無断引用不可

第1回 都市モデルを用いた都市・交通政策評価に関する研究会
(2008/03/05 計画・交通研究会)

「都市モデルで政策評価することの意義」について

上田孝行
東京大学大学院
工学系研究科
社会基盤学専攻

道路投資の費用便益分析指針

費用便益分析の指針　事例の紹介

費用便益分析による投資基準

純現在価値

$$NPV = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{T} \frac{C_t}{(1+r)^t} \geq 0$$

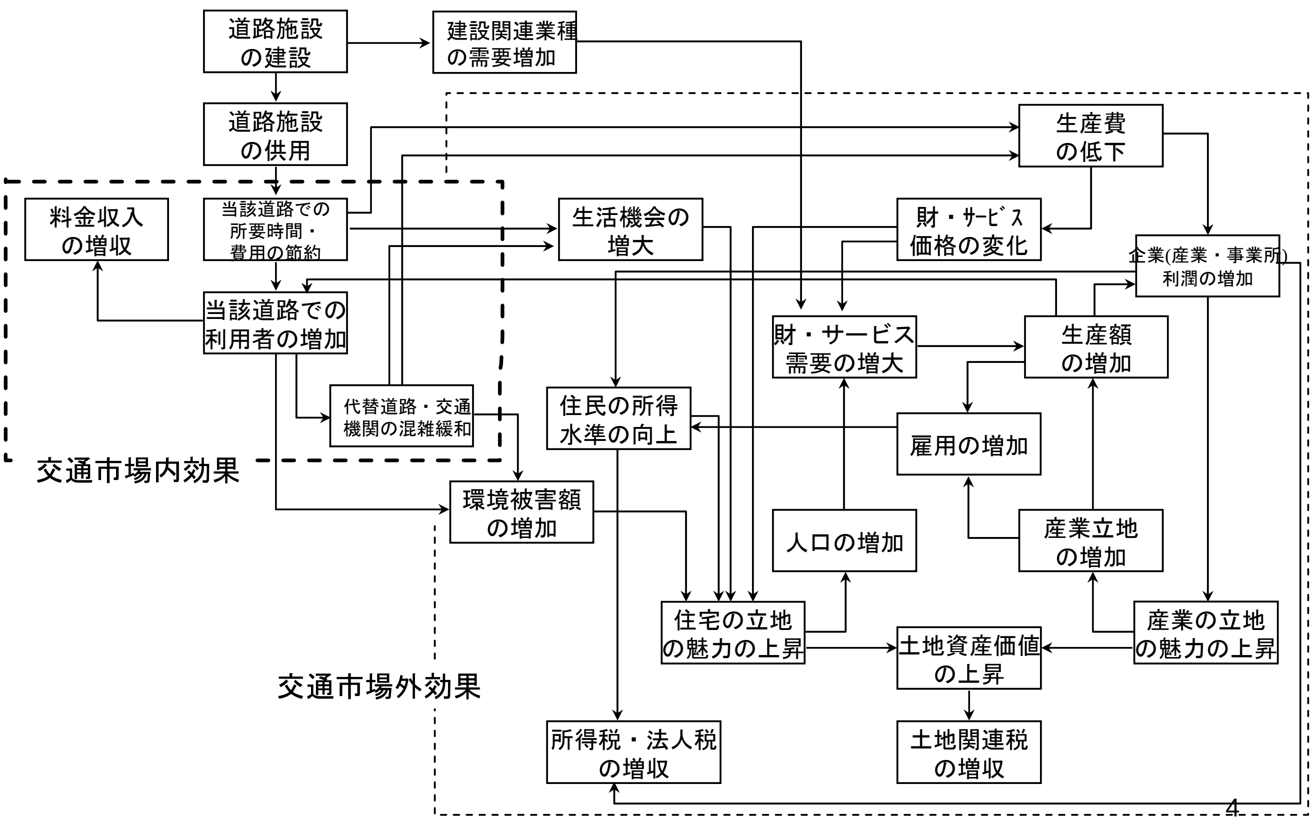
費用便益費

$$B/C = \frac{\sum_{t=0}^{T} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{T} \frac{C_t}{(1+r)^t}} \geq 1$$

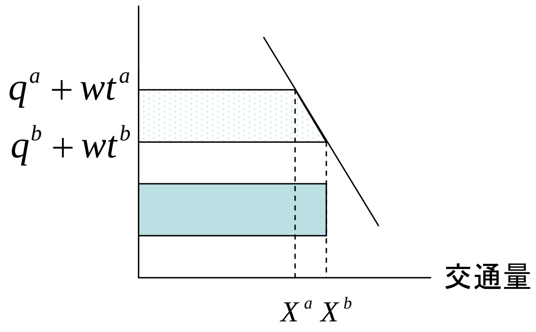
内部収益率

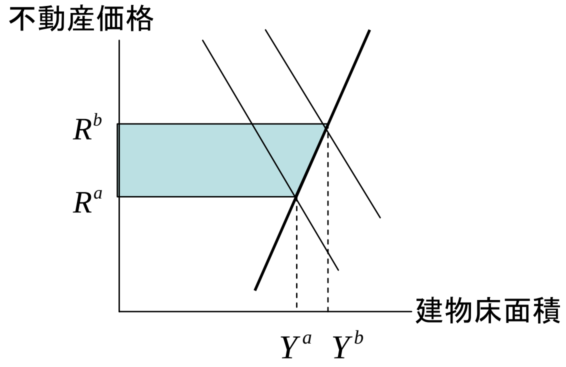
$$IRR = r \quad \text{such that} \sum_{t=0}^{T} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{T} \frac{C_t}{(1+r)^t} = 0$$

