MODELS OF NATIONAL SETTLEMENT SYSTEMS:
A PRELIMINARY PERSPECTIVE

M. Cordey-Hayes

July 1974   WP-74-23

MODELS OF NATIONAL SETTLEMENT SYSTEMS: A PRELIMINARY PERSPECTIVE

M. Cordey-Hayes

1. Introduction: The Problem and Approach

1.1   Most developed countries are concerned with prob-
lems of lagging regions, uncontrolled metropolitan expansion
and population growth and it is becoming increasingly recognized
that these problems should be tackled together as part of a na-
tional settlement strategy. Individual countries, however, have
very different national settlement concerns due to their differ-
ing size, location of resources, age of industrialization, and
rates of population growth. For example, the United Kingdom is
a geographically small country, with a well developed infrastruc-
ture, relatively low population growth rate, and has been indus-
trialized (and urbanized) for over a century. It has few options
for major changes to its distribution of population and economic
activity. However, the U.K. is vitally concerned with problems
of regional imbalances in opportunities, and also with the evalu-
ation of the regional implications of the discoveries of large
oil deposits in the seas surrounding its peripheral areas. In
contrast, Canada and the Soviet Union are large countries, with
vast natural resources deposited in uninhabited areas, and with
relatively rapidly growing populations--both countries have many
options for expanding and changing their national settlement dis-
tributions. Therefore, the national settlement strategies of
individual countries are likely to be very different, except in

so far that each will be concerned with the pursuit of national growth, promotion of inter-regional equity, and with general quality of life goals.

1.2   But given this need for national settlement strategy, the practical problems of managing economic and demographic growth in balance within and between cities and regions are formidable. The decision-maker finds that goals and objectives are difficult to define, are multidimensional and may conflict one with another, and various trade-offs have to be made. Conflicts may arise between national and regional goals, between economic, social and political objectives, between regional equity and individual equity etc. In this situation there is a need for methodologies which enable the decision-maker to conduct policy experiments, through analyzing and comparing the effects and repercussions of alternative courses of action. But the lack of understanding of how a system of interacting city-regions function is a major constraint. We need to know much more about spatial-economic processes through time, and of the relationship between various settlement patterns and quality of life aspects. National settlement policy is therefore likely to be a goal-oriented, pragmatic activity with formal methodology integrated with more intuitive forms of analysis and decision-making. Therefore, as well as identifying and testing policy options, the activity of model building needs to be a structured learning process which aims to provide a common conceptual framework·for both the researcher and the planner involved in the strategic analysis of national settlement policy. This approach attempts to integrate the policy need to

look at the 'whole system' with the traditional approach of science that is based on breaking down global problems into discrete and soluble ones. It is based on a hierarchical, iterative, learning form of urban analysis that may involve simulation methods at some iterations and optimization approaches at others.*

1.3   For these general reasons the initial aim of the modelling side of our research should be to evaluate critically and to assess the <u>potentiality</u> of various theories and methodologies for development and application to policy-oriented analysis of urban settlement systems. It should not aim at a protracted and major review and inventory of, for example, the extensive litera-tures of regional economics and central place theory. With this emphasis on potentiality for development, this note takes an extremely <u>brief first perspective</u> of some relevant literature to highlight areas where our December Conference paper is likely to focus This should help us now begin to select invited papers on topics which we consider of particular importance and which need to be considered in some detail. Also it identifies where our background paper is likely to be weakest, and where we may need help. Some pointers for our research on models of national settlement systems are given, but these will be considered in more detail in a separate note.

---

*Details of this approach and how it attempts to integrate simulation and optimization will be outlined in a separate note. But the application of the iterative approach to strate-gic planning at the County level is described in, for example, Massey and Cordey-Hayes, 1971.

2. Theories of Urban Size Distribution

2.1   City size distributions have been studied by

many researchers but no really adequate theories exist.

There are a number of complementary approaches and these have

been recently reviewed by Mills (1972) and Richardson (1973).

Essentially there are two types of theory to describe the

observed regularities in the distribution of city sizes.

These are:

(i)   Deterministic economic analysis based on demand

thresholds and the range of goods. These concepts of threshold

and range can be used to stratify cities into regular hierarchies

which approximately reproduce the observed distributions of

city sizes. The papers of Beckman (1958, 1970) and Tinbergen

(1968) are the seminal works of modern approaches to an

economic explanation of city size distributions; and

(ii) Stochastic models based on the hypothesis that the

size of an urban area is determined by the product of a large

number of random variables. This produces a growth pattern in

which growth is proportional to existing city size and which

results in a log-normal distribution of city sizes (Simon 1955).

