

## Chapter 13: Urban Development as Exchange

The New Science of Cities, Michael Batty, MIT Press, Nov. 2013.

BLG 556E - Digital Solutions for Smart Cities

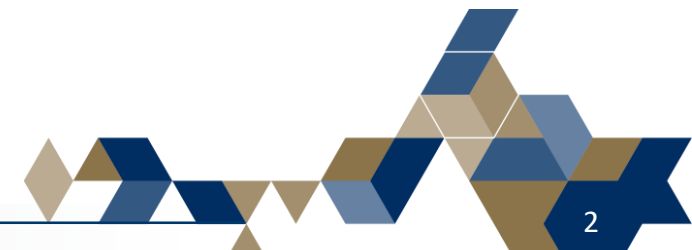
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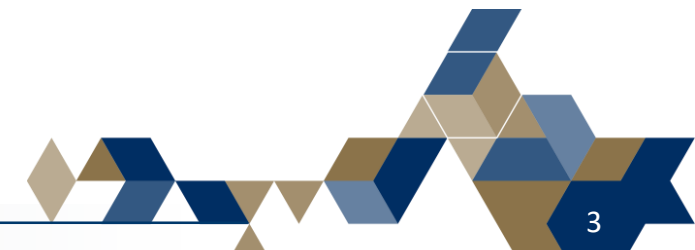
## Outline

1. Introduction
2. An Equilibrium Model
3. An Outline of the Land Development Model
4. The Battle for Tolmers Square
5. Structuring the Problem
6. Applications and Predictions



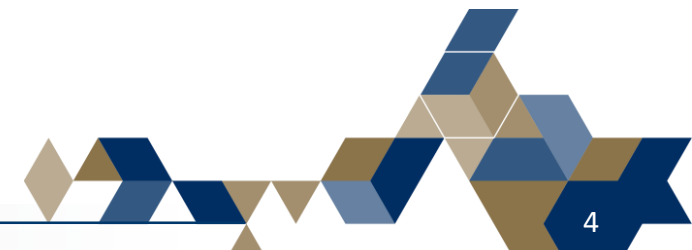
## Introduction

- Idea of exchange;
  - The notion that for a system to be in equilibrium.
  - Its agents must adjust their demands to the supplies controlled by other agents or vice versa.
- Perfect market (in theory);
  - Both demand and supply adjust to the point where a balance occurs and all agents are satisfied that no further improvement.
  - Price is the signature of this balance.
  - Process of adjustment for an equilibrium is likely to be one of trial and error (where convergence is assured).
  - The system moves seamlessly to an equilibrium where all actors (or their representation as factors) achieve a consensus (Coleman's theory of collective action).
  - Demand and supply are the basis of economic exchange.



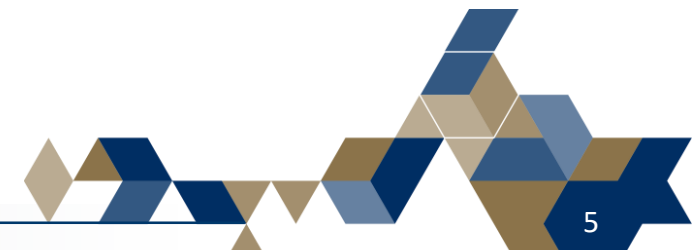
## Introduction

- This chapter focus on;
  - Conflict between agents with an interest and control over the land market.
  - How these ideas makes agents to reach an equilibrium where land is actually exchanged?
  - Develop a model of urban development that treats actors or agents more literally as agents of change in the urban system.
  - The process of change in land ownership will first be considered as a process of economic exchange.
  - Equilibrium system structural characteristic is examined with exchange processes.
  - Examine an application to land development in north Central London.
    - Actually on a historical urban conflict.
    - The crisis over property speculation in Tolmers Square (1973).