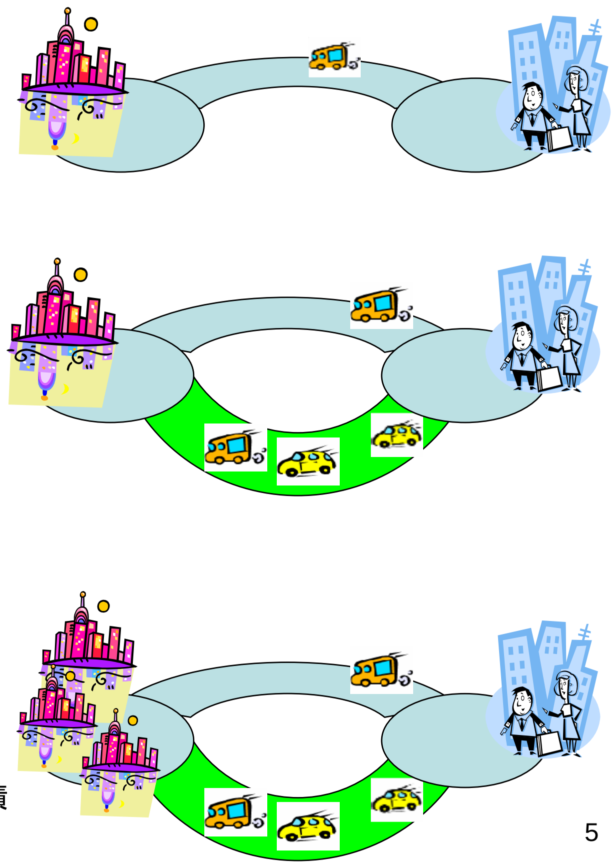
道路投資を例とした公共投資の効果の波及過程



道路整備の直接効果と間接効果







便益帰着分析の事例

森杉壽芳編著，社会資本整備の便益評価，勁草書房，1997

地域の変化を測る –必要性-

公共事業の**直接的な効果**だけに基づいて
事業を評価して良いのか?

国土・都市に生じる様々な変化(**間接的な効果**)を
どのように計測して，どのように公共事業評価に
取り入れていくのか?

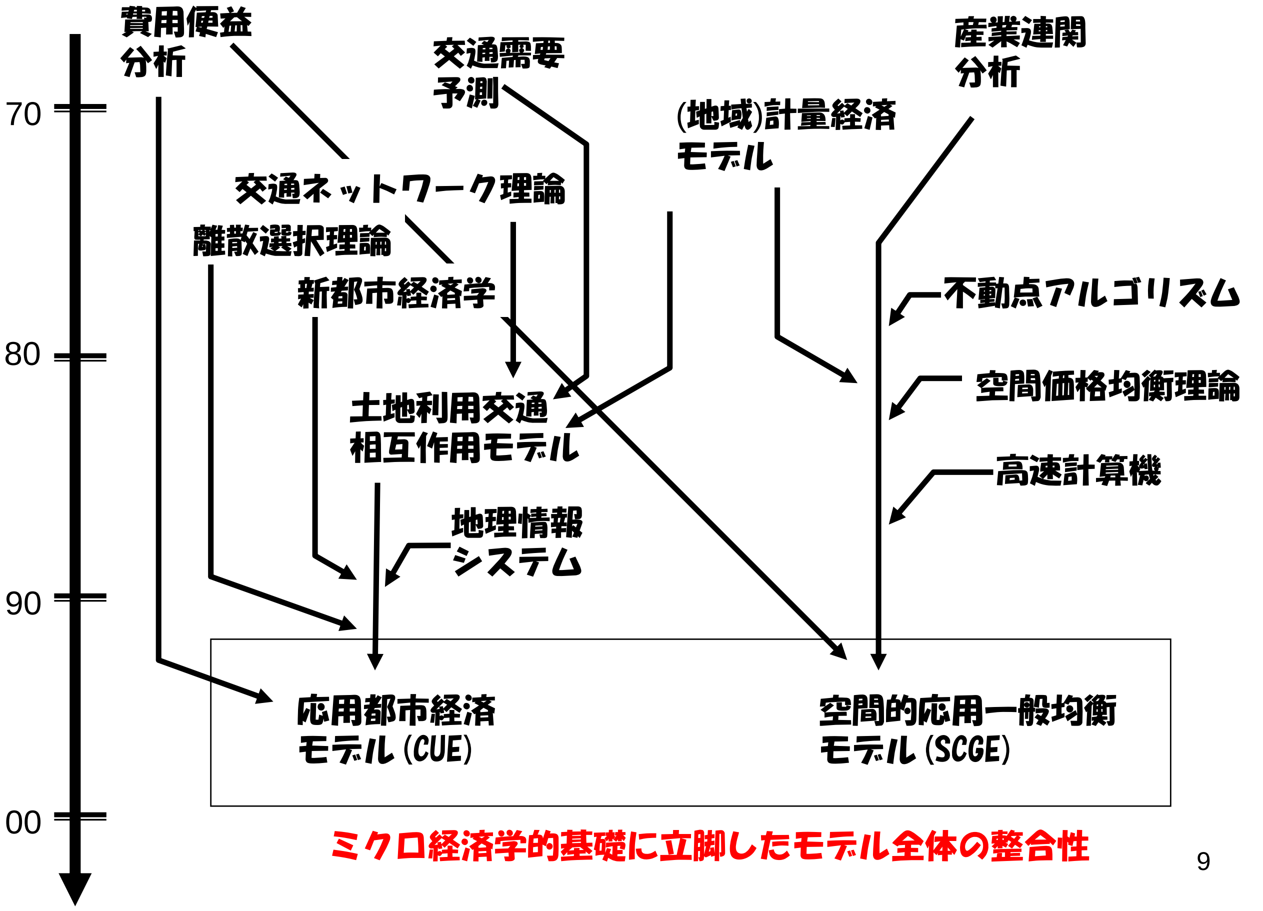
発生から波及，そして帰着の段階までを網羅的に
地域の変化を**空間的**な視点から捉える!