Both these approaches (and their variants) are essentially

static and retrospective, and certainly do not provide an

adequate framework for the analysis of interventions to be made

to the working of a system of post-industrial cities. However, the

approaches are useful in that they draw some attention to the

strong functional interdependencies that exist between a set of

city regions; that is, agglomeration economies operate

between cities as well as within. One of the fundamental inter-

dependencies that has been stressed in some of the more
recent approaches to city-size distributions is the spatial
diffusion of innovation in a hierarchical fashion from larger
to smaller cities (Berry, 1972). These (and other) systemic
functions of urban hierarchies comprise one area where we
may wish to invite a contributed paper, provided it is
integrated with policy oriented questions of the type:

Is there evidence of a re-structuring from a hierarchical dis-
tribution to a megalopolitan form, or to a more uniform distribu-
tion of city sizes? What are the causes and implications of the
restructuring? Is it desirable change...?

2.2   Another possible interest is the integration of a
Markov modelling approach to city size distributions with observed
migration patterns to give estimates of future city size dis-
tributions. This could begin to provide a methodology which
gives some indication if current migration patterns do point to
a restructuring of city size distributions, or merely indicate
a growth of one city and decline of another but with no overall
change in the distribution. Some researchers argue that migra-
tion favours medium sized towns and this will produce a more
uniform distribution of city sizes of around 100-200,000 popula-
tion (Lever, 1973). Others consider that this is largely a re-
flection of sub-urbanization and that strong inter-dependencies
and economies exist between cities of this size and neighbouring
metropolitan centres. Estimates of the long term implications
of existing migration patterns for city size distributions can

be looked upon in two ways. They can be considered to provide
a pointer to the settlement pattern that may occur without policy
actions, and this provides a background against which various
settlement policies may be compared. Alternatively, in a more
normative sense, some may consider that migration is a process
in which people are demonstrating their preferences amongst
various existing settlement types and that the projection
of these is in some sense a positive guide for policy.(Richardson,197?

2.3   However, the more general area of theories of city
size distributions will not be considered in detail in the
December paper, partly because it underemphasizes spatial aspects of
inter-dependence but more importantly its static and retrospective
conception give little insight for policy. Also, "satisfactory
economic growth as well as individual happiness of the inha-
bitants of a country are compatible with wide differences in
the degree of spatial concentration of the population and its
economic activities"--there is a wide range of indifference, we
need to explore where the boundaries of this range lie (von Boventer,
1971). A comparison of the settlement patterns of France and
West Germany support such a conclusion. There is no "optimum
optimorum" of city size distributions, but national settlement
policy needs to take account of the strong functional interde-
pendencies that exist between cities, and how these may change
over time and may lead to a restructuring of city sizes. The
next section considers models which aim to model these economic
interdependencies explicitly.

3. . Inter-regional economic models

3.1   These include classical economic models based
on international trade theory, inter-regional input-output
analysis and the multi-sector development planning models
of Tinbergen and his associates. Richardson (1973) has given
a recent summary and evaluation of these methods within
a regional growth theory context. Although the latter two
approaches can make useful contributions to national settlement
policy, each has major limitations. Inter-regional input-output
is a very versatile tool with potential application to a wide
variety of problems of direct relevance to national settlement
policy. Also the Sixth International Conference on Input-Output
Techniques (1974) made clear that the approach is being developed
in many countries. For example Granberg (1974)
considers that:

The territorial aspects of functionings of the USSR economy
are certain to be taken into account when constructing models
(or systems of models) of the national economy. Building of inter-
regional inter-industry models is one of possible ways of solving
general problems of territorial national economic planning in our
country .

        Other applications include the assessment of alter-
native policies to achieve economic development in the Italian
South. Further, French scholars have concentrated on the use of
input-output methods and inter-industry linkages in studying and/or

applying growth pole concepts--although Lasuen suggests that this
fails to recognize the essential dynamics of the growth pole
concept, and simply leads to a search for industries with
'super-multipliers'. Input-output analysis has also been used
to examine the effects of a planned major expansion of an existing
town in the U.K. (Morrison, 1973).

3.2   But basically, inter-regional input-output models are
demand models which give little consideration to the movement
of firms and people between regions (although in principle
it is possible to use an input-output table linked to migration
and economic activity location submodels, Harris 1970). The methods
assume constant technical coefficients and unchanging trade patterns.
And the approach is perhaps conceptually more of a data-structuring
and forecasting methodology appropriate to detailed analyses of one-
off case studies, than a versatile theoretical framework for the
general analysis of national settlement systems. Apart from theo-
retical drawbacks, inter-regional input-output analyses (particu-
larly if dynamic) pose major data problems.