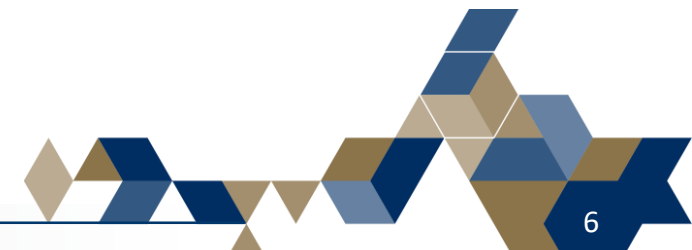
## An Equilibrium Model

- Well-known model of economic exchange;
  - Individual actors increase their overall levels of satisfaction by trading commodities they have control over for other commodities they desire.
  - General economic equilibrium is essential for market exchange and for an efficient allocation of resources.
  - Model stated in two ways:
    - A set of formal accounting relations.
    - A set of input-output equations.
  - Market for land represents one of the most well-defined of all economic markets.
    - Almost literal exchange for other land or cash through the finance market.



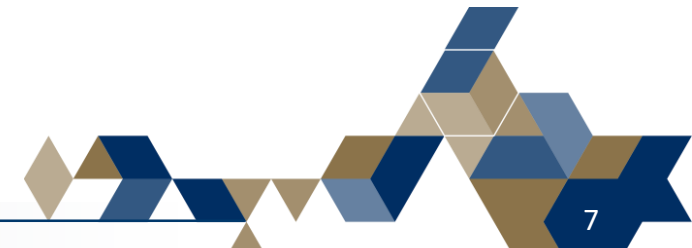
## An Equilibrium Model

- Tolmers Square model attempts to simulate;
  - The invasion of one land use over another.
  - More “profitable” land uses are expanding into areas of less-than-profitable use.
  - Expansion of offices around central areas of major cities, invading the poor, inner areas is the classic example.
  - Poorer tenants confronted by “rich” property speculators wishing to own those plots with the resources to “tempt” occupiers to sell or leave.
  - Local governments wishing to own the land to comprehensively redevelop it.
    - With the powers to do so in principle.
    - Inability to do so in practice.
  - Severe conflict of interests and ideologies.
- The essence of exchange;
  - Conflict between;
    - What people actually own.
    - What they desire to own.
- Assume that each actor initially has a budget;
  - Level of resources fixed by what they control.



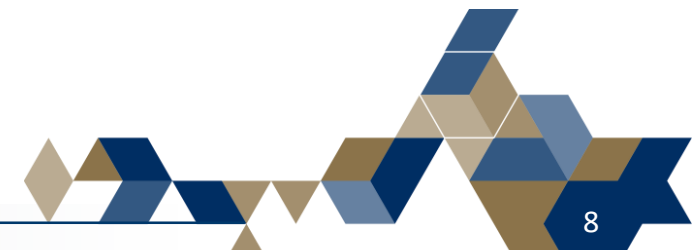
## An Equilibrium Model

- Land parcel or site:  $k$
- Agent or actor:  $i$  or  $j$
- Absolute allocation of resources to any land parcel or site  $k$  that each agent or actor  $j$  controls:  $\hat{C}_{kj}$
- Desired allocation that is the agent  $i$ 's interest in each site  $k$ :  $\hat{X}_{ik}$
- The matrices  $\hat{C}$  and  $\hat{X}$  are flow matrices measured in cash terms between actors and the sites they have control and interest over.
- Economic equilibrium theory;
  - The differences  $\hat{X} - \hat{C}^T$  between these disappear in the equilibrium;
    - Interest is equal to control.



## An Equilibrium Model

- Model works as follows;
  - On the basis of the mismatch between interest  $\hat{X}$  and control  $\hat{C}^T$
  - Compute an explicit degree of mismatch between any pair of actors  $i$  and  $j$
  - Argue that it is necessary to begin to exchange resources in proportion to this strength of interaction.
  - Exchange resources using the interactions between pairs of actors.
  - Continue until, the amount of resource “captured” by any actor will converge to a stable value and an equilibrium will emerge.
- What we wish to know;
  - The proportion of each actors interest they have in each site.
  - Proportion of control each actor has over a site.
- The measurement of actual ownership or control and desired ownership or interest is in money.





