then changes in (13) are specified as,

$$dn(\sigma) = \begin{cases} N_1 & \text{for } \sigma = \sigma' \\ 0 & \text{otherwise} \end{cases} \tag{14.a}$$

$$dR_1(\sigma) = 0 \quad \sigma \in [a, \sigma') \quad \text{and} \quad R_1(\sigma') = R_1(a) \tag{14.b}$$

$$dR_2(\sigma) = 0 \text{ for } \sigma' \in [a, \sigma') \text{ and } R_2(\sigma') = R_2(a) \tag{14.c}$$

$$dv_1(\sigma) = 0 \text{ for } \sigma' \in [a, \sigma') \text{ and } v_1(\sigma') = v_1(a) \tag{14.d}$$

$$\text{and} \quad dv_2(\sigma) = 0 \text{ for } \sigma' \in [a, \sigma') \text{ and } v_2(\sigma') = v_2(a)\,. \tag{14.e}$$

Finally we obtain the SNB in the following form (See Appendix).

$$\begin{aligned}SNB &= \{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 + L_1(R_1(b) - R_1(a)) - C_R N_1 \\ &+ N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \tfrac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\}\end{aligned} \tag{15}$$

We can interpret terms in the SNB stated in (15).

1) $\{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1$:change in utility of relocating households
2) $L_1(R_1(b) - R_1(a))$: change in land revenue at the origin region of relocation
3) $-C_R N_1$: total relocation cost
4) $N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \tfrac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\}$: change in utility of all households at the destination

The first term 1) is the improvement of quality of life for households in a relocating community if $y_2(a)+v(R_2(a),Q_2(a)) \geq y_1(a)+v(R_1(a),Q_1(a))$. Needs of community relocation in disaster prevention program, marginal area and slum clearance are motivated by the benefit of this term.

In the term 2), we can suppose in general that $R_1(b) \ll R_1(a)$, Then the term is negative. This is a cost of community relocation.

The final term 4) is significant when the size of the community at the destination grows so much after the relocation. If the communities are merged at the destination, the economy of scale or that of scope may function effectively. These merits are reflected in changes in income $y_2(b)-y_2(a)$ and in residential environment $\oint_{\sigma\in[a,b]} \frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\}$.

If the term $v(R,Q)$ is additive separable as $v(R,Q)=v_R(R)+v_Q(Q)$, then the SNB is rewritten as,

$$\begin{aligned} SNB &= \{y_2(a)-y_1(a)+v_R(R_2(a))-v_R(R_1(a))+v_Q(Q_2(b))-v_Q(Q_1(a)))\}N_1 \\ &+ (R_1(b)-R_1(a))L_1 - C_R N_1 + N\{y_2(b)-y_2(a)+v_Q(Q_2(b))-v_Q(Q_2(a))\} \end{aligned}. \tag{16}$$

3.4 Benefit incidence table of community relocation

The process of deriving the social net benefit stated in (15) through cancel-out properties of benefit/cost terms is summarized in the Benefit Incidence Table as shown in Table 1.

(Table 1)

The cancel-out properties of subsidy from the government and land revenue at the destination are indicated in the table.

4 Some Implications for Cases in Practical Benefit Assessment

4.1 Mobility of household

In a without-case, if households in region 1 don't want to relocate to region 2, then we have

$$y_1(a)+v(R_1(a),Q_1(a)) \geq y_2(a)+v(R_2(a),Q_2(a))-C_R. \tag{17}$$

When a relocation cost C_R is significant, the condition in (17) holds even if $y_1(a)+v(R_1(a),Q_1(a)) < y_2(a)+v(R_2(a),Q_2(a))$. Households stay at the origin of relocation where the utility level is lower than the destination.

When a relocation cost C_R is negligible small, in other words, when free mobility can be assumed, then the condition in (17) results in

$$y_1(a) + v(R_1(a), Q_1(a)) = y_2(a) + v(R_2(a), Q_2(a)) \,. \tag{18}$$

The SNB yields to

$$SNB = (R_1(b) - R_1(a))L_1 + N\{y_2(b) - y_2(a) + v_Q(Q_2(b)) - v_Q(Q_2(a))\} \,. \tag{19}$$