3.3   Inter-regional multisector models (Tinbergen, 1964;
Bos, 1968) are concerned with working out optimal regional-sec-
toral distributions of economic activity for achieving maximum
economic growth whilst at the same time meeting specified regional
income targets. The problem of allocating resources amongst
regions and sectors is directly related to national settlement
strategies, but so far the work on these models has been highly
mathematical. Richardson (1973) also suggests that "its data
requirements are heavy, and it is doubtful whether the solution
of the model can provide more than crude and broad guidelines
for planning decisions". It is also exclusively concerned with

the trade off between regional equity and national economic

efficiency, whereas "the spectrum of regional policy goals

is too broad to be reflected in a set of regional income targets.

In particular, the satisfaction of locational preferences and

other social goals cannot be easily converted into such targets"

3.4   Despite the above limitations and lack of

direct application to national settlement policy, both the input-

output and multisector methodologies are potentially useful and

are of longer term interest. However, the literature in these

areas is extensive and specialized and it may be sensible to

invite a paper from the Netherlands School (Paelinck,

or Klaassen) on 'the application of inter-regional economic

models to national settlement policy'.

3.5   An important question in this regional economics

area is: How can deterministic static location theory be linked

with the dynamics of inter-regional growth? Two loosely ar-

ticulated approaches are currently available;these are growth-

pole theory and the Tinbergen-Bös urban hierarchy model. But

as Richardson correctly argues both have an inadequate treatment

of time and have poorly formulated conceptions of the processes

of growth and interaction.

3.6   Klaassen (1973) has attempted to formalize growth

pole theory by introducing a concept of 'attractiveness' to

represent the extent to which industrial linkages influence the

spatial distribution of activities through supply considerations.

That is, the presence of one sector may often stimulate activity

in another sector and influence the location of that sector in

a way that leads to a clustering of industries. The approach is

based on notions of 'economic distance' between sec

(essentially the transport and communication costs of inter-mediate products), and 'location profiles'. Paelinck (1973) has recently integrated this attraction analysis into what is basically a control theory framework to give "Models of Multi-regional Economic Policy, Based on Attraction Analysis". Paelinck argues that:

"Compared with more classical methods (multiregional input-output), the methods now set forth have the following advantages:

a. integration of supply factors with demand factors, so that the effect of creating industrial complexes can be taken into account;

b. explicit integration of measures of regional economic policy;

c. it is possible to determine the effects of infrastructural policy (as the attraction concepts are a function of economic distance);

d. external effects, initiated in one region and communicated to others (spill-over) are integrated into the model, as are classical links by the flows of inter-regional trade".

3.7 This approach appears potentially very useful but much has still to be achieved with this model both in the exposition of the mathematical approach and in the application of these ideas in practice. Nonetheless, the model forms the base of the project FLEUR (Facteurs de Localisation en Europe Occidentale) which is a study being undertaken by the Netherlands Economic Institute and sponsored by the European

Economic Community.

3.8   If we invite a paper on the application of these
ideas to national settlement policy, then we should ask that
a number of explicit policy questions be included. For example,
what are the characteristics of the leading industries that
catalyse the clustering effects? What are the spatial and
sectoral inter-relations that are most important for national
settlement policy? How important is it to build up the transport
infra-structure of lagging regions?. What controls and incentives
are likely to be most effective in influencing the scale and
pattern of development of economic activity?

4.   Multi-region Demographic Models

4.1   Recently several papers have focussed on multi-
regional demographic models (Alonso, 1973; Rees and Wilson, 1973,
1974). The work of Alonso in particular considers the explicit
evaluation of a variety of alternative national settlement po-
licies. These papers are expected to form an important part
of our background paper, and we should also invite contributed
papers from Alonso and Wilson. A detailed evaluation of these
methods has been made and will be produced as a separate note.
Only very brief observations are given here.

4.2   Rees and Wilson generalize the earlier matrix methods
of population forecasting (Rogers 1966, 1968) and integrate
these with concepts of time-oriented accounting to yield an
elegant and rigorous inter-regional population forecasting metho-
dology. As yet the work has had little emphasis on policy, but
the 'intervention' approaches described by Rogers (1968) are

equally applicable to this newer formulation. An important
development of this style of accounting framework will be to
build models of the transition rates that occur as parameters within
the accounts. Ginsberg (1972) and Cordey-Hayes (1972) both empha-
size the importance of this and have given strategies for this
integration of probablistic transition matrices with causal theory.
This would then begin to introduce the causal structure necessary
for the analysis of policies aimed at steering a system of regions
towards some planned national settlement pattern.