## An Outline of the Land Development Model

- Total resources of each actor associated with control and interest;

$$r_j^c = \sum_k \hat{C}_{kj} \text{ and } r_i^d = \sum_k \hat{X}_{ik},$$

- Total value of the sites;

$$v_j^c = \sum_i \hat{C}_{ij} \text{ and } v_k^d = \sum_i \hat{X}_{ik}.$$

- The total money M associated with these investments;

$$\sum_j r_j^d = \sum_i r_i^d = \sum_k v_k^c = \sum_k v_k^d = \sum_k \sum_j \hat{C}_{kj} = \sum_i \sum_k \hat{X}_{ik} = M.$$



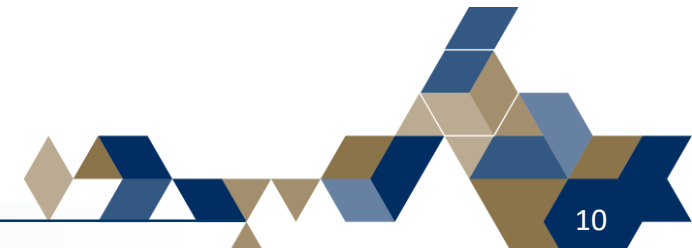
## An Outline of the Land Development Model

- Exchange will occur;
  - If there is a mismatch between actual and desired resource allocations.
- An equilibrium where the two flow matrices (actual and desired ownership) are identical;
  - $\hat{C}_{kj}$  and  $\hat{X}_{ik}$  will adjust so that eventually equations are satisfied;

$$\hat{C}_{kj} = \hat{X}_{ik} , \quad i = j,$$

$$r_i = r_i^c = r_i^d$$

$$v_k = v_k^c = v_k^d$$



## An Outline of the Land Development Model

- Relative interest  $X_{ik}$

$$X_{ik} = \frac{\hat{X}_{ik}}{r_i^d} = \frac{\hat{X}_{ik}}{\sum_z \hat{X}_{iz}}, \sum_k X_{ik} = 1,$$

- Relative control  $C_{kj}$

$$C_{kj} = \frac{\hat{C}_{kj}}{v_k^d} = \frac{\hat{C}_{kj}}{\sum_z \hat{C}_{kz}}, \sum_j \hat{C}_{kj} = 1.$$

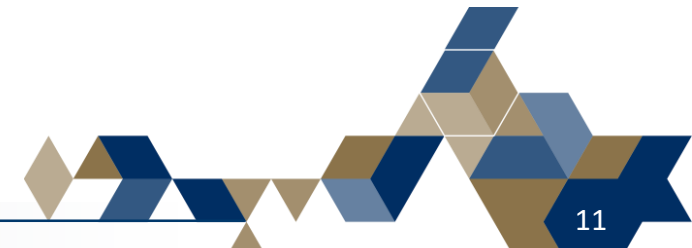
- The model can now be formulated and solved as the two-stage process described in previous section.
  - Iterative two-step process;

$$v_k(t+1) = \sum_i r_i(t) X_{ik} \Rightarrow r_j(t+1) = \sum_k v_k(t+1) C_{kj},$$

- Model start with resources  $r_i(t=1)$  and effect the continued substitutions until we reach some limit of convergence;