交通の整備と都市域の発展

交通整備による土地利用変化を示す航空写真の例示

出典:(社)日本写真測量学会編｢空から見る国土の変遷｣古今書院刊，2002

公共事業評価のための経済均衡モデルの日本での発展



ミクロ経済学的基礎に立脚したモデル全体の整合性

9

Alex ANAS(1982),Residential Location Markets and Urban Transportation, Academic Pressの紹介

Kim,T.J.(1989), Integrated urban Systems Modeling, Theory and Applications, Kluwer Academic Publisherの紹介

国際セミナー　土地利用と交通，LANDUSE/TRANSPORT INTERACTION, 1986, 土木学会　の紹介

常磐新線(つくばエクスプレス)開通に伴う影響分析-沿線全体-

分析の出力の紹介

出典:雑誌「新建築」新建築社刊，2002.1

WCTR SIG1 Meeting
2007/06/25 Berkeley

Taka UEDA
Department of Civil Engineering
The University of Tokyo

Model Wars:
Episode V
- The Equilibrium Strikes Back

http://www.amazon.co.jp/gp/product/images/6304539266/ref=dp_image_text_0/503-5281159-4753556?ie=UTF8&n=561960&s=video

Model Wars in Urban Modeling
(都市モデルの変遷)

Episode Ⅰ The Peaceful era of Geography
(地理学での記述的分析)

Episode Ⅱ The Empire of Equilibrium in Transport Network Analysis and Urban Economics
(都市経済学と交通ネットワーク理論での均衡概念の徹底)

Episode Ⅲ The Republic of ISGLUTI
(土地利用交通相互作用モデルに関する国際共同研究)

Episode Ⅳ The Alliance of GIS and Micro-simulation
(地理情報システムの普及とマイクロシミュレーションの多用)

Episode Ⅴ The Empire of Equilibrium Strikes Back
(均衡型都市モデルの復権)

Preview Today!!

Why Equilibrium Models Again ?
(なぜ均衡型モデルの復権か?)

Policy Making Practice	Standardization of Cost Benefit Analysis everywhere (政策現場における費用便益分析の世界的な標準化と定着)
Theoretical Foundation	Spatial Economics as an Applied Microeconomics (応用経済学としての空間経済学の理論的な体系化)
Model Operation	Mathematical Techniques for Variational Inequality Problem -Scarf Algorithm for Fixed Point -Projection Method -Merit Function (変分不等式や不動点解法等の均衡問題に関する求解手法の発展)

Practical/Operational Urban Models
fully based on spatial equilibrium theory

(応用経済学としての空間経済均衡の理論に完全に整合的でしかも実用的なモデルが適用可能)

Now Available !!