1.3   The demographic simulation model of Alonso provides an
interesting demonstration of the use of analytical methods to the
elaboration and comparison of alternative national settlement
strategies. Twelve alternative policies were tested; some of
these reflect variations on preferred urban sizes, others repre-
sent different approaches to an equity objective and one policy
is aimed at   economic efficiency. Overall there seems to be a
vague trade off between equity and efficiency in the sense that the
most efficient economic growth policy is the most inequitable and
vice versa. It will be of interest to compare these results with
the production function approach to the trade off between regional
equity and efficiency described by Mera (1973). However, one must
emphasize the crudity of Alonso's measure of income (which is used
as an attraction variable in the migration equations); it uses
simply population potential as a proxy for income--and therefore
it is hardly surprising that his policy aimed at maximizing in-
comes leads to the greatest concentration of population, with
many smaller towns losing population.

A major weakness of the Alonso model is that it considerably
underplays the importance of the inter-dependent link between
demographic growth and economic growth. Alonso acknowledges
this, but then argues that the poverty of location theory for
footloose industry and for service activity means that a joint
model mediating demographic growth and the dynamics of
location of economic activity is some distance away. This is
partly true, (and offers an interesting challange to the IIASA
urban project) but perhaps this economic-demographic link is
best found in terms of a more stochastic approach rather than
the deterministic, static, behavioural approach of location
theory suggested by Alonso (some comments are given on this in the
next section).

4.4   Whilst partly agreeing with Alonso's assessment,
it is important to note that his own model implicitly contains
a crude economic growth model based on a correlation between income
and population potential. And by not making this economic model
explicit, his results can be very misleading. It is impossible to
side-step this problem of the dynamics of the inter-dependent
interaction between demographic movements and economic growth
and this means that migration theories must play an important role
in models of national settlement systems. Further, implementation
of national urban policy implies a steering of migration flows
to selected growth areas and therefore migration is also an important
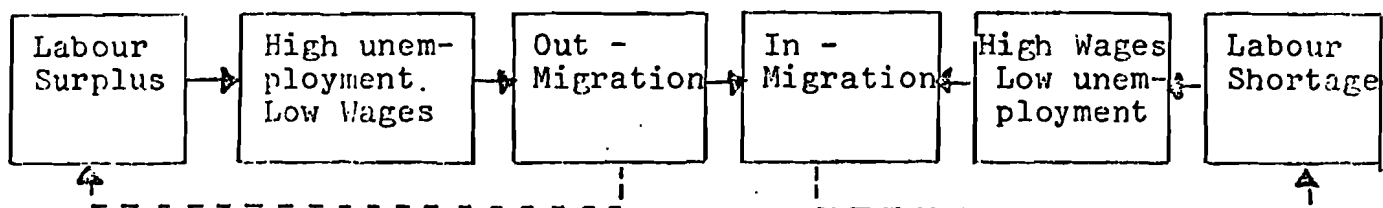policy variable.

4.5   Before going on to discuss migration, it is worth
noting that the IIASA urban project could make a useful first

advance on the above approaches by combining the analytical rigour of the Wilson approach with the policy orientation of the Alonso simulation, and at the same time attempting to strengthen the demographic-economic link of the latter. The work of Cordey-Hayes and Gleave looks explicitly at this link for city regions in the U.K., and a variant on this approach could perhaps be integrated with those above to provide an initial prototype framework, or demonstration model, related to national settlement policy.

5. Migration

5.1   This section considers the inadequacies of current theories of inter-urban population migration and outlines the longer term implications of these inadequacies for the building of models of national settlement systems.

5.2   The traditional economic approach to migration is summarised in the flow diagram below:

Labour Surplus	High unemployment. Low Wages	Out - Migration	In - Migration	High Wages Low unemployment	Labour Shortage

