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Author(s)	Inoue, Gen; Yamamura, Etsuo; Higano, Yoshiro
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A Study the Optimal Redevelopment of Sapporo City

Gen Inoue
Department of System Information, The Graduate School of Engineering,
Toyohashi University of Technology, Toyohashi 440, Japan
Etsuo Yamamura
Department of Regional Planning, Division of Environmental Science,
Graduate School of Environmental Science, Hokkaido University
060 Sapporo, Japan
Yoshiro Higano
Department of Knowledge Information, The Graduate School of Engineering,
Toyohashi University of Technology, Toyohashi 440, Japan

Abstract

The study examines the scale and agglomeration economies partaing to the future growth of Sapporo city by applying an optimal redevelopment model to the salient development activities taking place within the city environs. First, we show the structure of the model and then go on to simulate the stock and formations of these development activities within the city. We especially analyze issues concerned with housing stock, capital formation, working dwellers and the transport infrastructure.

The results of this simulation indicate a desirable growth pattern for Sapporo city within this fifteen years simulation period.

Key words : Scale and agglomeration Redevelopment Optimal redevelopment model Simulation Housing stock Capital formation Working dwellers Transport infrastructure

1. Introduction

Sapporo city is the capital of Hokkaido and urban plan in this city was based on the lattice street system. This city founded in 1869 has continued to grow every year, and nowadays constitutes the largest city north of Tokyo. This rapid growth resulted in serious noise and traffic congestion problems similar to those in Tokyo. Now, to cope up with the problem the purpose of this paper is to analyze the transition of the central district in this city. In this paper, we present the simulation analysis of agglomeraion and scale economies in this city by the application of the analytical method for the optimal redevelopment Tokyo Metropolitan Area (Y.Higano)

2. Optimal Redevelopment Model

We introduce the analytical method for the optimal redevelopment of Tokyo Metropolitan Area (Y. Higano, 1986)

In the model, the scale and agglomeration economies describe more precisely to firms

in the same or different industries.

We assume that the production technology is as follows.

(i=1, 2, 3, .., ni, j=1, 2, 3, ..., ni ; ni can be infinity)

$$Y\ ih \leq RCOi\ K\ ih \tag{1}$$

$$Y\ ih \leq RLOi\ L\ ih \tag{2}$$

where

Y ih ; output of the h-th firm in the i−th industry

K ih ; capital stock available in the h-th firm in the i-th industry

L ih ; labour available in the h-th firm in the i-th industry

RCO i ; reciprocal of the capital-output ratio of the i-th industry.

RLO i ; reciprocal of the labour-output ratio of the i-th industry.

The production technology of the firms is linear and is common among firms. Then we define that the reciprocal of the capital-output ratio in the i-th industry is RCO i and the reciprocal of the labour − output ratio of the i-th industry is RLO i.

Here, note that RCO i and RLO i are given parameters for individual firms. When the city is bigger by aggregation, the production technology of the i-th industry will be obtained. (i=1, 2, ..., n)

$$YS\ ih \leq RCO\ i\ KS\ ih \tag{3}$$

$$YS\ ih \leq RLO\ i\ LS\ ih \tag{4}$$

where

$YS\ ih = \sum_{k=1}^{ni} Y\ ih$: output of the i-th industry

$KS\ ih = \sum_{k=1}^{ni} K\ ih$: capital stock available in the h-th firm in the i-th industry.

$LS\ ih = \sum_{k=1}^{ni} L\ ih$: labour available in the h-th firm in the i-th industry.

Furthermore, we assume that;

$$RCO\ i = FC\ i(k1, k2, k3, ..., kn) \tag{5}$$

$$RLO\ i = FL\ i(k1, k2, k3, ..., kn) \tag{6}$$

Where FC i and FL i are positive valued function. Therefore, FC i and FL i are variables dependent upon the amount of the industrial capital stock. This can be consistent with the assumption that RCO i and RLO i are given for individual firms.