The Evaluation of the Metropolitan Area Policy by Computable Urban Economic Model (CUE)

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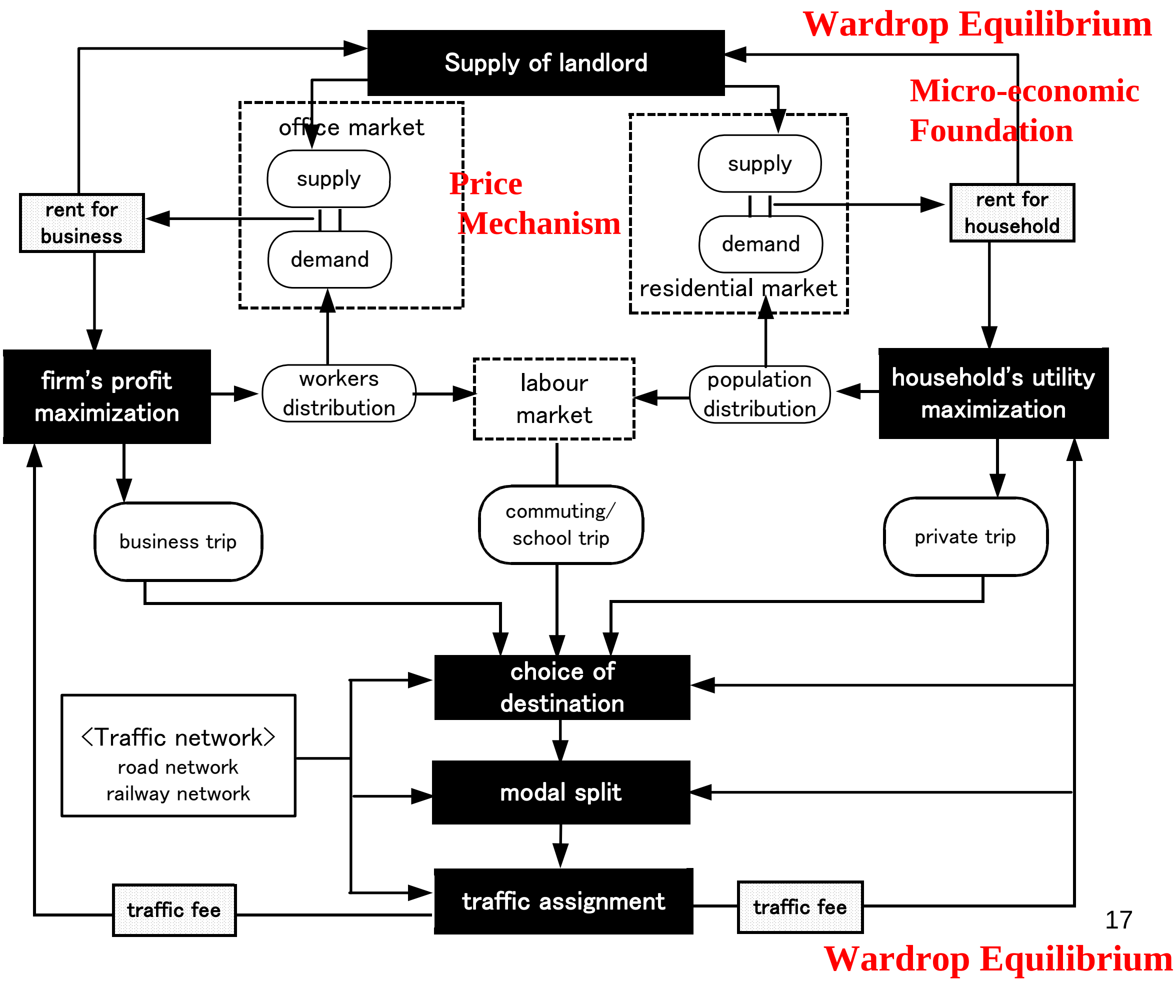
Yamanashi University



Benefit Incidence Analysis :Benefit/Cost Distribution in Spatial and Sectoral Dimensions

Table 5: Benefit at year 2030 (hundred million Yen/year)

		Case2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10
Household	Shorter time	−10	5,277	−12	3,692	−1,219	−541	−821	2,647	7,231
	Cheaper fare					12,753	4,253	10,922	14,235	14,388
	Income from RP			−112					−101	−102
firm	Shorter time	11	830	−21	328	−33	−29	11	316	1,062
	Cheaper fare					805	284	675	887	874
	Income from RP			−124					−117	−119
Absentee landlord		7	313	5	343	−84	−39	−52	290	555
Fare earned by railways						−13,558	−4,537	−11,597	−15,122	−15,262
Income earned by road				236					218	221
Cost of the policy			−4,286		−2,057				−2,057	−6,343
Total (without the cost)		8	6,420	−27	4,362	−1,336	−609	−863	3,253	8,848
Total (with the cost)		8	2,134	−27	2,305	−1,336	−609	−863	1,196	2,505

Theoretical Basis and Structure of Model

Spatial Coverage and Unit

Methodology

Data Availability

Linkage of Transport Model with Spatial Economic Model

Parameter Estimation

Reliability of Output

Social Acceptability for Model and Output

Methodological Diversity

Good or Bad ?

(多様な手法があることは良いことか，悪いことか?)