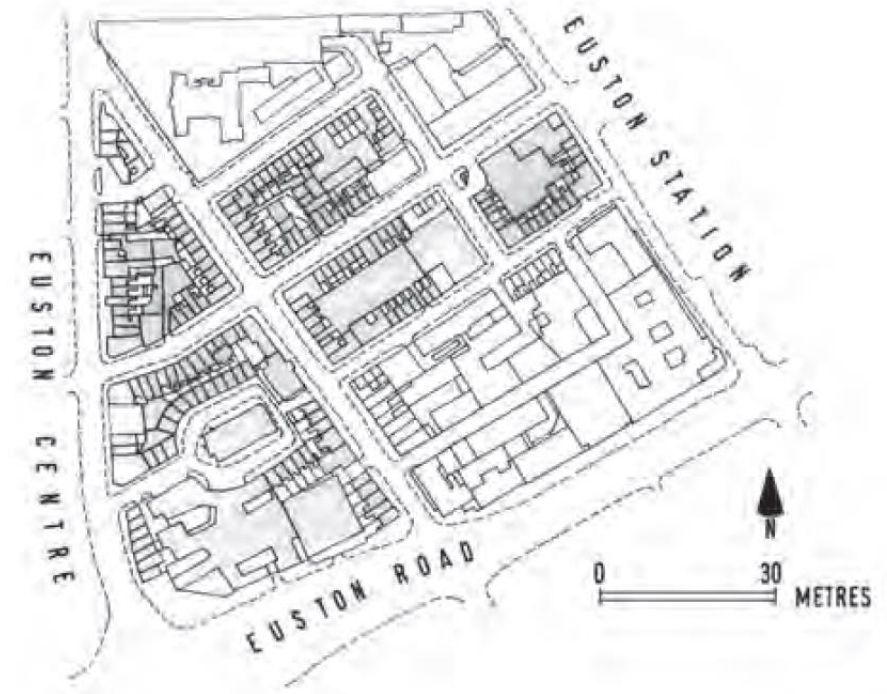
$$v_k = \sum_i r_i X_{ik}$$

$$r_j = \sum_k v_k C_{kj}$$



## The Battle for Tolmers Square

- Tolmers Square is an area of north Central London.
- A company called “Stock Conversion” built up enormous assets based on the profits of property speculation (1973).
- Stock Conversion was;
  - Buying properties in the Tolmers Square area as early as 1962.
  - Owned well over half the area of interest by 1974.
- Local authority prepared series of planning schemes but failed;
  - Because of the excessive cost of compulsory purchase.
- Local authority tries to negotiate with Stock Conversion to agree a joint development.
- Residents opposed. A local pressure group was formed.
- Local authority finally decided to buy out Stock Conversion’s interest and undertake a more socially relevant development for the area.



1. Introduction
2. An Equilibrium Model
3. An Outline of the Land Development Model

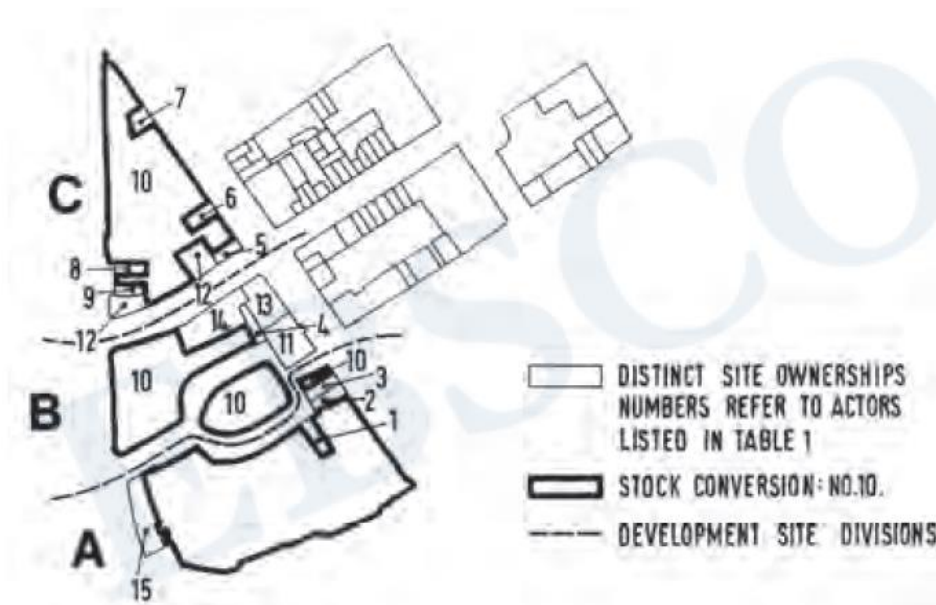
4. The Battle for Tolmers Square
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## Structuring the Problem

