SIMULATION ANALYSIS OF CONSTRUCTION COST SUPPORT POLICY ON LAND READJUSTMENT PROJECT AREAS

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ABSTRACT

Speed of urbanization is a key issue in Land Readjustment Projects (LRP). To expedite the pace of construction in project areas, economic measures such as construction cost support might be a very effective policy option. In order to clarify the effect of construction cost support policy, built-up processes in relatively fine spatial resolution must be prospected. In this research, a land-use model considering construction cost variables is applied to two LRPs in the study area, and the effects of cost support on the pace of construction activities are analyzed. In addition, the effects on the surrounding geographical areas of the projects have also been analyzed in terms of land-use change and additional infrastructure requirements.

Keywords: Land-use, Land Readjustment, Construction Cost Support, Urbanization

INTRODUCTION

A Land Readjustment Project (LRP) is considered as a powerful tool for city governments to achieve basically two types of development objectives: one being qualitative improvement of a city’s landscape, and the other being quantitative change to urbanization in accordance with a desired spatial configuration for the city. In the former case, such projects are generally implemented in areas composed of usually irregular-shaped land lots located within historically developed older parts of cities, having their competitive advantages lost due to insufficient or substandard infrastructure provisions existing there. In such cases, LRPs are implemented to provide new infrastructures to enhance the quality of cityscapes and to enhance the attractiveness and competitive power. In the later case, LRPs are generally implemented in locations composed of large-scale pre-urbanized private properties which might experience urban expansion in future, and are used to prepare land required for the construction of basic infrastructure. In both cases, the LRP finances the construction cost by selling the reserved land acquired from the sacrifice of land by each individual landowner in the project area. Land owners sacrifice some amount of land to meet the project cost, but they would do so while anticipating the future increase in their overall property value with the introduction of new infrastructure in the project area, which would make the location more attractive to new businesses.

City government usually gives financial support for construction of new infrastructure on land prepared by an LRP. In the project area, generally all buildings are demolished at the beginning of the project. So, if after construction of necessary infrastructure the project area remains vacant for a long time, it may lose its attractiveness and, as a result, expected increases in land values will never be realized, causing financial loss to land-owners. As far as the city government is concerned, it might find such a project is not able to generate desired land-use in the project area and the effects on the surroundings cannot be realized.

To facilitate timely construction activities and also to expedite the pace of construction in a project area, which has important implications on the development of areas surrounding the project areas, an effective strategy is, therefore, of utmost importance. If financial reasons are considered as the main inertia that prohibits construction activity in project areas, then economic measures such as construction cost support might be a very effective policy option to remove such inertia and to expedite construction activity in the areas. In order to clarify the effect of construction cost support policies, building up a mechanism in a relatively fine resolution must be prospected.

In this research, a land-use model considering construction cost variables is applied in two LRPs in the study area; effects of cost support on the pace of construction activity are analyzed. Moreover, the effects on the surrounding areas of the projects have also been analyzed in terms of land-use change and additional infrastructure requirements, and a reasonable explanation of cost support from the city government in the LRP area has been proposed.

RELATED RESEARCH

In an LRP, the speed of urbanization is considered as a key issue in determining the success or failure of the project [1]. Nishi discussed several ideas to expedite construction activity in project areas [2], but these were technical measures considered in the design process, and financial support for construction costs was out of his scope.

In order to describe the temporal change of urbanization, growth curves are fitted to the overall urbanization rate defined as the proportion of built-up land-lots in each project area [3]. A comparison between the curves for different project areas reveals that urbanization occurs faster in individual landowner projects than in cooperative ones, near downtown areas in contrast to in suburbs, with residential zoning rather than other zoning, and with penetration of trunk roads rather than without them [4]. Once seeing the built-up patterns on each land-lot in an LRP area, it is clear that built-up speed is very different according to the former ownership, as well as the distance from the reserved land, which usually supplies commercial functions in the project area [5].