Tolstoy begins *Anna Karenina* with the famous sentence:

"All happy families are alike but an unhappy family is unhappy after its own fashion."

(幸福な家族はみな同じように幸せである.不幸な家族はそれぞれごとに不幸である.)

Pranab Bardhan and Christopher Udly(1999), Development Microeconomics, Oxford University Press

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Variety of Non Equilibrium Approach

(非均衡型モデルの多様性)

All equilibrium models are alike

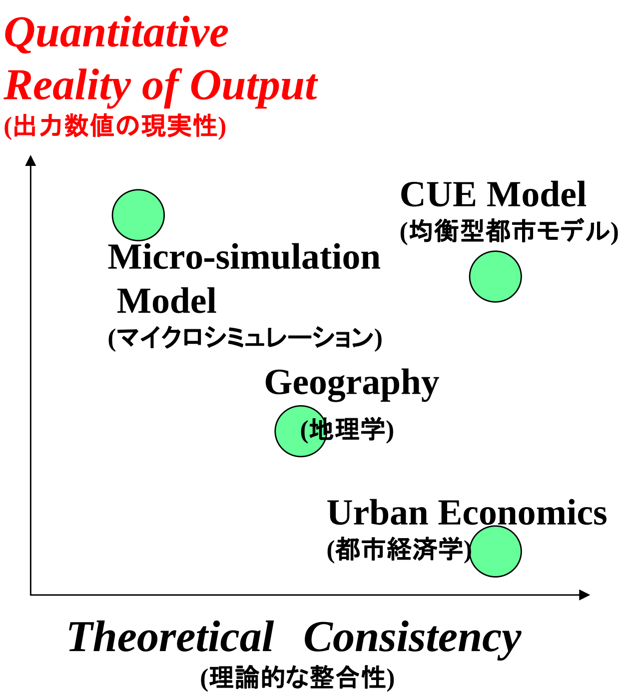
but a non-equilibrium model is ~~ad-hoc~~ after its own fashion.

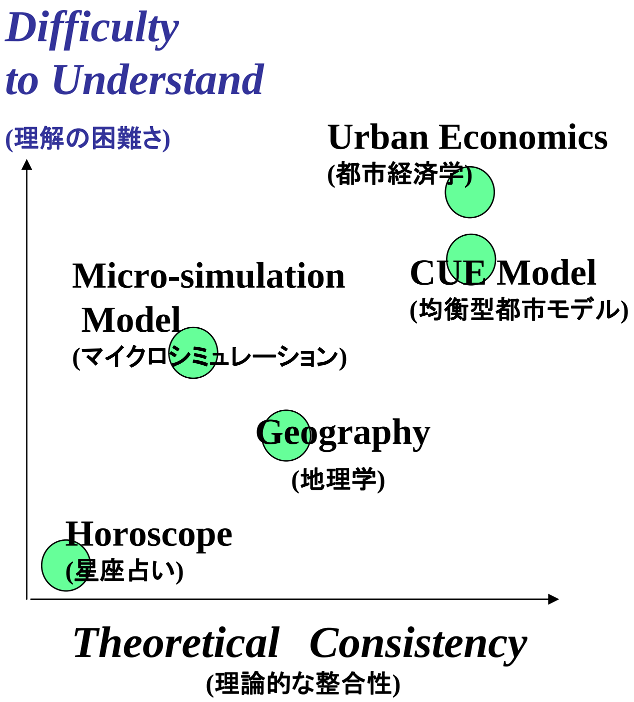
interesting

(均衡型モデルはみな同じような構造である. 非均衡型モデルはそれぞれごとに~~恣意的~~興味深い.)

Social Acceptability of Tools

(様々な手法についての社会の受入れ易さ)





Methodological Diversity is Good !
(手法の多様性は良いことである)

Double Checking of Policy Feasibility by Different Tools
(異なる手法による政策実行可能性のダブルチェック)

	Model A	Model B	Model C
Policy α	Yes	Yes	Yes
Policy β	Yes	Yes	No
Policy γ	No	No	No

Reduction of Risk in Social Decision Making
(社会的意思決定におけるリスクの軽減)

Methodological Diversity is Bad !
(手法の多様性は悪いことである)

Discretional Selection of Model
(裁量主義的な手法の選択)

Policy α

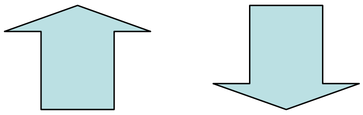
	Model A	Model B	Model C
Region X	+ +	+	--
Region Y	+	-	-
Nation	+	±	-

Policy β

	Model A	Model B	Model C
Region X	--	-	++
Region Y	-	+	+
Nation	-	±	++

Opportunistic/Political Justification of Model
(機会主義/日和見主義的/政治的な手法の正当化)

Methodological Diversity



Taxonomy of Urban Models

(多様な手法が存在するならば，それらをどのように分類して特徴付けるのか?)