Table 13.1  
Actors and events

| Agents/actors                         |                              | Events/sites                          |                        |
|---------------------------------------|------------------------------|---------------------------------------|------------------------|
|                                       |                              | 1                                     | A Tolmers Square South |
|                                       |                              | 2                                     | B Tolmers Square North |
|                                       |                              | 3                                     | C The island site      |
| Owners/occupants of residential sites |                              | Owners/occupants of residential sites |                        |
| 1                                     | Tolmers Square South         | 4                                     |                        |
| 2                                     | North Gower Street           | 5                                     |                        |
| 3                                     | North Gower Street           | 6                                     |                        |
| 4                                     | Tolmers Square North         | 7                                     |                        |
| 5                                     | North Gower Street           | 8                                     |                        |
| 6                                     | North Gower Street           | 9                                     |                        |
| 7                                     | North Gower Street           | 10                                    |                        |
| 8                                     | Hampstead Road               | 11                                    |                        |
| 9                                     | Hampstead Road               | 12                                    |                        |
| Owners/occupants of commercial sites  |                              | Owners/occupants of commercial sites  |                        |
| 10                                    | Stock conversion (developer) | 13                                    |                        |
| 11                                    | Cecil House (club)           | 14                                    |                        |
| 12                                    | Victor Laurence (shop)       | 15                                    |                        |
| 13                                    | TGWU (trade union office)    | 16                                    |                        |
| 14                                    | London CHA (club-office)     | 17                                    |                        |
| Local governments                     |                              |                                       |                        |
| 15                                    | Greater London Council       |                                       |                        |
| 16                                    | London Borough of Camden     |                                       |                        |
| Pressure groups                       |                              |                                       |                        |
| 17                                    | Housing subsidies            |                                       |                        |
| 18                                    | Rent control                 |                                       |                        |
| 19                                    | Special education            |                                       |                        |

- Intended goal is to simulate this change in Camden's policy toward their ownership of land as a switch in control within the exchange model.
- There are at least 132 actors and 62 sites.
- We model a smaller, simplified representation of the conflict.



## Structuring the Problem

- Identify all the actors involved over the time period of interest.
- Actors divided into two sets;
  - Actors in bargaining over land prior to 1973. (pre-1973)
  - Actors whose “interest” was awakened by the 1973 crisis. (post-1973)
- 15 actors in the pre-1973 situation all have some control over these 3 sites.
- Very large “rest of the world” sector;
  - For events that enable a type of migration of actors into and out of the system to take place.
- Four models;
  - 1) pre-1973 with rest of the world: actors  $i = 1, 2, \dots, 15$ ; sites  $k = 1, 2, \dots, 17$
  - 2) post-1973 with rest of the world: actors  $i = 1, 2, \dots, 19$ ; sites  $k = 1, 2, \dots, 17$
  - 3) pre-1973 without rest of the world: actors  $i = 1, 2, \dots, 15$ ; sites  $k = 1, 2, 3$
  - 4) post-1973 without rest of the world: actors  $i = 1, 2, \dots, 19$ ; sites  $k = 1, 2, 3$
- These sparsity indices are based on a direct count of positive entries divided by the total possible entries.
  - Control matrices are sparser than the interest matrices,