To describe such a difference of built-up speed owing to the geographic conditions for each land-lot, an urban model with finer resolution rather than a macro-growth curve model is needed. With the progress of GIS techniques and improved availability of detailed geographic data, cellular automata models have been proposed, but such models possess neither a theoretical nor empirical background for land-use transition rules [6]. Recently, behavior-based random bid-rent models with fine spatial resolution have been developed[7,8]. In the present study, to assess the impact of cost support policy, one of those models [8] has been improved to endogenously determine the inertia effects due to former land use. Osaragi and Kurisaki showed the effect of land use change costs in a logit bid-rent model, but they used exogenously-given values for those costs [9]. As it is very difficult to obtain cost information at lot level due to the very private nature of such data, cost variables have been made endogenous in the present model formulation.

THE STUDY AREA

Two LRP areas, one in front of Saijo JR Station (Project Area 1) and one in front of Higashi-Hiroshima Shinkansen Station (Project Area 2) of Higashi-Hiroshima City were selected to assess the effect of cost support policies on the change of land use. Project Area 1 is comprised of eight 100 m meshes, is located in a historically developed city core, and is surrounded by already developed built-up meshes. Project Area 2 is comprised of forty-four 100 m meshes (three are planned as public park land) and is located in a relatively vacant location in the southeastern part of the city, as shown in **Fig. 1**.

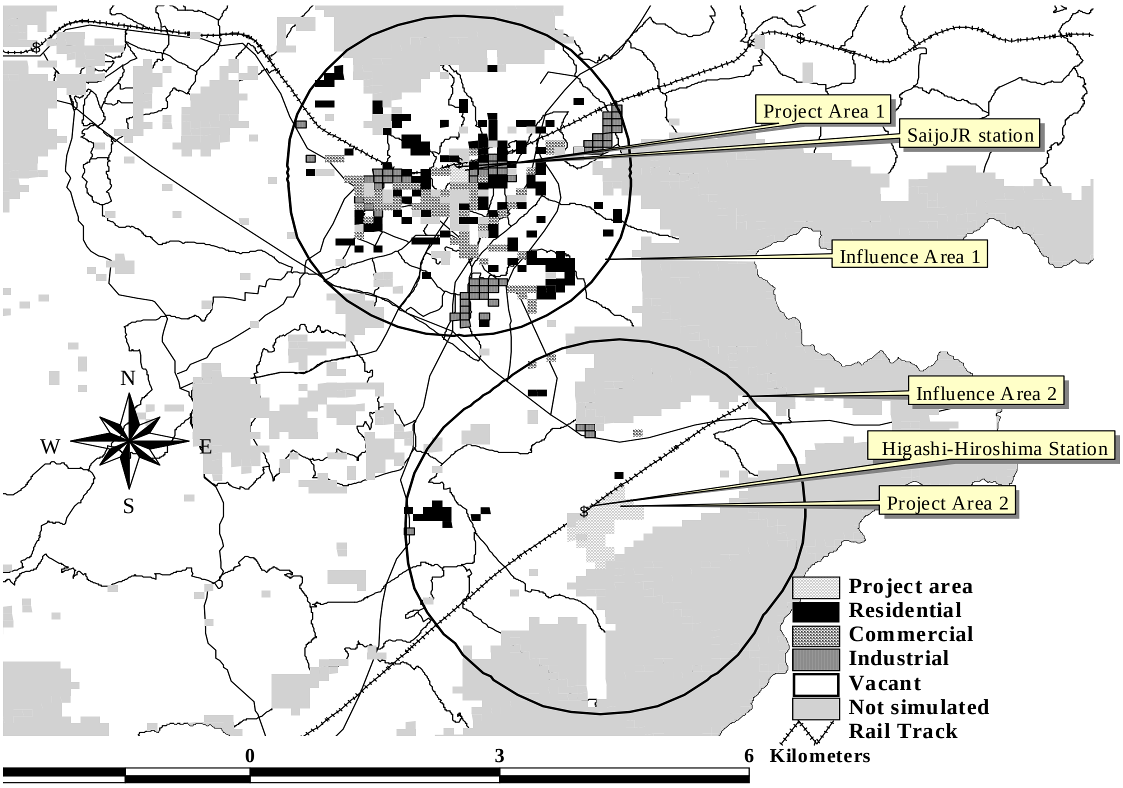

Fig. 1 Location of land readjustment projects in the study area.