4.2 Changes in income and residential environment

The size of a relocating community is so small $N_1 \ll N_2$ that the income and residential environment in region 2 which is the destination of relocation may not change. Then we can assume that

$$y_2(b) = y_2(a) \ \text{ and } \ Q_2(b) = Q_2(a) \,. \tag{20}$$

The conditions in (20) mean that we have

$$y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \frac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma) = 0 \,. \tag{21}$$

The SNB yields to

$$SNB = \{y_2(a) - y_1(a) + v(R_2(a), Q_2(a)) - v(R_1(a), Q_1(a)))\}N_1 + (R_1(b) - R_1(a))L_1 - C_R N_1 \,. \tag{22}$$

4.3 Free Mobility and No Changes in income and residential environment

There may exist a special case that we can assume both free mobility and no changes in income and residential environment at the destination of relocation. That is a combination of the cases discussed in 4.1 and 4.2.

Inserting (21) into (20), we obtain the SNB in the form,

$$SNB = (R_1(b) - R_1(a))L_1 \tag{23}$$

The SNB implies only the change in land revenue at the origin of relocation, which is negative as a item of project cost.

5 Illustrations of Community Relocation with Particular Needs

5.1 Relocation of less mobile households

If households at the origin cannot relocate in the without-out case because of the significant relocation cost C_R, the condition (17) holds. Recalling and arranging it, we obtain

$$0 \geq y_2(a) + v(R_2(a), Q_2(a)) - \{y_1(a) + v(R_1(a), Q_1(a))\} - C_R \, . \tag{24}$$

We can suppose that the change in land revenue at the origin (region 1) $(R_1(b) - R_1(a))L_1$ may be negative in general. Then the SNB stated in (15) is rewritten as,

$$\begin{aligned} SNB = & \underbrace{\{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 - C_R N_1}_{(-)} + \underbrace{L_1(R_1(b) - R_1(a))}_{(-)} \\ & \underbrace{+N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \frac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\}}_{(?)} \end{aligned} \, . \tag{25}$$

The SNB is positive if and only if the second line in (25) is significantly positive. This is a case that a merge of communities by relocation enhances the income level and residential environment including a variety of community activities. However, this item of benefit is rarely supposed to amount sufficiently. A need of community relocation project for a small village at marginal area is hardly justified in this context.

5.2 Community relocation as an effective alternative to public obligation

A public sector usually has to provide any communities with a public service no matter where they are locating. In a case of disaster prevention program, the public sector also has an obligation to protect any communities from disasters like flood, landslide and earthquake. The public obligations are justified from a viewpoint of equity among citizens in a nation or in a society. In this context the public sector must attain the equal level utility between the regions. The cost of a policy which is to be implemented in the origin of relocation for equalization of utility is denoted by C_E. Then the Social Surplus in a case without community relocation is stated as,

$$\text{Without)} \quad SS = N_1(y_1^a + v(R_1^a, Q_1^a)) + R_1^a L_1 + N_2(y_2^a + v(R_2^a, Q_2^a)) + R_2^a L_2 - C_E \tag{26}$$

The SS in a case with relocation is same as (2.b). The Social Net Benefit is hence,

$$SNB = \{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 + L_1(R_1(b) - R_1(a)) - C_R N_1 \\ + N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \frac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\} + C_E \quad . \tag{27}$$

Since we have already discussed the condition of equal utility as (18) in subsection 4.1, $y_1(a) + v(R_1(a), Q_1(a)) = y_2(a) + v(R_2(a), Q_2(a))$, we obtain the SNB in the same manner as we have derived (19),

$$SNB = (R_1(b) - R_1(a))L_1 + N\{y_2(b) - y_2(a) + v_Q(Q_2(b)) - v_Q(Q_2(a))\} - C_R N_1 + C_E \, . \tag{28}$$

Note that the SNB in (28) differs from (19) since it includes the terms $-C_R N_1$ and C_E. They are the relocation cost and the saving of the policy cost alternatively to implement in the case without relocation respectively. If the saving C_E amounts so much, the SNB can be large. The saving may be large when the cost of providing a small village in marginal area with public services is so high. This is also the case that the cost of improving the embankment or the protection wall for disaster prevention is so high.