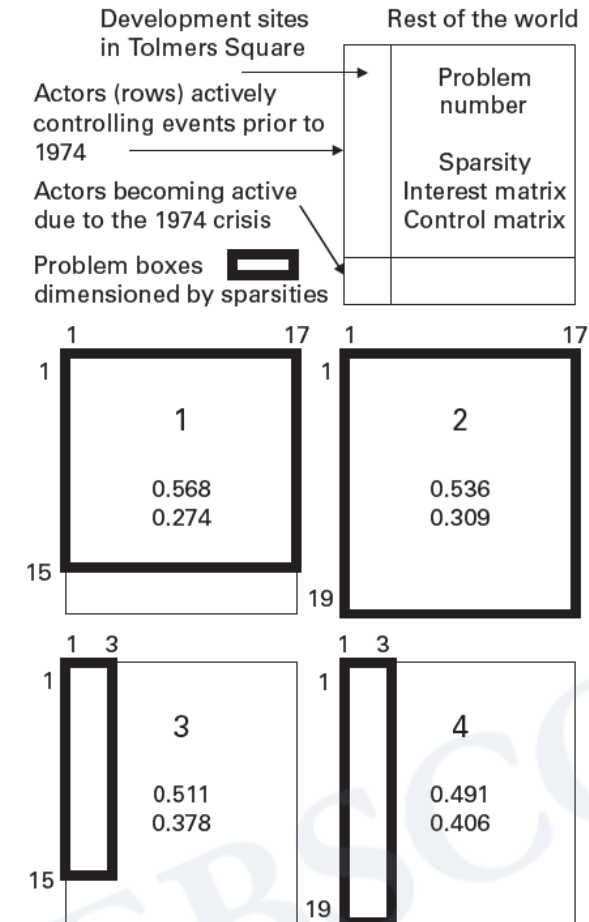


Figure 13.2  
Dimensions and sparsity of the four models.