LAND USE MODEL

Our model is based on random bid-rent theory, which provides a consistent economic basis to evaluate discrete choices among various land uses under economic policy interventions. The formation of an urban land use pattern is considered as the result of individual land owner's choices in each individual small land lot. Considering each individual land lot's characteristics in terms of its topographic condition, planning restrictions, accessibility, and neighborhood's land-use, a potential future land-user makes his/her assessment about expected future profits if he/she buys the lot for the intended use and expresses it as bid-rent. In this regard, cost, required to use a particular land lot for a future intended use, if different from its existing use, is an important consideration, but it is very difficult to obtain private data for such costs. We include land use change costs which are indirectly estimated based on published land price information such as *Roadside Price*. A brief description of the model can be found in **Fig. 2**. **Table 1** shows the parameter estimates and t-values based on land-use data in 2000 for the 3,067 meshes sampled out of 12,259, considering the effects from surrounding land use in 1990 described through the number of meshes of each type of land use inside the 500 m buffer from each mesh; many of them have expected signs and are statistically significant. A likelihood ratio and a hit rate suggest sufficiently high reproductive power of the model.

$$U_{nj} = V_{nj} + (1-\delta_{kj})(d_k + c_j) + \varepsilon_{nj}, \qquad (1)$$

where, U_{nj} is the expressed bid-rent of land-user j for lot n,

V_{nj} is the average bid-rent, of land-user j for lot n described as function of land characteristics,

d_k is the effect from former land use type k (negative for demolition cost), $d_k = 0$ if former land use k is vacant,

c_j is the effect of intended future land use type j (usually negative because it means construction cost), $c_j = 0$ if future use j is vacant,

δ_{kj} is a dummy variable which takes 1 if $k=j$, else 0.

$$P_n(j) = \frac{\exp(V_{nj} + (1-\delta_{kj})(d_k + c_j))}{\sum_{i \in J_n} \exp(V_{ni} + (1-\delta_{ki})(d_k + c_i))}, \qquad (2)$$

where, $P_n(j)$ is the probability that any land lot n is sold to the jth user in the set of possible land-users J_n.

A likelihood function based on the observed land use as well as observed land price is given by:

$$L' = \sum_n \left[\sum_j \zeta_{nj} \ln P_n(j) + b\rho_n \ln \Phi[LP_n - (\max_j V_{nj} + \sum_a \theta_a \varphi_{na})] \right], \qquad (3)$$

where, ζ_{nj} is a dummy variable for land-use type j at land lot n,

b is relative weight defined as total sample number / number of price observations,

ρ_n is a dummy variable for roadside price observation in each land lot n,

$\Phi[]$ is a normal distribution probability function with zero mean and variance of σ^2,

LP_n is roadside price of land lot n,

θ_a is regional parameter for land price,

φ_{na} is a dummy variable showing whether land lot n is included in sub-region a.

Fig. 2 Random bid-rent model used for land-use assessment.

Table 1 Parameter estimates of the land-use model.

Parameters of Bid-rent functions (D):dummy variable	Industrial Use		Commercial Use		Residential Use		Vacant	
	estimates	t-value	estimates	t-value	estimates	t-value	estimates	t-value
Inverse distance to JR station	-927	-3.12*	414.3	3.78*	258.3	2.61*	-	-
Inverse distance to major road	-	-	5.35	3.06*	4.54	2.74*	-	-
Public use meshes in 500 m buffer	2.25	8.76*	2.25	8.31*	2.22	8.19*	2.25	8.32*
Commercial meshes in 500 m buffer	2.69	18.5*	2.63	18.3*	2.63	18.4*	2.64	18.3*
Residential meshes in 500 m buffer.	0.35	2.82*	0.45	3.65*	0.46	3.73*	0.41	3.28*
Industrial meshes in 500 m buffer.	-1.23	-9.63*	-1.32	-10.3*	-1.39	-10.9*	-1.41	-11.0*
Proximity to Disaster Prone Area (D)	-	-	-	-	0.62	3.78*	-	-
Permitted use in zoning (D)	2.77	9.65*	2.22	10.5*	0.97	6.07*	-	-
Designated as Urbanized Area (D)	-	-	-	-	-	-	-0.92	-4.9*
Constant	1.43	3.52*	5.27	3.32*	1.69	6.42*	-	-
Parameters for land use change	estimates	t-value	estimates	t-value	estimates	t-value	estimates	t-value
Effect of predicted future use	-3.71	-9.43*	-7.80	-4.9*	-2.64	-10.1*	-	-
Effect of former use	-0.03	-11.8*	6.04	3.81*	1.48	4.61*	-	-
Land price observation parameters	estimates	t-value	Land price observation parameters				estimates	t-value
Around Saijo Station (D)	59.32	17.6*	Land Adjusted Project area(D)				91.01	70.2*
Around City Office (D)	84.52	26.8*	Jike Area(D)				86.52	35.6*
Doyomaru Area (D)	78.63	24.9*	Misonou Area (D)				53.07	24.0*
Variance	2.16x10^{-3}		（37.96*）					