進化論にみる分類学の考え方

徳永幸彦(2001)，絵でわかる進化論，講談社サイエンティフィック

一つの都市モデル分類学(taxonomy)－(既存研究レビューの一つのスタイル)

上田孝行，堤盛人:
「わが国における近年の土地利用モデルに関する統合フレームについて」
土木学会論文集 No.625/IV-44，pp.65-78，1999.7

統合フレームに組み入れる土地利用モデル－比較対象のモデル－

K-MODEL	柏谷(1986)，Kashiwadani・Ogura(1987)
MOM-MODEL	森杉・大野・宮城(1991)，大野(1993)
HDO-MODEL	林・土井・奥田(1990)，林・土井(1989)
RURBAN-MODEL	Miyamoto・Kitazume(1990)，Miyamoto et al(1993)
UNHT-MODE	Ueda・Nakamura・Hiratani・Tsustumi(1993)，平谷・中村・堤・上田(1993)

ロジット型の立地選択行動

需給均衡による土地価格決定

Unified framework Model(統合フレームのモデル)

Location choice by Locator type *k*

$$S(V_k,\theta_k) = \max_{a_k} \sum_{i\in \mathbf{I}_k}\left\{a_{ki}V_{ki} - \left(\frac{1}{\theta_k}\right)a_{ki}\left(\ln a_{ki}-1\right)\right\}$$

$$s.t.\quad \sum_{i\in \mathbf{I}_k} a_{ki} = 1 \quad for \quad all \quad i\in\{1,\cdots,I\}$$

$$a_{ki} = \frac{\exp(\theta_k V(Y_k, R_i, e_i(N), E_i, \alpha_k))}{\sum_{i'\in \mathbf{I}_k}\exp(\theta_k V(Y_k, R_i, e_{i'}(N), E_{i'}, \alpha_k))}$$

$$N_{ki} = N_{kT}a_{ki}$$

$$for \quad all \quad i\in\{1,\cdots,I\} \quad \text{and} \quad for \quad all \quad k\in\{1,\cdots,K\}$$

Clearing of floor market in zone *i*

$$-\sum_{k(i\in \mathbf{I}_k)} N_{kT}a_{ki}q(Y_k,R_i,e_i,E_i,\alpha_k) + Q(R_i,P_i,Z_i,\beta) = 0$$

$$for \quad all \quad i\in\{1,\cdots,I\}$$

Clearing of land market *m*

$$L_i^S(P_m,W_m,\gamma) - L^D(R_i,P_i,Z_i,\beta) = 0$$

$$for \quad all \quad i\in\{1,\cdots,I\} \quad and \quad m\in\{1,\cdots,M\}$$

Programmability of equilibrium

$$SW(E,\bar{e},Z,W,\alpha,\theta,\beta,\gamma) = \min_{R,P} \sum_{k=1}^{K}\frac{N_{kT}}{\overline{MIV}_k}\cdot S(V_k,\theta_k)$$
$$+\sum_{i=1}^{I}\pi^D(R_i,P_i,Z_i,\beta) + \sum_{m=1}^{M}\pi^L(P_m,W_m,\gamma)$$

$$\frac{\partial V(\bullet)}{\partial R_i} = -\overline{MVI}_k\cdot q(R_i,\bar{e}_i,E_i,\alpha_k)$$

$$Q_i = Q(R_i,P_i,Z_i,\beta) = \frac{\partial \pi^D(R_i,P_i,Z_i,\beta)}{\partial R_i}$$

$$L_i^D = L^D(R_i,P_i,Z_i,\beta) = -\frac{\partial \pi^D(R_i,P_i,Z_i,\beta)}{\partial P_i}$$

$$L_i^S = L_i^S(P_m,W_m,\gamma) = \frac{\partial \pi^L(P_m,W_m,\gamma)}{\partial P_i}$$

$$a_{ki} = a(V_k,\theta_k;i) = \frac{\partial S(V_k,\theta_k)}{\partial V_{ki}}$$

Table 1 Comparison of zone setting
(ゾーン設定の比較)

Model	Label for zone	Label of zone for locator to locate	Label of zone for landowner to supply land
Unified Framework	i	$\mathbf{I}_k$	$\mathbf{I}_m$
K-MODEL	$i=(k,m)\in\{(1,1),\cdots,(K,M)\}$	$\mathbf{I}_k=\{(k,1),\cdots,(k,M)\}$	$\mathbf{I}_m=\{(1,m),\cdots,(K,m)\}$
MOM-MODEL	$i=m\in\{1,\cdots,M\}$	$\mathbf{I}_k=\{1,\cdots,M\}$	$\mathbf{I}_m=\{m\}$
HDO-MODEL	$i=(k,m)\in\{(1,1),\cdots,(K,M)\}$	$\mathbf{I}_k=\{(k,1),\cdots,(k,M)\}$	$\mathbf{I}_m=\{(1,m),\cdots,(K,m)\}$
RURBAN-MODEL	$i=(k,m)\in\{(1,1),\cdots,(K,M)\}$	$\mathbf{I}_k=\{(k,1),\cdots,(k,M)\}$	$\mathbf{I}_m=\{(1,m),\cdots,(K,m)\}$
UNHT-MODEL	$i=m\in\{1,\cdots,M\}$	$\mathbf{I}_k=\{1,\cdots,M'\}\subset\{1,\cdots,M\}$	$\mathbf{I}_m=\{m\}$