## Applications and Predictions

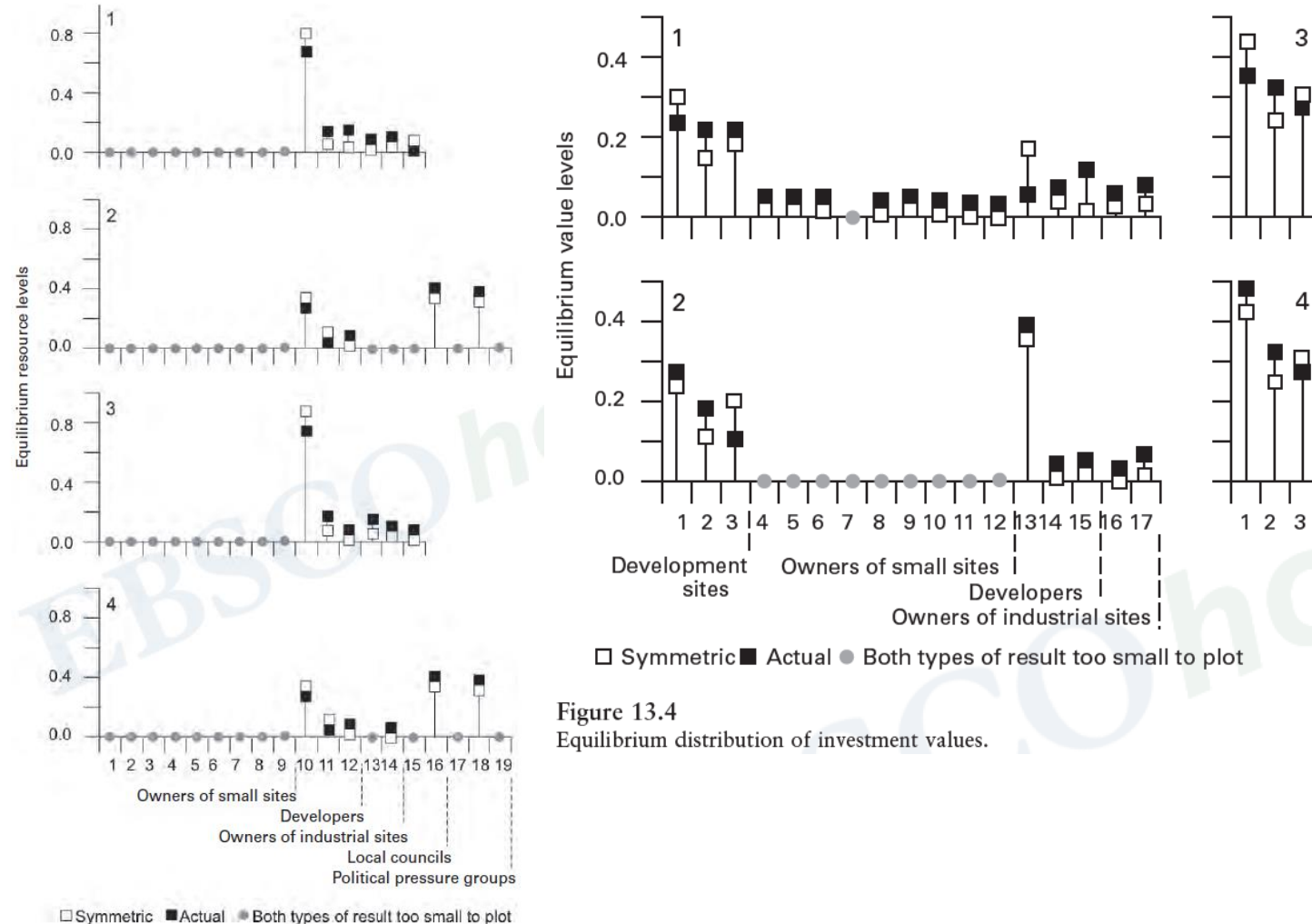


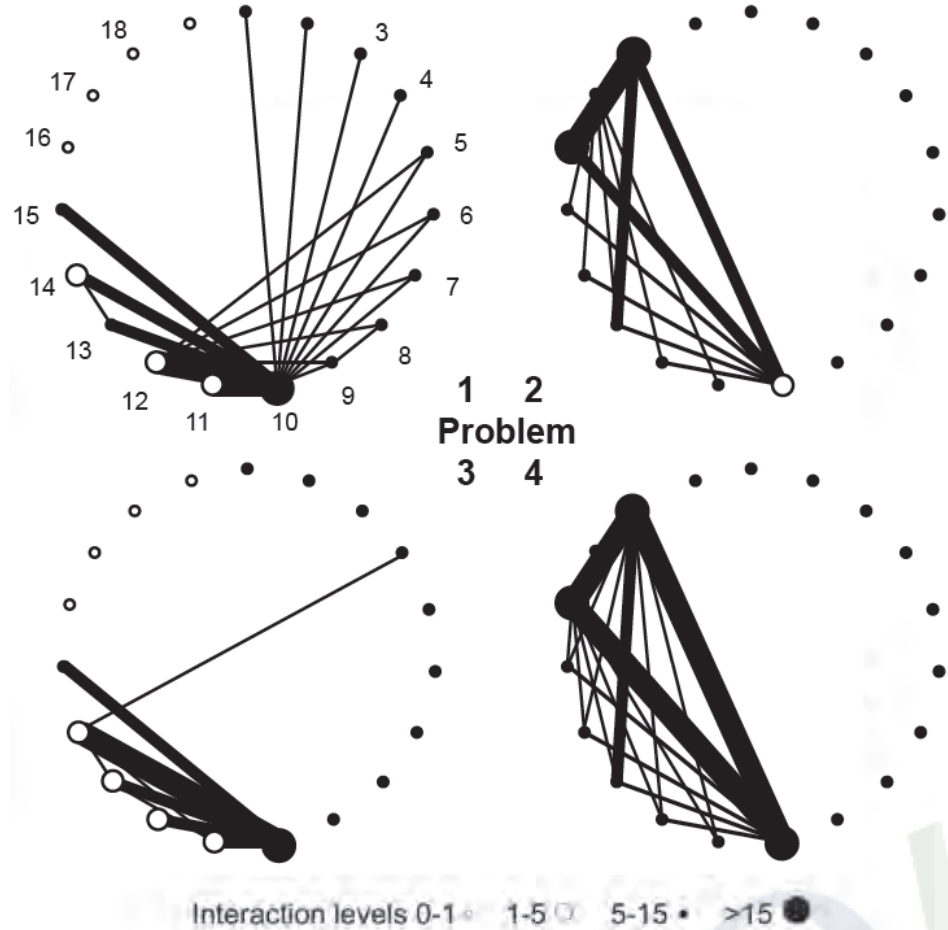
Figure 13.4  
Equilibrium distribution of investment values.

Figure 13.3  
Equilibrium distribution of resources.