Initial likelihood	-29924	Likelihood ratio	0.5	Sample size	3057
Final likelihood	-15017	Hit rate	66%		

(D): dummy variable, *:1 % level of significance,
Unit of the parameters: 10^3yen/m^2 (besides variance)

SIMULATION

Case Setting

Land-use changes among four categories — industrial, residential, commercial and vacant —were observed in both the project areas and their surroundings, identified as influence areas in **Fig. 1**. Influence areas have been considered as the meshes lower than 260 m altitude within a 2 km buffer of the project areas, excluding the meshes in project areas. In total, Influence Area 1 was comprised of 1,111 meshes, while Influence Area 2 contained 927 meshes. LRP is modeled in the following way. Initially, all eight meshes in Project Area 1 and 41 non-public meshes out of 44 meshes in Project Area 2 are considered vacant. Next, construction cost in the project area is set higher than that of other places, assuming that the price of reserved land is usually higher than the price before the project is taken up, and that former land owners accept burdens. Then, 10% of the average bid-rent values are added in simulations. Three scenarios were considered, i.e., without any support, with flat rate support of average construction cost (5,221 yen/m^2) of residential and commercial uses permitted in the LRP areas, and with exclusive flat rate support for one particular land use category.

Effects in the Project Areas

In Project Area 1, two meshes out of eight become developed as commercial if no support is provided, though the project area is located in a potentially attractive commercial location within the city core. Industrial development in the project area is prohibited by planning regulations. To make all eight meshes commercial, either support of 67% of the average construction cost (5,221 yen/m^2) for residential and commercial categories or that of 45% of the estimated commercial construction cost (7,799 yen/m^2) would be required. The differences between residential and vacant bid-rents (2,800 yen/m^2) were found to be higher than estimated residential construction costs (2,637 yen/m^2), suggesting that there is no possibility of residential development in Project Area 1 even if 100% support of residential construction cost is provided. Residential development in such a case would require an exclusive zoning regulation for residential use or exclusive cost support for residential use.

In Project Area 2, out of 41 simulated meshes, only one becomes developed as residential if no support is provided. Industrial use is also prohibited in Project Area 2, where there is an exclusive residential zone comprised of 18 meshes, and where commercial use is prohibited by planning regulations. If 10% of the average construction cost is provided, all 41 meshes become residential. In this area, exclusive support is needed to develop commercial land-use.

Table 2 Effect in Influence Area 1 for cost support in Project Area 1.

Policy	Effect on Project Area	Effect within 2 km from Project Area excluding Project Area					
		Public	Industrial	Commercial	Residential	Vacant	Total
Without support	2 Commercial, 6 Vacant	22	83	112	387	507	1111
With support	8 Commercial	22	84	111	387	507	1111

(All values are in number of meshes)

Table 3 Effect in Influence Area 2 for cost support in Project Area 2.

Policy	Effect on Project Area	Effect within 2 km from Project Area excluding Project Area					
		Public	Industrial	Commercial	Residential	Vacant	Total
Without support	3 Public, 41 Vacant	18	3	4	87	815	927
With support	3 Public, 41 Residential	18	3	4	110	792	927

Effects in the Surroundings of Project Areas

Table 2 shows the effect of cost support in the neighboring regions of Project Area 1. It can be observed from **Table 2** that one commercial mesh became industrial, but no other changes occurred due to support in Project Area 1. This suggests that with the concentration of commercial land-use in Project Area 1, one mesh in Influence Area 1 lost its commercial importance. That mesh, instead, gained importance for industrial use by taking advantage of commercial concentration of the Project Area 1. No changes in the number of vacant meshes suggests that the influence of cost support in the projects, taken within a built-up city core does not result in quantitative increases or decreases in overall built-up areas, but rather qualitative changes occur which the present model cannot determine.