5.3 Relocation for slum clearance or infrastructure project

A slum clearance may improve the residential environment in an urban area widely, or in other words, may generate the positive externality spilling over the urban area. A large scale infrastructure project itself may generate the large amount of economic benefit. The Social Surplus in a case with relocation is rewritten by modifying the (2.b) as,

With) $SS = N_1(y_2^b - C_R + v(R_2^b, Q_2^b)) + R_1^b L_1 + N_2(y_2^b + v(R_2^b, Q_2^b)) + R_2^b L_2 + B_I$ (29)

where B_I is the benefit of a alum clearance project or a large infrastructure project. The SS in a case without relocation is same as (2.a). Then the Social Net Benefit is

$$SNB = \{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 + L_1(R_1(b) - R_1(a)) - C_R N_1 \\ + N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \frac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\} + B_I \quad . \tag{27}$$

The cost benefit analysis of these projects in practice usually accounts the terms $L_1(R_1(b) - R_1(a))$ and $-C_R N_1$ into project cost but rarely covers $\{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1$ and $N\{y_2(b) - y_2(a) + \oint_{\sigma \in [a,b]} \frac{dv(R_2(\sigma), Q_2(\sigma))}{dQ_2} dQ_2(\sigma)\}$. The latter two terms must be measured and explicitly considered in the practical cost benefit analysis.

6 Concluding Remarks

This paper has proposed the theoretical foundation of cost benefit analysis for community relocation project. Based on the simple spatial economic model, the social net benefit has been derived and decomposed to items of benefit and cost to be measured in practice. The SNB in some particular cases are examined to provide some implications for practical applications.

The practical assessment of each term in the SNB should employ the already established techniques like Contingent Valuation Method (CVM), Hedonic Price Approach and others. We should verify applicability of such techniques in a real case of community relocation project.

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Appendix

$$
\begin{aligned}
&SNB = \\
&\int_{n(a)}^{n(\sigma')} \{(y_2(\sigma) + v(R_2(\sigma), Q_2(\sigma))) - (y_1(\sigma) + v(R_1(\sigma), Q_1(\sigma)))dn(\sigma) \\
&+\{(y_2(\sigma') + v(R_2(\sigma'), Q_2(\sigma'))) - (y_1(\sigma') + v(R_1(\sigma'), Q_1(\sigma')))\}N_1 \\
&+\int_{n(\sigma')}^{n(b)} \{(y_2(\sigma) + v(R_2(\sigma), Q_2(\sigma))) - (y_1(\sigma) + v(R_1(\sigma), Q_1(\sigma)))dn(\sigma) \\
&+\int_{R_1(a)}^{R_1(\sigma')} L_1 dR_1(\sigma) + \int_{R_1(\sigma')}^{R_1(b)} L_1 dR_1(\sigma) + \int_{R_2(a)}^{R_2(\sigma')} L_2 dR_2(\sigma) + \int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma) \\
&-C_R \int_{n(a)}^{n(\sigma')} dn(\sigma) - C_R N_1 - C_R \int_{n(\sigma')}^{n(b)} dn(\sigma) \\
&+\oint_{\sigma\in[a,b]} (N_1 - n(\sigma))((dy_1(\sigma) + dv(R_1(\sigma), Q_1(\sigma))) + (N_2 + n(\sigma))(dy_2(\sigma) + dv(R_2(\sigma), Q_2(\sigma)))
\end{aligned}
$$

$$
\begin{aligned}
&\Rightarrow \\
&\{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 \\
&+\int_{R_1(a)}^{R_1(a)} L_1 dR_1(\sigma) + \int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma) + \int_{R_2(a)}^{R_2(a)} L_2 dR_2(\sigma) + \int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma) \\
&-C_R N_1 + \oint_{\sigma\in[a,b]} (N_1 - n(\sigma))((dy_1(\sigma) + dv(R_1(\sigma), Q_1(\sigma))) + (N_2 + n(\sigma))(dy_2(\sigma) + dv(R_2(\sigma), Q_2(\sigma)))
\end{aligned}
$$

$$
\begin{aligned}
&\Rightarrow \\
&\{(y_2(a) + v(R_2(a), Q_2(a))) - (y_1(a) + v(R_1(a), Q_1(a)))\}N_1 \\
&+\int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma) + \int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma) \\
&-C_R N_1 \\
&+\oint_{\sigma\in[\sigma',b]} (N_1 - n(\sigma))((dy_1(\sigma) + dv(R_1(\sigma), Q_1(\sigma))) + (N_2 + n(\sigma))(dy_2(\sigma) + dv(R_2(\sigma), Q_2(\sigma)))
\end{aligned}
$$

