# MEASURING BENEFIT INCIDENCE DERIVED FROM GIFU RING ROAD

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## 1. INTRODUCTION

This study aims at measuring the benefit incidence of each socio-economic sector in each zone by using a benefit measurement model as introduced in the following sections, and discussing especially the landowners' share of the total transport benefits. The case study is on the ring road construction in Gifu City, Japan.

## 2. BENEFIT MEASUREMENT METHOD

A benefit measurement model can be derived by considering the market equilibrium conditions on the evolution of new definition for the project benefit. The derivation of the model has been referred to in the paper [Morisugi and Ohno (1990)]. Equation (1) is the measurement model of the social net benefits (SNB) by the project.

$$
\begin{aligned}
SNB = {} & \Sigma_j \Sigma_h \Sigma_O \Sigma_D (N^a_{jh} x^a_{jh,OD} + N^b_{jh} x^b_{jh,OD})(q^a_{h,OD} - q^b_{h,OD})/2 \quad \langle 1 \rangle \\
& + \Sigma_h \Sigma_m \Sigma_O \Sigma_D (M^a_{hm} X^a_{hm,OD} + M^b_{hm} X^b_{hm,OD})(q^a_{h,OD} - q^b_{h,OD})/2 \quad \langle 2 \rangle \\
& + \Sigma_j \Sigma_h (N^a_{jh} a^a_{jh} + N^b_{jh} a^b_{jh})(r^a_j - r^b_j)/2 \quad \langle 3 \rangle \\
& + \Sigma_h \Sigma_m (M^a_{hm} A^a_{hm} + M^b_{hm} A^b_{hm})(R^a_h - R^b_h)/2 \quad \langle 4 \rangle \\
& - (\Sigma_j k_j (r^a_j - r^b_j) + \Sigma_h K_h (R^a_h - R^b_h)) \quad \langle 5 \rangle \\
& + g_T \Sigma_j \Sigma_h \Sigma_O \Sigma_D (N^a_{jh} x^a_{jh,OD} + N^b_{jh} x^b_{jh,OD})(c^a_{OD} - c^b_{OD})/2 \quad \langle 6 \rangle \\
& + g_T \Sigma_h \Sigma_m \Sigma_O \Sigma_D (M^a_{hm} X^a_{hm,OD} + M^b_{hm} X^b_{hm,OD})(c^a_{OD} - c^b_{OD})/2 \quad \langle 7 \rangle \\
& - g_R \{\Sigma_j k_j (r^a_j - r^b_j) + \Sigma_h K_h (R^a_h - R^b_h)\} \quad \langle 8 \rangle \\
& + \Delta G \quad \langle 9 \rangle \\
& - \Delta C \quad \langle 10 \rangle
\end{aligned} \tag{1}
$$

where $N_{jh}$: number of the households, $M_{hm}$: number of the private firms, $x_{jh,OD}$: road service demand of the households, $X_{hm,OD}$: road service demand of the private firms, $a_{jh}$: residential land service demand of the households, $A_{hm}$: industrial land service demand of the private firms, $k_j$: supply of residential land service, $K_h$: supply of industrial land service, $q_{h,OD}$: generalized transport cost ($= c_{OD} + w_h t_{OD}$), $c_{OD}$: gasoline cost, $t_{OD}$: transport time, $w_h$: wage rate, $r_j$: rent of residential land, $R_h$: rent of industrial land, $g_T$: gasoline tax rate (=0.5), $g_R$: property tax rate (=0.142), $G$: tax revenue, $C$: project cost, $^a$ and $^b$: superscription of the case without and with the road project.

The term <1> of equation (1) indicates the road users' benefit of households. <2> is the road users' benefit of private firms, <3> is the land users' benefit of households, <4> is of private firms, <5> is the land producers' benefit of landowners, <6> is the gasoline tax payment of households, <7> is of private firms, <8> is the property tax payment of landowners, <9> is the tax revenue of government, and <10> is the project cost payed by government.

Introducing the benefit incidence matrix shown as table 1 [Morisugi and Ohno (1989)], we make the structure intelligibly between the benefit generation

and incidence calculated by equation (1). The total value of each column is the net benefit or loss of each sector; household, private firm, landowner and government. Each row indicates that of each item; road (users') benefit, land benefit, gasoline tax, property tax and project cost. The grand total of these benefits and losses, namely the SNB, is indicated at the bottom right corner.

## 3. CASE STUDY

The studied region is Gifu Metropolitan area, where the population is 1,171 thousand persons or 336 thousand households, the area is 117 thousand hectares, and the core is Gifu City which has 412 thousand persons or 127 thousand households and 20 thousand hectares, in 1985. The project to be analyzed is the inner-city ring road construction in Gifu City, which is the toll free road, as shown in figure 1. The part with the number <·> in figure 1 are completed by the year <·>, and roads without the number were completed by 1980. The total length of this ring road is 25 kilometers, and the total construction cost is 54.4 billion yen.

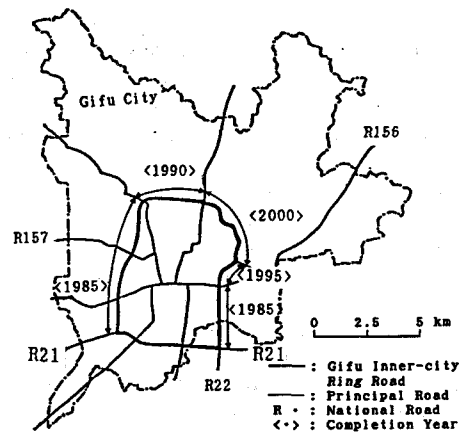


Fig.1 Gifu Ring Road

The table 1 shows that the estimated benefit incidence matrix of the project from 1985 to 2015 for the whole studied region. The project benefits is 56.2 billion yen when we assume that the project life is within this term (1985-2015). Therefore, because the social net benefits is 1.8 billion yen and the benefit cost ratio is 1.03, this project may be efficient. From the viewpoint of equity, however, this project might not be adequate, because there are great differences of the benefit incidence among socio-economic sectors; where the households' benefit incidence is 4.6, the private firms' is 2.1, and the landowners' is 40.2 billion yen. The landowners' share of the total benefits is 83.5%, while 79.8% of the households' benefits and 87.5% of the private firms' are transferred to the landowners'. However the landowners return their gains only 14.3% through the property tax system. Discussions about the benefit incidence in zone level, on the other hand, can not be reffered to because of this small space, but will be in our presentation.

Tab.1 Benefit Incidence Matrix

| ITEM \ SECTOR | | HOUSEHOLD | PRIVARE FIRM | LANDOWNER | GOVERNMENT | TOTAL |
|---|---|---|---|---|---|---|
| ROAD BENEFIT | | 29.7 | 26.5 | | | 56.2 |
| LAND BENEFIT | | -23.7 | -23.2 | 46.9 | | 0 |
| TAX | GASOLINE TAX | -1.4 | -1.2 | | 9.3 | 0 |
| | PROPERTY TAX | | | -6.7 | | |
| PROJECT COST | | | | | -54.4 | -54.4 |
| TOTAL | | 4.6 | 2.1 | 40.2 | -45.1 | 1.8 |

[unit: billion yen]

## REFERENCES

* ***Morisugi,H. and Ohno,E.*** (1989) "A Benefit Incidence Matrix for Urban Transport Improvement", Paper Presented at the 11th PRSCO.

* ***Morisugi,H. and Ohno,E.*** (1990) "Transport Benefit Evaluation with Inter-City Migration - Proposal of a Shortcut Method -", Paper Presented at the 4th ARSC.