The theory is essentially based on a 'push-pull' phenomenon that seems intuitively sensible--migration is motivated by poor employment conditions (low wages, high unemployment) and migrants are differentially attracted to areas with high wages and low unemployment. Such a process is self-equilibrating since out-migration reduces the labour surplus and vice-versa. This equilibrating mechanism between the supply and demand for
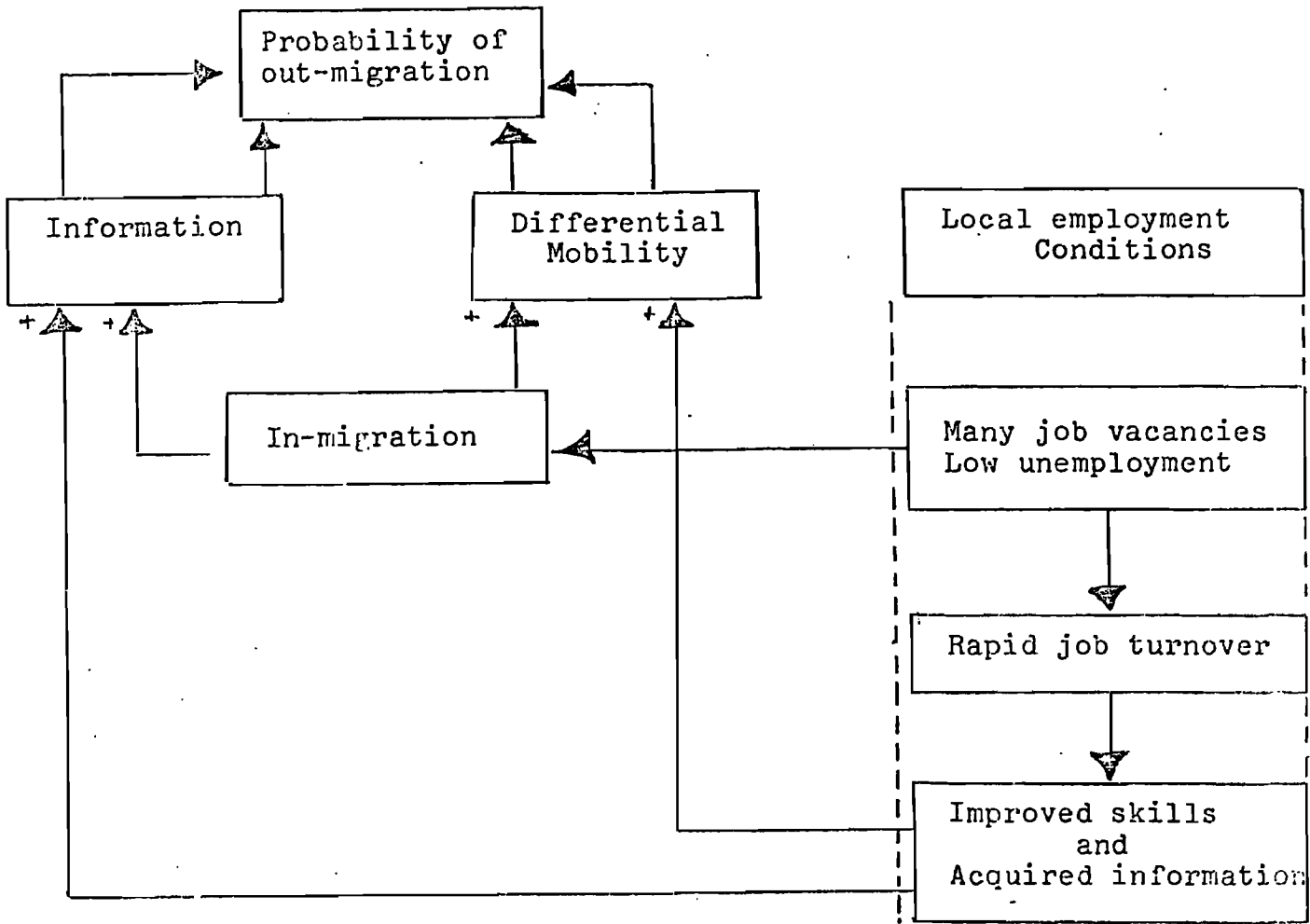
labour has been used to link the employment and deomographic sectors of a number of regional models (for example, see Hamilton, 1969). The basic hypotheses that underlie the above push-pull theory is that in-migration is directly related to the economic attractiveness of an area, and that out-migration is inversely proportional to in-migration.

5.3   A great deal of research was carried out on migration in the 1960's and the general conclusion was that in-migration could be interpreted in terms of concepts of economic attractiveness, but several researchers (in particular Lowry, 1966, and Lansing and Mueller, 1968) conclude that per capita gross out-migration is independent of the economic characteristics of the generating region, that is the per capita rates of out-migration are similar for all regions irrespective of their economic character. Thus, there are two rival hypotheses on the relationship between the directional components of migration; these are: (i) the standard economic hypothesis that in- and out-migration are inversely related, and (ii) the empirically derived hypothesis that out-migration is independent of the economic characteristics of an area (and is therefore unrelated to in-migration which is dependent on areal characteristics).