- If it is assumed the system is already in equilibrium and initial pattern of control in value terms  $\hat{C}$  is in equilibrium.
  - $\hat{C}^T = \hat{X}$
  - Such a model is in equal exchange and its flow matrices are symmetric.
  - The symmetric are close to the actual values and thus represent a good first approximation to resource levels.
  - Taking out the rest of the world sector increases the dominance of the “large actors” like Stock Conversion.
  - New actors reduces the value of the three sites



## Applications and Predictions



- These networks show the percentage of resources exchanged and identify the critical actors in this process.
- In model 1, Stock Conversion dominates most of the (48%) exchange.
- In model 2, Three actors — Stock Conversion, Camden, and Claudius engage in about 70% of the exchange.
- When the rest of the world sectors are deleted, patterns of exchange intensify;
  - In model 3, 63% of trade becomes internal to Stock Conversion.
  - In model 4, three key actors are involved in 86% of the exchange.

Figure 13.5  
Equilibrium exchange between actors.

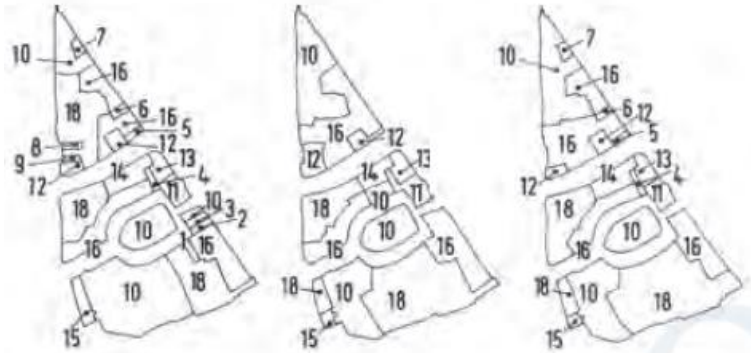
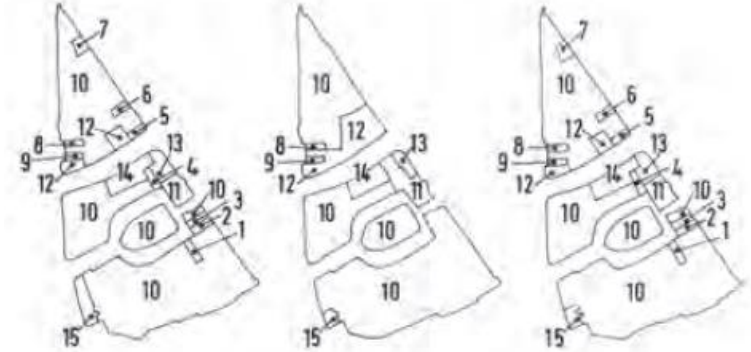


## Applications and Predictions

Initial control  
problems 1 & 3

Final control  
problem 1

Final control  
problem 3



Initial control  
problems 2 & 4

Final control  
problem 2

Final control  
problem 4

- Four predicted patterns of land ownership are presented.
  - In model 1, owners and occupiers disappear at the expense of the property developers.
  - In model 2, the main interest is that Claudius loses its control over the Island site while increasing its land holdings in Tolmers Square South
  - In model 3, there is little change from the pattern of initial control without the rest of the world sector.
  - In model 4, the exclusion of the rest of the world sector leads to less change from the pattern of initial control.
- The predictions from these models at least appear consistent with the actual chronicle of events.

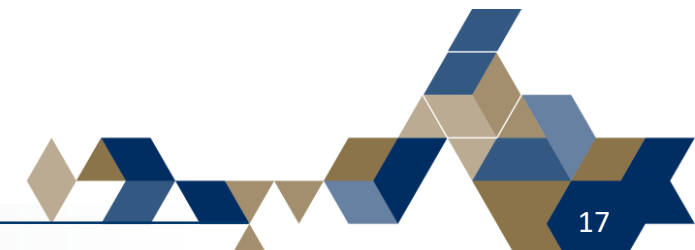


Figure 13.6  
Equilibrium predictions of land ownership patterns.

Thank you for your time.

Any questions?