The assumption that the influence of each participant is zero, is possible only when the number of participants is infinity. In other words, we assume that,

$$\frac{\partial Ki}{\partial k\ ih} = 0 \qquad \text{for all i and h} \tag{7}$$

Formally, we shall define that the scale and agglomeration economies is

$$FC_h^i = \frac{\partial FC\ i}{\partial Kh}$$

$$FL_h^i = \frac{\partial FL\ i}{\partial Kh}$$

〖 SCALE ECONOMIES 〗

If $FC_h^i > 0$ or $FL_h^i > 0$, $(i \neq h)$ then in the production technology of the i-th industry, there exist scale merits of the type of marshallian external economies which is external to the individual firm in the industry and shows themselves only in changes of the organization of the industry as a whole we shall call such scale merits.

〖 AGGLOMERATION ECONOMIES 〗

If $FC_h^i > 0$ or $FL_h^i > 0$, $(i \neq h)$, then in the production technology of the industrial complex, there exist agglomeration merits that is marshallian external economies which is external to the individual firm in the industry. It shows themselves only in changes of the organization of the industry as a whole. One advantage to the firm is a large and skilled labour pool available to each firm in an area in which the industry is concentrated. We shall call such agglomeration merits.

In addition, let us define there types of the scale and agglomeration economies. For KB= (KB1, KB2, ..., KBn), and KA= (KA1, KA2,... KAn), such that KB ≠ KA, and for FCB i, FCA i, FLB i, and FLA i such that FCB i = FC i(KB), FLB i= FL i(KB), FCA i= FC i(KA) and FLA i = FL i(KA).

〖 RELATIVE CAPITAL AUGMENT (RCA) 〗

If the inequalities of FCB i < FCA i and FLB i < FLA i imply that $\frac{FCB}{FLB} < \frac{FCA}{FLB}$, then there exist relative capital augmenting scale agglomeration economies in the change KB to KA.

〖 RELATIVE LABOUR AUGMENT (RLA) 〗

If the inequalities of FCB i < FCA i and FLB i < FLA i imply that $\frac{FCB}{FLB} > \frac{FCA}{FLB}$, then there exist relative capital augmenting scale agglomeration economies in the change KB to KA.

〖 NEUTRAL (NEU) 〗

If the inequalities of FCB i < FCA i and FLB i < FLA i imply that $\frac{FCB}{FLB} = \frac{FCA}{FLB}$, then there exist relative capital augmenting scale agglomeration economies in the change KB to KA.

Let us specify the structure of the model. This model is a non linear dynamic urban model. We can illustrate this as follows;

$$\max \sum_{t=1}^{T}(1+SD)^{-t}\{UC1\ F1(t)+UC2\ F2(t)\} \tag{8}$$

s.t.

$$\begin{vmatrix} X1(t) \\ X2(t) \end{vmatrix} = \begin{vmatrix} A11 & A12 \\ A21 & A22 \end{vmatrix} \begin{vmatrix} X1(t) \\ X2(t) \end{vmatrix} + \begin{vmatrix} B11 & B12 \\ B21 & B22 \end{vmatrix} \begin{vmatrix} K1(t) \\ K2(t) \end{vmatrix} + \begin{vmatrix} C1(t) \\ C2(t) \end{vmatrix} \tag{9}$$

$$(t=0,1,2,3,\cdots\cdots,T)$$

$$\begin{vmatrix} X1(t) \\ X2(t) \end{vmatrix} = \begin{vmatrix} RCO^t1 & K1(t) \\ RCO^t2 & K2(t) \end{vmatrix} \qquad (t=0,1,2,3,\cdots\cdots,T) \tag{10}$$

$$\begin{vmatrix} K1(t) \\ K2(t) \end{vmatrix} = \begin{vmatrix} K1(t-1)+\Delta K1(t) \\ K2(t-1)+\Delta K2(t) \end{vmatrix} \qquad (t=0,1,2,3,\cdots\cdots,T) \tag{11}$$

and

$$\begin{vmatrix} K1(0) \\ K2(0) \end{vmatrix} = \begin{vmatrix} K1^{\theta} \\ K2^{\theta} \end{vmatrix} \tag{12}$$

Where

T = time horizon
Xi(t) = output of industry(i) at T(i=1, 2; t=0, 1, 2...T)
Ki(t) = capital stock of the industry (i) at T (i=1, 2, ; t=0, 1, 2, ..., T)
Ci(t) = consumption of the commodity (i) − products of the industry (i)
ki(t) = capital formation of the industry (i) at T (i=1, 2, ; t=0, 1, 2, ..., T)
SD = social discount rate
UC i = consumption utility of the commodity (i) (i=1,2)
A ij = input coefficient matrix of the Leontief type
B ij = capital formation matrix
RCO i = reciprocal of the capital output ratio of the industry (i) at T(i=1, 2 ; t=0, 1, 2, ..., T)
K i = initial capital stock of the industry (i) (i=1, 2)