Table 2 Comparison of Location attractiveness function and Individual demand function
(立地の魅力度または効用関数と立地者による床または空間の需要関数)

MODEL	Location attractiveness function (Indirect utility or profit)	Individual demand for space (land or floor)
Unified Framework	$V_{ki}=V(Y_k,R_i,e_i,E_i,\alpha_k)$	$q_{ik}=q(Y_k,R_i,e_i,E_i,\alpha_k)$
K-MODEL	$V_{ki}=\phi(e_i,E_i,\alpha_k)-R_{ki}$	$q_{ik}=1$
HDO-MODEL	$V_{ki}=\phi(e_i,E_i,\alpha_k)-R_{ki}\overline{q}_{ki}+\ln\left(\frac{L_i}{\overline{q}_{ki}}\right)$	$q_{ik}=\overline{q}_{ik}\,(=exogenous)$
MOM-MODEL	$V_{ki}=\phi(e_i,E_i,\alpha_k)-\rho_k\ln R_i+\varphi_k\ln Y_k$ (ρ_k is specific to each k)	$q_{ik}=\rho_k\dfrac{Y_k}{R_i}$
RURBAN-MODEL	$V_{ki}=\phi(e_i,E_i,\alpha_k)-\rho\ln R_i+\varphi_k\ln Y_k+\ln\left(\frac{L_i}{q_{ki}}\right)$ (ρ is identical for all k)	$q_{ik}=\rho\dfrac{Y_k}{R_i}$
UNHT-MODEL	$V_{ki}=\phi(e_i,E_i,\alpha_k)+\int_{R_i}^{R_{\max}}\min\{0,a-bs\}ds$	$q_{ik}=a-bR_i$

Table 3 Comparison of Aggregate supply for land
(土地の集計的供給関数)

MODEL	Aggregate supply for land
Unified Framework MODEL	$L_i^S=L^S(P,W,\gamma;i)$
K-MODEL	$L_{ki}^S=\dfrac{\exp(\gamma R_{ki})}{\sum_{k'=1}^{K}\exp(\gamma R_{k'i})}L_m \quad for \quad i\in\mathbf{I}_m$
HDO-MODEL	$L_{ki}^S=\dfrac{\exp(\gamma R_{ki}+\ln N_k)}{\sum_{k'=1}^{K}\exp(\gamma R_{k'i}+\ln N_{k'})}\cdot L_m \quad for \quad i\in\mathbf{I}_m$
MOM-MODEL	$L_i^S=\overline{L_i^S}\,(=exogenous)$
RURBAN-MODEL	$L_{ki}^S=\dfrac{\exp(\gamma\ln R_{ki}+\ln N_k)}{\sum_{k'=1}^{K}\exp(\gamma\ln R_{k'i}+\ln N_{k'})}\cdot L_m \quad for \quad i\in\mathbf{I}_m$
UNHT-MODEL	$L_i^S=\dfrac{1}{1+\exp\{-\gamma(P_i^t-\delta P_i^{t-1})+\varepsilon\}}\cdot(\overline{L_i}-L_i^{t-1})+L_i^{t-1}$

$$\pi_m^L=\max_{L_i}\sum_{i\in\mathbf{I}_m}\left[B(R_i,Z_i)\left(\frac{L_i}{L_m}\right)-\left(\frac{1}{\gamma_i}\right)\left(\frac{L_i}{L_m}\right)\left\{\ln\left(\frac{L_i}{L_m}\right)-1\right\}\right]L_m$$

$$s.t.\quad \sum_{i\in\mathbf{I}_m}L_i=L_m$$

$$B(R_{(k,m)},Z_m)=R_{(k,m)}+\ln N_{kT}$$

$$B(R_{(k,m)},Z_{(k,m)})=\ln R_{(k,m)}+\ln N_{kT}$$

Table 4 Aggregate supply for floor and demand for land
(床面積の集計的供給関数と土地の集計的需要関数)

MODEL	Aggregate supply for floor	Aggregate demand for land
Unified Framework MODEL	$Q_i = Q(R_i, P_i, Z_i, \beta)$	$L_i^D = L^D(R_i, P_i, Z_i, \beta)$
K-MODEL	$Q_i = L_i^D h_i L_i$ (h_i is specific to each i)	$L_i^D = h_i L_i$ (h_i is specific to each i)
HDO-MODEL	$Q_i = L_i^D h_i L_i$ (h_i is specific to each i)	$L_i^D = h_i L_i$ (h_i is specific to each i)
MOM-MODEL	$Q_i = L_i^D h_i L_i$ (h_i is specific to each i)	$L_i^D = h_i L_i$ (h_i is specific to each i)
RURBAN-MODEL	$Q_i = L_i^D h_i L_i$ (h_i is specific to each i)	$L_i^D = h_i L_i$ (h_i is specific to each i)
UNHT-MODEL	$Q_i = \beta_0 \beta_1 R_i^{\beta_1 - 1} P_i^{\beta_1 - 1}$	$L_i^D = \beta_0 \beta_2 R_i^{\beta_1} P_i^{-\beta_2 - 1}$