$$\Rightarrow$$

$$\{(y_2(a)+v(R_2(a),Q_2(a)))-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$$
$$+\int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma)+\int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma)$$
$$-C_R N_1+\oint_{\sigma\in[\sigma',b]}(N_2+N_1)(dy_2(\sigma)+dv(R_2(\sigma),Q_2(\sigma)))$$

$$\Rightarrow$$

$$\{(y_2(a)+v(R_2(a),Q_2(a)))-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$$
$$+\int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma)+\int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma)$$
$$-C_R N_1+N\oint_{\sigma\in[\sigma',b]}(dy_2(\sigma)+\tfrac{dv(R_2(\sigma),Q_2(\sigma))}{dR_2}dR_2(\sigma)+\tfrac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma))$$

$$\Rightarrow$$

$$\{(y_2(a)+v(R_2(a),Q_2(a)))-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$$
$$+\int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma)+\int_{R_2(\sigma')}^{R_2(b)} L_2 dR_2(\sigma)$$
$$-C_R N_1+N\oint_{\sigma\in[\sigma',b]}(dy_2(\sigma)-q(R_2(\sigma),Q_2(\sigma))dR_2(\sigma)+\tfrac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma))$$

$$\Rightarrow$$

$$\{(y_2(a)+v(R_2(a),Q_2(a)))-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$$
$$+\int_{R_1(a)}^{R_1(b)} L_1 dR_1(\sigma)+\int_{R_2(\sigma')}^{R_2(b)}\{L_2-Nq(R_2,Q_2)\}dR_2(\sigma)$$
$$-C_R N_1+N\oint_{\sigma\in[\sigma',b]}(dy_2(\sigma)+\tfrac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma))$$

From (1.a),(1.b) and (1.c)

$$L_2-Nq(R_2,Q_2)=0$$

$$\Rightarrow$$

$$\{(y_2(a)+v(R_2(a),Q_2(a)))-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$$
$$+\int_{R_1(a)}^{R_1(b)} L_1 dR_1-C_R N_1+N\oint_{\sigma\in[\sigma',b]}(dy_2(\sigma)+\tfrac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma))$$

Table 1 Benefit Incidence Table of Community Relocation Project

Stakeholder	Region 1		Region 2		Government	Sum.
	Household	Landowner	Household	Landowner		
Utility Change by Relocation	$\{(y_2(a)+v(R_2(a),Q_2(a)))$ $-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$					$\{(y_2(a)+v(R_2(a),Q_2(a)))$ $-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$
Relocation Cost	$-N_1C_R$					$-N_1C_R$
Land revenue change at Origin		$L_1(R_1(b)-R_1(a))$				$L_1(R_1(b)-R_1(a))$
Land revenue Change at Destination			$-\int_{R_2(\sigma')}^{R_2(b)} Nq(R_2,Q_2)dR_2(\sigma)$	$\int_{R_2(a)}^{R_2(b)} L_2dR_2(a)$		0
Subsidy or Compensation for Relocation	N_1S_R				$-N_1S_R$	0
Subsidy or Compensation for Land at Origin		S_L			$-S_L$	0
Utility Change at Destination	$N_1\{y_2(b)-y_2(a)$ $+\oint_{\sigma\in[a,b]}\frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma)\}$		$N_2\{y_2(b)-y_2(a)$ $+\oint_{\sigma\in[a,b]}\frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma)\}$			$N\{y_2(b)-y_2(a)$ $+\oint_{\sigma\in[a,b]}\frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma)\}$
Sum.	$\{(y_2(a)+v(R_2(a),Q_2(a)))$ $-(y_1(a)+v(R_1(a),Q_1(a)))\}N_1$ $-N_1C_R+N_1S_R$ $+N_1\{y_2(b)-y_2(a)$ $+\oint_{\sigma\in[a,b]}\frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma)\}$	$L_1(R_1(b)-R_1(a))+$ S_L	$-\int_{R_2(\sigma')}^{R_2(b)} Nq(R_2,Q_2)dR_2(\sigma)$ $+N_2\{y_2(b)-y_2(a)$ $+\oint_{\sigma\in[a,b]}\frac{dv(R_2(\sigma),Q_2(\sigma))}{dQ_2}dQ_2(\sigma)\}$	$\int_{R_2(a)}^{R_2(b)} L_2dR_2(a)$	$-N_1S_R$ $-S_L$	SNB