Our objective is to maximize the sum of the utility of commodity consumption over the time. These equations mean several socio econometric systems. Equation (9) means that

(output) = (intermediate demand) + (capital formation demand) + (consumption)

Equation (10) means that

(demand for capital) = (capital supply)

Equation (11) means that

(capital supply at the next period) = (capital stock at this period) + (capital formation at this period)

The capital is specified by each industry and cannot be diverted to the other industry . One unit capital formation of the industry (i) requires B1i unit of the commodity 1 and B2i unit of the commodity 2.

This specification of capital and its formation has advantages in the analysis of large urban areas. As capital occupies land and because of land scarcity, the capital formation of an industry in an area which the industry is most efficient will induce capital demolition of the industries which are less efficient in that area. Most of actual urban redevelopment, which represents capital demolition in the model, is based on that of the basic model.

In the model, the commodity flow for production purposes is distinguished from that for consumption. By this distinction , both the ware house and commercial industries can be effectively built into the model. The commodity flow into production purposes can come from factories or warehouses or retail outlets through the trade between the households

and retailers. This trade induces shopping.

Such distinction is at least required for the analysis of the optimal reorganization of transport system in the large urban area in which the pattern of commodity flow is very complex.

The working dwellers is the measuring unit for the labour. The labor grows by natural and social factors. The natural growth of the labour at the periods, is an increase of the labour supply at the period $t+1$. That is proportional to the working dweller at the period t. The social growth of the labour is represented by migration from other regions and interindustrial movements.

The industrial capital stock, housing stock and transportation infrastructures occupy portions of the land. It is used for production which requires land input and for open space. The amount of the land supply in each zone is fixed over time. New demand for land are met through demolition of the industrial capital stock and housing stock, reduction of the production which requires land inputs, and reduction of the open space at the cost of disutility. The house in the zone (i) occupies one unit of housing stock in the zone, and supplies some units of working dwellers.

In this model, the housing type is classified into six based on housing structures and the residential environment. The types are defined as follows ;

HOUSE 1: A SINGLE FAMILY HOUSE A (WITH SUNSHINE OVER THREE HOURS)
HOUSE 2: A SINGLE FAMILY HOUSE B (WITH SUNSHINE WITHIN THREE HOURS)
HOUSE 3: APARTMENT OF MULTI BUILDINGS WITH A GREEN TRACT OF LAND (WITH SUNSHINE OVER THREE HOURS)
HOUSE 4: APARTMENT OF MULTI BUILDINGS WITH A GREEN TRACT OF LAND (WITH SUNSHINE WITHIN THREE HOURS)
HOUSE 5: A SINGLE APARTMENT HOUSE WITH OFFICES OF A SINGLE BUILDING AND WITH GREEN (WITH SUNSHINE OVER THREE HOURS)
HOUSE 6: A SINGLE APARTMENT HOUSE WITH OFFICES OF A SINGLE BUILDING AND WITH GREEN (WITH SUNSHINE WITHIN THREE HOURS)

They represent policy variable units of the large scale comprehensive urban renewal. This comprehensive urban venture jointly supplies industrial capital for building. That will promote efficient utilization of the land to enhance agglomeration in CBD and will make residence close to places of work thereby reducing commuting time.

The process of solution algorithm of the linear programming model can not be directly incorporated into this model. But we will utilize a merit of the algorithm applicable to the large scale model through its iterative application to the solution to the series of the linear models whose solutions gradually approximate to the solution of this model. Nonlinear equations occasionally occur indirectly from a problem in the calculus of variations. We illustrate the iterative solution algorithm for this model. The object for this model is maximizing social utilities.