5.4   The difference between these two hypothese have important implications for national settlement policy considerations. For example, the second implies that policies aimed at halting out-migration are likely to be ineffective and the best that can be achieved is to steer out-migrants away from congested cities to selected growth areas. Cordey-Hayes and

Gleave (1973), have tested these hypotheses by reference to city-region data for England and Wales. It was found that neither hypothesis was correct and in fact, a strong <u>direct</u> correlation between the per capita rates of in-migration and out-migration was observed. That is, areas with the highest rates of in-migration also had the highest per capita out-migration rates. Declining regions were observed to have the <u>lowest</u> per capita rates of out-migration and minimal in-migration. Decline should therefore be associated with a lack of a compensating flow of in-migrants, rather than with high out-migration.

5.5   This direct relationship between the directional components of migration was explained by a dynamic mechanism which associated regional out-migration with in-migrants from a previous time period. That is, an intrinsic attractiveness concept was used to explain the differential attraction of migrants to specific destinations, but then a positive feedback mechanism was introduced such that recent migrants to an area were more likely to move on again than were the remainder of the resident population who had established a strong network of social and economic ties in the area. This feedback based on differential mobility satisfactorily explains the <u>mechanism</u> that relates the directional component of migration, but what is missing is an associated <u>theory</u> of labour mobility. Currently, a theory which looks at inter-urban migration as an extension of the local labour market is being developed and tested (Renshaw, 1972, Gleave and Cordey-Hayes, 1974). This theory is outlined in the flow diagram below.

Probability of
out-migration

Information

Differential
Mobility

Local employment
Conditions

+   +

+   +

In-migration

Many job vacancies
Low unemployment

Rapid job turnover

Improved skills
and
Acquired information

5.6   Here the probability of out-migration is hypothe-
sized to depend on local employment condition, the differential
mobility of individuals within the region, and on their know-
ledge/information of the opportunities outside their own region.
It is further hypothesized that a regional labour market in which
there are many job vacancies and low unemployment will generally
have a rapid voluntary turnover of jobs. This is because employees
have a relatively risk free opportunity to change their jobs

in an attempt to match their differential skills and tastes to a differentiated job market. This matching of abilities and tastes to jobs can be regarded as a stochastic learning process in which movers are acquiring new skills and gaining information not only of the local labour market but also of a more extensive one. That is, conditions that favour local labour market turnover are also those that induce occupational mobility and give a better knowledge of spatially move extensive labour markets—both of these increase the likelihood of inter-urban migration (as indicated by the positive feedback arrows in the flow diagram). The high number of job vacancies also attract migrants from other regions and therefore growth regions will be characterised by high in-migration and high out-migration.

5.7   Conversely, low vacancies and high unemployment lead to a static local labour market with few people changing jobs. The tightness of the labour market produces caution, over-specialisation and possibly low productivity. Low turnover results in individuals not having the opportunity to enter the learning process that was outlined above and there is little occupational mobility and low out-migration.

5.8   These arguments are not intended to be rigorous here, they aim simply to re-cast inter-urban migration in a way that has implications for both research and policy on national settlement systems. Firstly, consider briefly the implications for research.

5.9   The results suggest that the traditional demographic-employment linkage based on migration as the equilibrating

mechanism between the supply and demand for labour is incorrect.
Therefore, the results of regional and inter-regional models
based on this conceptual linkage should be treated with
caution (Hamilton, 1969, Forrester, 1969, Kandanoff, 1972).
It is of interest to compare the flow diagrams for the 'standard eco-
nomic theory'   (p. 14) and the 'mobility theory' sketched above
The former is based on a deterministic chain of mono-causality
and is static. The latter is stochastic, with many feedback
loops giving multi-causality and is dynamic. Whereas the concepts
of the traditional economic approach are homogeneous labour,
complete information and perfect mobility, the approach argued
here is based upon heterogeneous labour, partial information and
strong differential mobility.   It considers that the labour market
is a complex stochastic process that involves interactions amongst
many participants—and therefore should be modelled as such.
One of the key variables in a stochastic linkage between the demo-
graphic and employment sectors is the dynamic concept of job
vacancy. In a separate context (that of manpower planning), several
labour market models based on a dynamic treatment of job vacancies
have been developed (Holt and David, 1966; Harrison White, 1970;
Bartholomew, 1971), and these are currently being researched in
an attempt to link migration to a stochastic treatment of the
components of employment change (Gleave, Cordey-Hayes, 1974).