Table 3 shows the effect of cost support in the surrounding regions of Project Area 2. An increase in residential meshes and a decrease in vacant meshes in Influence Area 2 are observed with cost support option, suggesting a quantitative increase in residential land-use in the surrounding regions if cost support is provided in the project area in the outskirts of the city.

From **Fig. 3** it can also be observed that new development takes place in the vicinity of the project area. As a proxy of required expansion of line infrastructure, average distance from the existing built-up areas (considering the base case of 1990) to predicted newly built-up areas, when no support was provided, was found to be 117 m compared to 193 m when supports were provided. The increase in this distance is mainly due to the development of new residential meshes within the vacant core of existing built-up meshes. However, the average distance of built-up meshes from Higashi-Hiroshima Station was found to be 1.33 km if cost support is provided to Project Area 2, compared to 1.66 km if no support is provided. So, it can be concluded that a more concentrated spatial form, which is desirable to minimize the additional cost of providing urban infrastructures such as electricity lines and sewerage lines, is expected if cost support is provided to this type of LRP on a city fringe. This is considered as one reason to support cost assistance policies from city governments to LRPs.

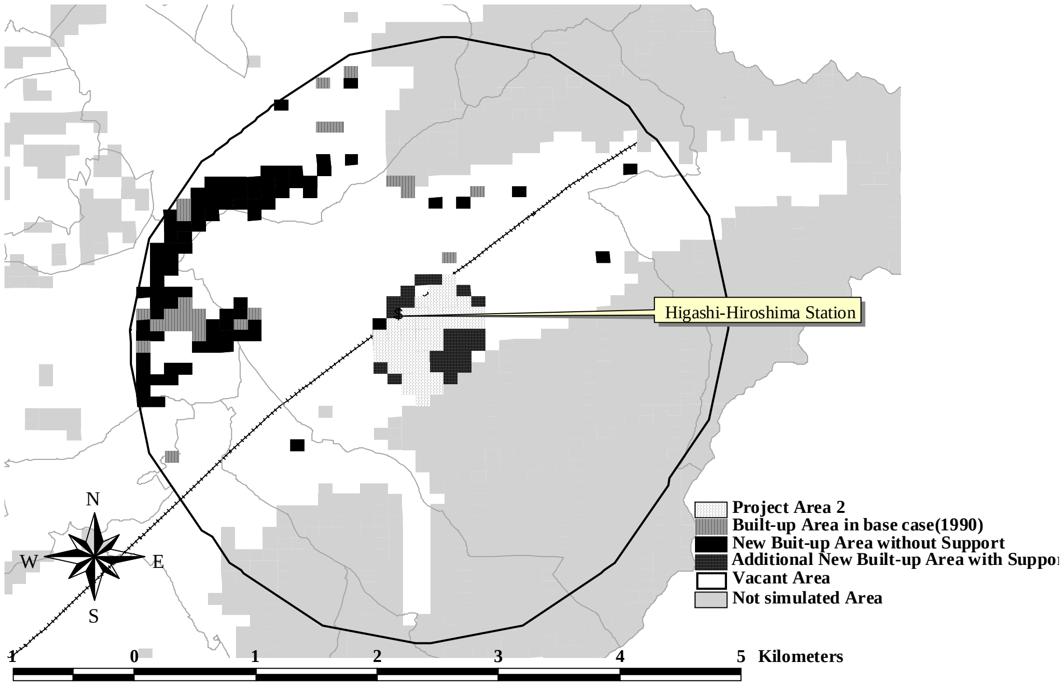

Fig. 3 Effect in Influence Area 2 with and without cost support in Project Area 2.

CONCLUSIONS

In this research it has been substantiated that policy measures such as cost support for LRPs have considerable effects both in the project areas and surrounding regions. However, the model that has been used in this research only deals with a situation where the generation of an urban spatial pattern is considered as an unconstrained process and is a result of spatial interactions between changes in land lot levels. But the reality is considerably different. Many processes and constraints at the macro-level play roles in shaping a city’s spatial pattern. Furthermore, in the model, due to the unavailability of data in finer temporal resolution, the time frame considered was 10 years, which is too long to consider the effect of cost components in the model.

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