Note that the function of RCO (i) represents a specific case that h(MS, JK)=1 and h(AS, JK)=0. This function implies that each industry will enjoy an increase in the productive efficiency of the capital stock as it accumulates.

$$RCO\ i \mid Ki\ (t) \mid = Ki/\ [1+EXP.\ \{\lambda i * K\ i(i)\}]$$
$$(Ki>0,\ \lambda i<0,\ i=1,2)$$

First step, in other words initializing, we define the value of the initial capital stock and all the parameters other than RCO i(ti) (t=0, 1, 2, ..., T : i=1, 2 : and all of them other than RCO (ti) are constant of the iteration) In the second step : solution to basic model. Then

$$RCO\ (ti) = RCO\ (i)\ [K\ (0,i)] \quad (t=0,\ 1,\ 2,\ ...\ T)$$

In the third step : solutions are obtained for the basic model. In this solutions, RCO (ti) (t=0, 1, 2, ...T) are changed for each period. Set n=1, (parameter 'n' is an iteration counter) go to the step n.

We introduce the notation that K (t, n−1, i) = the solution for the capital stock, Ki(t) (i=1, 2), at the step (n−1) (t=0, 1, 2, ..T) and RCO (RCO , n, i)= RCO i(k, n−1, i) (i=1, 2 : t=0, 1, 2, ..T).

If RCO (t, n−1, i) = RCO (t, n, i) for all t (t=0, 1, 2, ..T) then stop the iteration. The iteration is stopped as the error is less than 0.01(1%) for all t. Changes in the percentage of the increase in the value of the objective function show that series of the solutions rapidly converge to the solution.

3. Sapporo Model

Consider only two adjacent properties at the time. Part of the whole rights purchased by each owner may be the external economy, external diseconomy, or has neutral effect with respect to the adjacent property. Since rights purchased go into the future, the whole rights purchased include not only the present externalities but also some other future externalities.

The purpose of zoning ordinances has been to prevent wide fluctuating externalities. These diseconomies are supposed to be abundant in the urban property market. The zone 1 is CBD (chuo-ku) and the zone 2 is the rest of the Sapporo city. It is assumed that the commodity flow into the city of Sapporo from the other region of Japan always goes through the zone 2.

There are 11 sectors of industries and are described as follows.

INDUSTRY 1 : THE PRIMARY INDUSTRIES
INDUSTRY 2 : THE MANUFACTURING INDUSTRIES
INDUSTRY 3 : THE OTHER SERVICES INDUSTRIES
INDUSTRY 4 : THE HEADQUARTERS INDUSTRIES
INDUSTRY 5 : THE WHOLESALE INDUSTRIES
INDUSTRY 6 : THE RETAIL INDUSTRIES
INDUSTRY 7 : THE WAREHOUSE INDUSTRIES
INDUSTRY 8 : THE BUS TRANSPORT INDUSTRIES
INDUSTRY 9 : THE TAXI TRANSPORT INDUSTRIES

INDUSTRY 10 : THE RAILWAY TRANSPORT INDUSTRIES
INDUSTRY 11 : THE TRUCK TRANSPORTATION INDUSTRIES

There are six types of capital commodity.

COMMODITY 1 : BUILDING
COMMODITY 2 : MACHINE
COMMODITY 3 : BUS
COMMODITY 4 : TAXI
COMMODITY 5 : RAILWAY
COMMODITY 6 : TRUCK

The commodity 1 constitutes the capital stock of all other industries except the industry 1. The commodity 2 constitutes the capital stock of industries 1,2.

The object to be maximized is the sum of the utilities which depend upon ; the surplus consumption, the housing service level, the amount of the open space, the amount of the inter-industrial migration, the comfortability of commuting and shopping.

The consumption estimates are for the minimum permissible level.

The validity of this model is indicated by the convergence of the output capital and labour ratio RCO (IS,JK), RLO (I,K). As the parameters for scale and agglomeration are set for logistic curve, it is sufficient to show that the convergence of the output capital ratio converges for only one capital commodity of one capital structure. The convergence error is set for 0.05.

The solution algorithm for the nonlinearity of this model is effective only when the optimal solution is obtained by four or five iteration.

In this model, the simulation is carried out for five cases. The cases are sets of the variation in the social discount rate and in the type of the scale and agglomeration economy. The social discount rate is the key parameter to compare the welfare in future with that of the present.