5.10   More generally, the above research on migration sug-
gests that it would be very useful to develop a methodology capable
of treating occupational mobility and geographical mobility
within the same analytical framework. Potentially, the framework

would be able to integrate spatial settlement systems with
sociological concepts of relative opportunity, occupational
mobility and equity.

5.11   On the policy side, the results suggest that a
large part of inter-urban migration in developed countries
is a spontaneous movement of individuals moving from economic
'strength to strength' (rather than being 'pushed' from
economically weak regions). This is of interest because
it suggests that there may be a more subtle re-structuring
occuring than simply the growth and decline of some regions.
Also, the result implies that national settlement policy does
not need to stimulate migration but simply to channel it
to selected growth areas. But these growth areas will be more
successful if they have a diverse range of job opportunities,
providing a setting for voluntary job turnover and occupa-
tional mobility, rather than a highly specialized employed
structure based on one or two large plants.

5.12   The results also suggest that it is inevitable
that each region lose a substantial proportion of its young,
dynamic and most mobile population each year, and therefore
national settlement policy should recognize that new or
expanding towns will have to be continually attracting
population to compensate for the large numbers who will
leave irrespective of how successful the town may be.

5.13   These conclusions do not, of course, have univer-
sal applicability--in areas where rural to urban migration is the
dominant process then the conclusions are far less applicable.
However, the 'spontaneity' of inter-urban migration appears

to apply in both market and socialist economies (Matlin, Tshukhnov, 1974). Also, variants on the above stochastic approaches (but which are still structured upon differential mobility, information, and local labour market conditions) are likely to be more generally applicable than the traditional deterministic models based on neo-classical economics.

6. Conclusions

5.1 This brief perspective on models of national settlement systems serves to conclude that:

(i) Models of city size distributions do not provide an adequate framework for national settlement policy considerations, but they do usefully draw attention to the hierarchical structure and functional interdependencies that exist between cities. There are several important policy questions on hierarchical restructuring that need to be considered, and Markov models may have a role to play in this.

(ii) Inter-regional input-output models are flexible tools directly applicable to settlement policy. They appear to provide however a methodology more appropriate to one-off studies than a general theory. Input-output analyses are also demand oriented and do not consider agglomeration economies and locational preferences. Klaassen's attraction analysis aims to alleviate this by introducing these interdependencies of supply, and this when integrated with Paelinck's dynamic modelling approach gives a methodology of interest to national settlement policy. It still however has to be proven in practice, and the progress

of the FLEUR project will be of interest in this respect.

(iii) Inter-regional demographic models are conceptually relatively straight forward and the Alonso formulation can be used to address important policy questions relating to preferred city size, equity and national growth. But until these inter-regional demographic models are more strongly linked to the dynamics of economic growth, their results are likely to be misleading.

(iv) The traditional demographic-economic link in which migration is seen as an equilibrating mechanism between the supply and demand for labour is of doubtful value when considering the dynamics of the interdependent interactions between the growth sectors. Research is required to recast migration in more general terms--some progress to date on this was outlined.

(v) The IIASA urban project should probably aim to have operational fairly quickly a model that could begin to provide the genesis of a common conceptual framework for the policy analyst and researcher alike. From this brief perspective it seems that perhaps a promising approach is a fusion of the models of Alonso, Wilson, and Cordey-Hayes and Gleave. Work could begin on this quite soon, but it is probably better to delay this until a fuller and more thoughtful assessment of our needs has been made. In parallel to this activity, further explorations of the Paelinck approach should be made. This would really require that Paelinck (or an expert to) spend some time here this summer.

6.2   This perspective of models of national settle-
ment policy is based largely on the literature of the regional
science schools of the North Americas and Western Europe.
It is hoped that in the forthcoming months we will gather litera-
ture from the Soviet Union, and perhaps Dr. Sokolov could pre-
pare an initial summary of this literature. These impressions
could then be integrated to form a wider perspective early in
July.

References

Alonso, N. "National Inter-Regional Demographic Accounts: A Prototype." Monograph 117, Institute of Urban and Regional Development, Univ. of California, 1973.

Bartholomew, D.J. "Stochastic Models for Social Processes" J.Wiley, London, Second Edition, 1973.

Beckman, M.J. "City Hierarchies and the Distribution of City Sizes." Economic Development and Cultural Change 6, (1958).

Beckman, M.J. and McPhersan J. "City Size Distributions in a Central Place Hierarchy: An Alternative Approach," Journal of Regional Science 10, 1970.