Table 5 Comparison of Programmability
(均衡の最適化問題への変換可能性)

MODEL	Mathematical Programming
Unified Framework MODEL	$\min_{R,P} \sum_{k=1}^{K} \frac{N_{kT}}{MIV_k} \cdot S(V_k(\cdot), \theta_k) + \sum_{i=1}^{I} \pi^D(R_i, P_i, Z_i, \beta) + \sum_{m=1}^{M} \pi^L(P_m, W_m, \gamma)$
K-MODEL	$\min_{R_{ki}} \sum_{k=1}^{K} N_{kT} \left(\frac{Y_k}{\varphi_k}\right) \cdot V_k^{\max} + \sum_{m=1}^{M} L_m \left(\frac{1}{\gamma}\right) \ln\left\{\sum_{i \in \mathbf{I}_m} \exp(\gamma R_i + \ln N_{kT(i \in \mathbf{I}_k)})\right\}$ $s.t.\quad V_k^{\max} = \max_{N_{ki}} \sum_{i \in \mathbf{I}_k} \left(\phi(\bar{e}_i, E_i, \alpha_k) - \rho R_{ki} + \varphi_k \ln Y_k\right) N_{ki}$ $s.t.\quad \sum_{i \in \mathbf{I}_k} N_{ki} = N_{kT}$
HDO-MODEL	$\min_{R_{ki}} \sum_{k=1}^{K} N_{kT} \left(\frac{Y_k}{\varphi_k}\right)\left(\frac{1}{\theta_k}\right) \ln\left[\sum_{i \in \mathbf{I}_k} \exp\left\{\theta_k \left(\phi(\bar{e}_i, E_i, \alpha_k) - \rho R_{ki} + \varphi_k \ln Y_k\right) + \ln L_{mT(i \in \mathbf{I}_m)}\right\}\right]$ $+ \sum_{m=1}^{M} L_m \left(\frac{1}{\gamma}\right) \ln\left\{\sum_{i \in \mathbf{I}_m} \exp(\gamma R_i + \ln N_{kT(i \in \mathbf{I}_k)})\right\}$
MOM-MODEL	$\min_{R_i} \sum_{k=1}^{K} N_{kT} \left(\frac{Y_k}{\varphi_k}\right)\left(\frac{1}{\theta_k}\right) \ln\left[\sum_{i \in \mathbf{I}_k} \exp\left\{\theta_k \left(\phi(\bar{e}_i, E_i, \alpha_k) - \rho_k \ln R_i + \varphi_k \ln Y_k\right)\right\}\right]$ $+ \sum_{m=1}^{M} \sum_{i \in \mathbf{I}_m} R_i L_m$
RURBAN-MODEL	$\min_{R_{ki}} \sum_{k=1}^{K} N_{kT} \left(\frac{Y_k}{\varphi_k}\right)\left(\frac{1}{\theta_k}\right) \ln\left[\sum_{i \in \mathbf{I}_k} \exp\left\{\theta_k \left(\phi(\bar{e}_i, E_i, \alpha_k) - \rho \ln R_{ki} + \varphi_k \ln Y_k\right) + \ln L_{Ti}\right\}\right]$ $+ \sum_{m=1}^{M} L_{Ti} \left(\frac{1}{\gamma}\right) \ln\left\{\sum_{i \in \mathbf{I}_m} \exp(\gamma R_i + \ln N_{kT(i \in I_k)})\right\}$
UNHT-MODEL	$\min_{R_i, P_i} \sum_{k=1}^{K} N_{kT} \left(\frac{1}{\theta_k}\right) \ln\left[\sum_{i \in \mathbf{I}_k} \exp\left\{\theta_k \left(\phi(e_i, E_i, \alpha_k) + \int_{R_i}^{R_{\max}} \min\{0, a - bs\} ds\right)\right\}\right]$ $+ \sum_{i=1}^{I} \beta_0 R_i^{\beta_1} P_i^{-\beta_2} + \sum_{m=1}^{M} \sum_{i \in \mathbf{I}_m} \left[(\bar{L}_i - L_i^{t-1})\left(\frac{1}{\gamma}\right) \ln\left\{\exp(\gamma P_i) + \exp(\gamma P_i^{-1})\right\} + P_i L_i^{-1}\right]$

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時系列データを用いた交通－土地利用モデルの構築*
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における土地利用モデルの捉え方の紹介