The rate varies from 0.04 to 0.08 by 0.02. The types of the scale and agglomeration economies are those defined in chapter 2. We define that RLA is saved more than capital by reasons attributed to scale and agglomeration economies, and that RCA is also saved more than labour by the same reasons i.e. scale and agglomeration economies. It is assumed that the efficiency in the labour input saving is higher than that of the capital by 5% in the case of RLA. Here, we define the six cases as follows:

CASE 1 (NTL) : NATURAL SOCIAL DISCOUNT RATE : SD = 0.04
CASE 2 (NTL) : NATURAL SOCIAL DISCOUNT RATE : SD = 0.06
CASE 3 (NTL) : NATURAL SOCIAL DISCOUNT RATE : SD = 0.08
CASE 4 (RLA) : RELATIVE LABOUR AUGMENTING
SOCIAL DISCOUNT RATE : SD = 0.06
CASE 5 (RCA) : RELATIVE CAPITAL AUGMENTING
SOCIAL DISCOUNT RATE : SD = 0.06

4. Results of the Simulation

4. 1. Housing Stock Formation

The transition of the housing stock in the results of the simulations is found to be wide varying. Under House 1, the change from t=0 to t=1 represents a decrease, but for the period t=1 to t=2 it is found to be increasing. The reason for such the change is that the number of houses with good environment are on the increase. This means that the number of suburban residents are on the increase at this time. But in the near future, the resident population of the central area (j=1) will rather be on the increase.

House 2 shows that the change in CASE 1 from t=0 to t=2 is decrease. The reason for this change is that the number of houses with good environment are on the decrease. This means that the number of suburban residents is constant at this time period, but soon the resident population of the suburb area decreases.

These results indicate that concentration in the central area is on the increase. The same characteristics are shown by HOUSE 3 and 5 simulation.

HOUSE 4 and 6 show that the housing stock is gradually on the increase. As a whole, it is observed that the housing stock is gradually moving towards better environmentally accepted conditions.

4. 2. Capital Formation

Figure 2 shows the capital formation for each industry, Case 1. The figure shows the same formation in the suburban area. The figures for the other CAPITAL FORMATION are the same. These figures indicate that the industry 3 and 4 will be concentrating in the central area in the future, but the other industries will extend to the suburban area. In the suburban area, capital formation does not reform, excepting in the case of industry 2. Other cases indicate that it would be difficult to form more capital in the suburban area, excepting within industry 2. Capital formation is observed to continue in the central area in the future.

4. 3. The Working Dwellers

Presently the number of all working dwellers in Sapporo city is about 750,000 men. One result of the simulation indicates that the number of the working dwellers in the industry 3 at the central area continue to increase rapidly, while in the industry 4 at the central area the increase is gradual. In industry 6, it conversely shows a decrease. The number of the working dwellers engaged in industry 4 will increase in the future.

As a whole, the number of the working dwellers it is observed show an increasing tendency for the future.

4. 4. Transporo Infrastructure

In the transportation system, the capital commodity has commodities 3, 4, 5, 6. Commodities 3, 4 and 6 use the same road link. Only commodity 5 uses a special link. Now, we define the road link with respect to the commodities 3, 4, and 6 as ROAD 1, and with respect to the commodity 5 as ROAD 2. Then we have 2 zone, therefore the road links with departure and arrival is indicated as follows ; [1−1], [1−2] (or [2−1]), [2−2].

The results of simulation show an increase on the road link [1−1], [1−2] in ROAD 1. In ROAD 2, the link [1−1] only increases in the future.

It is observed that these increases correspond to those in the volume of car traffic on the road link. The increase in the stock of the transportation infrastructure will be represented by the increase in the social discount rate.

5. Conclusion of the Study

The study has examined the scale and agglomeration economies of pertaining to future urban development Sapporo city. These results indicate that initial fruits by the scale and agglomeration economies when put into urban activities will promote further agglomeration.

Sapporo city will practically enjoy the fruits of the scale and agglomeration economies for this fifteen years. After this, when the social discount rate decreases, the value of the function of Sapporo city will increase.

The simulation results indicate that the application of scale and agglomeration economies to Sapporo city will be advantageous in view of the existing conditions and to formulate policies for future urban development guidance.

The simulation results also indicate that application of this technique will not only be advantageous for fifteen more years but also indicate that when the social discount rate decreases the value of function will increase.