Berry, B.J. "Hierarchical Diffusion: The Basis of Developmental Filtering and Spread in a System of Growth Centres" in Hansen N.M. (ed.), Growth Centers in Regional Economic Development, Free Press, New York, 1972.

Bos, H.C. "The Spatial Dispersion of Economic Activity," North Holland, Amsterdam, 1965.

Cordey-Hayes, M. "Dynamic Frameworks for Spatial Models," Socio-Economic Planning Sciences 6, 1972

Cordey-Hayes, M. and Gleave D. "Migration Movements and the Differential Growth of City Regions in England and Wales," Centre for Environmental Studies Research Paper 1, 1973, and PPRSA Volume 33, 1974.

Forrester, J. Urban Dynamics, MIT Press, 1969.

Gleave, D. and Cordey-Hayes M. "Inter-Urban Migration Seen as an Extension of the Local Labour Market," Centre for Environmental Studies, Working Note, 1974.

Ginsberg, R.K. Incorporating Causal Structure and Exogenous Information with Probabilistic Models, Journal of Mathematical Sociology 2, 1972.

Granberg, A.G. "The Construction and Use of Inter-Regional Inter-Industry Models in the USSR", Sixth International Conference on Input-Output Techniques, Vienna, 1974.

Hamilton, H.R. et al. "Systems Simulation in Regional Analysis", MIT Press, 1969.

Harris, C.C. Jr. The Urban Economies, 1985, Lexington Bode 1973.

Holt, C.C. and David M.H. 'Concept of Job Vacancies in a
      Dynamic Theory of the Labour Market' in The Measurement
      and Interpretation of Job Vacancies, NBER, Columbia Press
      1966.

Kadanoff, L.P. "From Simulation Model to Public Policy,"
      American Scientist 60, 1972.

Klaassen, L.H. "The Location of Industry, Some Considerations,"
      Netherlands Economic Institute, Series: Foundations of
      Empirical Economic Research, 1973.

Lasuén, J.R. "On Growth Poles," Urban Studies (June), 1969.

Lansing, J.B. and Mueller E. "The Geographical Mobility of
      Labor," Survey Research Center, Institute for Social
      Research, Ann Arbour, 1968.

Lever,   "A Markov Approach to the Optimal Size of Cities in
      England and Wales, Urban Studies, Oct., 1973.

Lowry, I.S. Migration and Metropolitan Growth: Two Analytical
      Models, Chandler, San Francisco, 1966.

Massey, D.B. and Cordey-Hayes M. "The Use of Models in Structure
      Planning", Town Planning Review, 42, 1971.

Matlin, I.S. and Tshukhnov A.I. "One Model of Inter-Regional
      Migration in the USSR," Sixth Int. Conference on Input-
      Output Techniques, Vienna, 1974.

Mera, K. "Regional Production Functions and Social Overhead
      Capital"- Regional and Urban Economics 3, 1973.

Mills, E. Urban Economics, Scott Foreman, Glenview, Illinois.

Morrison, W. "The Development of an Urban Inter-Industry
      Model," Environment and Planning 5, 1974.

Paelinck, J.H.P. "Models for Multi-Regional Economic Policy,
      Based on Attraction Analysis," Netherlands Economic
      Institute, 1973.

Renshaw, V. "Labor Mobility, Turnover and Gross Migration,"
      Working Paper, University of Nebraska, Lincoln.

Richardson, H.W. Economics of Urban Size, Saxen House Press, 1973

Richardson, H.W. Regional Growth Theory, Macmillan, 1973.

Reer, P.H. and Wilson A.G. "Accounts and Models for Spatial
      Demographic Analysis I: Aggregate Populations,"
      Environment and Planning 5, 1973, and 6, 1974.

Rogers, A.   "Matrix Methods of Population Analysis" <u>JAIP</u> 32, 1966.

Rogers, A.   "Matrix Analysis of Inter-Regional Population
     <u>Growth Distribution</u>," University of California Press, 1968.

Simon, H.   "On a Class of Skew Distributions," <u>Biometrika</u> 42,
     1955.

Tinbergen, J.   "The Hierarchy Model of Size Distribution of
     Centres," <u>PPRSA</u> 20, 1968.

Tinbergen, J.   "Sur un Modèle de la Dispersion Géographique
     de l'activité economique" <u>Revue d' Economie Politique</u>
     74, 1964.

White, H.   "<u>Chains of Opportunity: System Models of Mobility</u>
     <u>in Organizations</u>," Harvard Univ. Press, 1970.

Von Boventer, E.G.   Rehovot Conference: On Urbanization and
     Development in Developing Countries, 1971.