The application of this technique on a large scale for different zones of the city will prove to be more advantageous to assess and solve the city's development problems.

Table 1. HOUSING STOCK
[CASE 1] T=0 : unit 10^4houses

HOUSE	ZONE 1	ZONE 2	TOTAL
1	15.85	173.55	189.40
2	3.43	20.58	24.01
3	1.75	19.49	21.24
4	0.79	5.93	6.72
5	33.32	161.26	194.58
6	13.93	51.46	65.39
TOTAL	69.07	432.27	501.34

Table 2. CAPITAL FORMATION
[CASE 1] T=0 : unit 10^8yen

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.028	0.084	0.112
2	1.712	33.696	35.408
3	3.562	5.718	9.28
4	1.299	2.981	4.28
5	0.938	2.451	3.389
6	0.198	4.721	4.919
7	0.096	0.013	0.109
8	0.953	7.263	8.216
9	0.138	0.177	0.315
10	0.456	3.566	4.022
11	3.279	6.949	10.228
TOTAL	12.659	67.619	80.278

Table 3. WORKING DWELLERS
[CASE 1] T=0 : unit 10^3men

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.96	1.68	2.64
2	41.06	104.29	145.35
3	90.15	98.76	188.91
4	33.91	21.09	55.00
5	45.30	38.72	84.02
6	79.26	153.50	232.76
7	2.04	2.35	4.39
8	1.18	7.45	8.61
9	0.60	11.82	12.42
10	0.86	2.13	2.99
11	3.15	10.70	13.85
TOTAL	298.47	452.47	750.94

Table 4. TRANSPORT INFRA(ROAD)
[CASE 1] T=0 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	0.96	18.63	19.59
ZONE 2	18.63	11.63	30.26
TOTAL	19.59	30.26	49.52

Table 5. TRANSPORT INFRA(RAIL)
[CASE 1] T=0 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	0.36	0.93	1.29
ZONE 2	0.93	4.35	5.28
TOTAL	1.29	5.28	6.57

Table 6. HOUSING STOCK
[CASE 1] T=1 : unit 10^4houses

HOUSE	ZONE 1	ZONE 2	TOTAL
1	22.22	148.38	170.60
2	2.95	17.65	20.60
3	1.59	17.75	19.34
4	0.72	5.34	6.06
5	37.76	179.97	217.73
6	15.78	57.43	73.21
TOTAL	81.02	426.52	507.54

Table 8. WORKING DWELLERS
[CASE 1] T=1 : unit 10^3men

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.96	2.10	3.00
2	41.06	84.27	125.33
3	90.15	21.09	111.24
4	61.15	33.66	94.81
5	50.33	38.72	89.05
6	79.26	53.55	132.81
7	2.04	2.35	4.39
8	1.33	8.28	9.61
9	0.68	13.17	13.85
10	0.98	2.37	3.35
11	3.57	11.92	15.49
TOTAL	331.45	271.48	602.93

Table 7. CAPITAL FORMATION
[CASE 1] T=1 : unit 10^8yen

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.017	0.084	0.101
2	4.929	67.955	72.884
3	3.884	6.348	10.232
4	0.986	5.092	6.078
5	2.294	2.141	4.435
6	0.541	4.195	4.736
7	0.081	0.015	0.096
8	0.429	3.269	3.698
9	0.050	0.064	0.114
10	0.471	7.132	7.603
11	7.974	8.192	16.166
TOTAL	21.656	104.48	126.14

Table 9. TRANSPORT INFRA(POAD)
[CASE 1] T=1 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	1.50	20.65	22.15
ZONE 2	20.65	11.57	32.22
TOTAL	22.15	32.22	54.37

Table 10. TRANSPORT INFRA(RAIL)
[CASE 1] T=1 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	0.49	0.91	1.40
ZONE 2	0.91	4.32	5.23
TOTAL	1.40	5.23	6.63

Table 11. HOUSING STOCK
[CASE 1] T=2 :unit 10^4houses

HOUSE	ZONE 1	ZONE 2	TOTAL
1	26.32	127.06	153.38
2	2.53	15.12	17.65
3	1.43	15.90	17.33
4	0.65	4.82	5.47
5	39.98	181.96	221.94
6	16.71	58.07	74.78
TOTAL	87.62	402.93	490.55

Table 13. WORKING DWELLERS
[CASE 1] T=2 : unit 10^3men

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.96	2.10	3.06
2	41.06	50.40	91.46
3	90.15	21.09	111.24
4	70.95	43.86	114.81
5	50.33	38.72	89.05
6	79.26	53.55	132.81
7	2.04	2.35	4.39
8	1.41	8.31	9.72
9	0.72	13.27	13.99
10	1.04	2.40	3.44
11	3.78	12.00	15.78
TOTAL	341.70	248.05	589.75

Table 12. CAPITAL FORMATION
[CASE 1] T=2 : unit 10^8yen

INDUST	ZONE 1	ZONE 2	TOTAL
1	0.010	0.084	0.094
2	2.666	50,889	53.555
3	4.436	5.619	10.055
4	1.107	6.542	7.649
5	2.118	1.846	3.964
6	0.620	3.694	4.314
7	0.142	0.007	0.149
8	0.196	1.492	1.688
9	0.021	0.028	0.049
10	0.467	7.059	7.526
11	7.870	7.613	15.483
TOTAL	19.653	84.873	104.52

Table 14. TRANSPORT INFRA(ROAD)
[CASE 1] T=2 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	1.50	20.55	22.05
ZONE 2	20.55	11.51	32.06
TOTAL	22.05	32.06	54.11

Table 15. TRANSPORT INFRA(RAIL)
[CASE 1] T=2 : unit 10^9yen

LINK	ZONE 1	ZONE 2	TOTAL
ZONE 1	0.50	0.91	1.41
ZONE 2	0.91	4.27	5.18
TOTAL	1.41	5.18	6.59

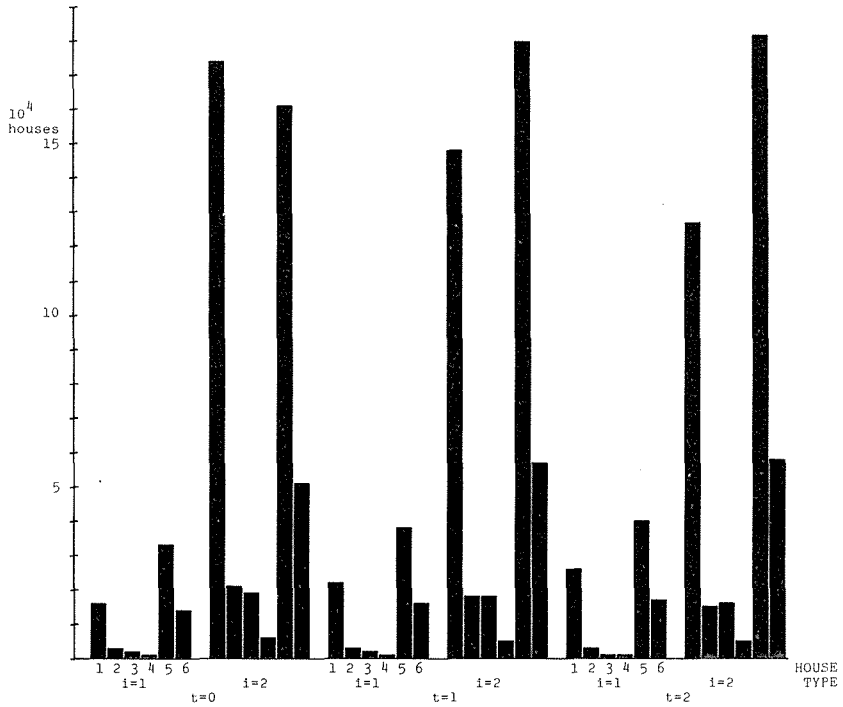

Figure 1. Housing stock : Case 1.

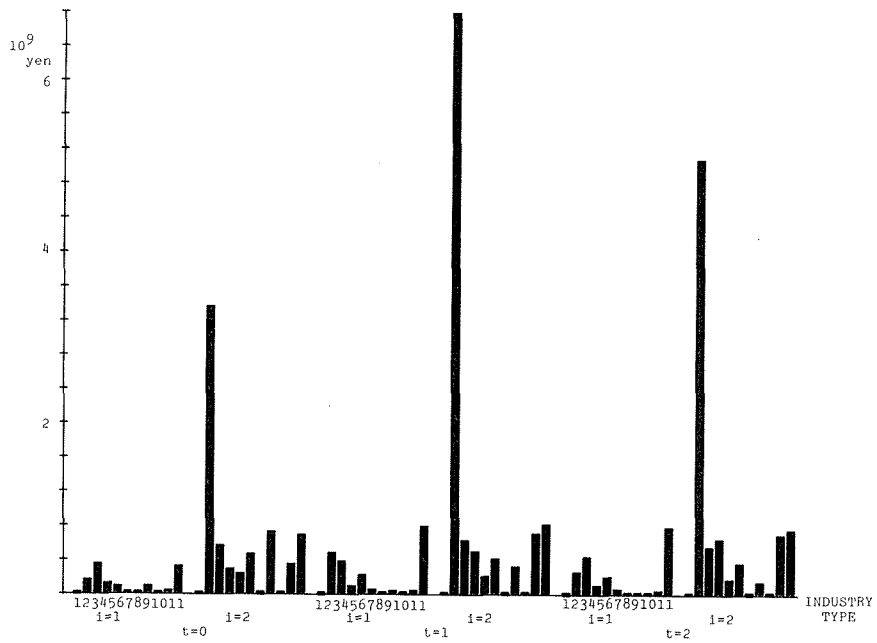

Figure 2. Capital Formation : Case 1.

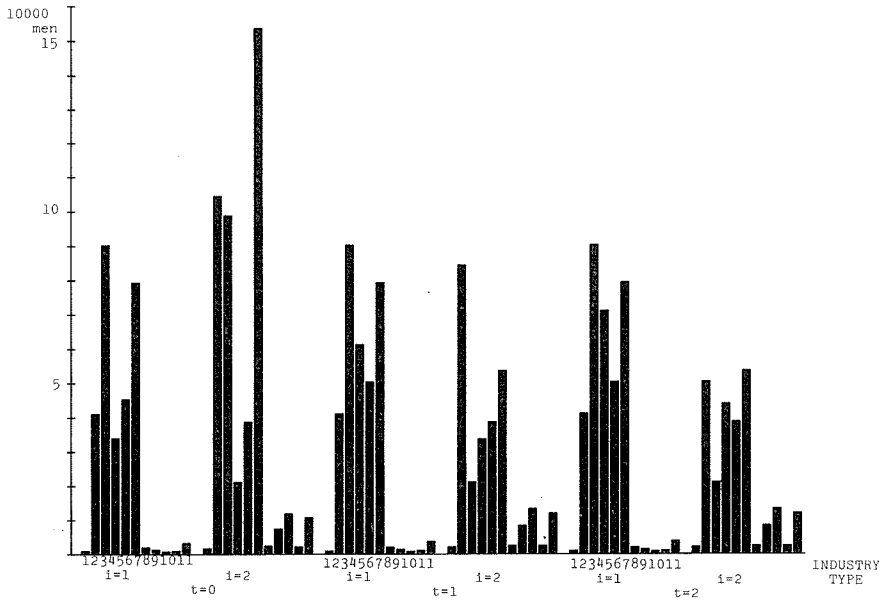

Figure 3. Working Dwellers : Case 1.

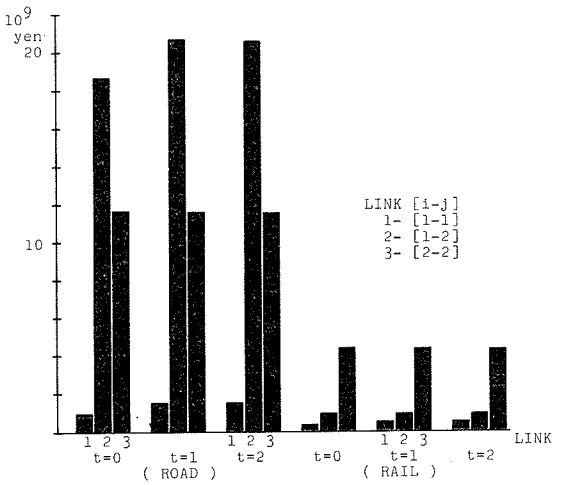

Figure 4. Transport Infrastructure : Case 1.

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