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CONFIGURATIONAL ANALYSIS AND URBAN AND REGIONAL THEORY

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1. The context: some major schools of 'theory'

A point has been reached in the development of urban and regional theory where it is useful to introduce a particular notion which helps to provide a meta-structure for further research. At present, the field is characterised by a variety of theoretical and methodological approaches, usually presented as being in competition with each other; sometimes even, proponents of any one claiming their own as an all-embracing paradigm. Three examples of this variety of approaches will be used to illustrate the argument: neo-classical economics, geographical modelling and marxist theory. The first is illustrated in modern times by the work of Alonso (1964), reviewed in a variety of applications by Richardson (1977) and presented recently in a way which is maximally compatible with modelling by Anas (1982,1985). The second is characterised by spatial interaction model underpinnings (Wilson 1970, 1974, Wilson and Bennett, 1985) and a focus on structural stability and dynamics (Harris and Wilson, 1978, Wilson and Clarke, 1979, Clarke and Wilson, 1983). The third rests on Harvey's (1973) *Social justice and the city* and a more recent example, which we use below, is Massey's (1984) *Spatial divisions of labour*.

It is important to distinguish between the theoretical and methodological dimensions of these approaches. Theories are collections of hypotheses about structures and processes in cities or regions at a variety of scales. Methods provide ways of representing these hypotheses and of demonstrating the consequences of belief in particular sets of hypotheses. At a more fundamental level (even at an epistemological level, if philosophy is taken as methodological),methods enable new kinds of hypotheses to be formulated; and, if they are effective, they allow us to clear the fog generated by the sheer complexities of cities and regions.

The three schools identified for use as examples are typically characterised (in their 'majority' manifestations) by methodological styles as well as theoretical differences. Neo-classical urban and regional economics rests on particular categorisations of the actors, and particular hypotheses about what governs their behaviour: utility maximising, profit maximising and so on. A certain style of mathematical apparatus is used to deduce the consequences of these assumptions. Marxist theory rests on different categorisations and different assumptions about behaviour in relation to these: capital and labour; class struggle. Research in urban and regional studies tends to be emprical and non-mathematical, focusing on interpretations of the behaviour of different kinds of agents. Spatial-interaction based geographical modelling involves a shift to phenomena at a coarser scale and so its hypotheses are not so directly related to the typical micro-scale hypotheses of, say, neo-classical theory. The style is mathematical but often differs from the economic in being based on discrete spatial units of analysis rather than treating space continuously.

There are more (actual and potential) similarities than this brief sketch implies - or is typically acknowledged by the proponents of each approach. This is particularly true of the economic and interaction-model schools. By casting economic analysis in a discrete zone framework, and by recognising market imperfections, a substantial reconciliation can be achieved (cf. Senior and Wilson, 1974, Wilson and Senior, 1974). More recently, it has been shown that prices and rents can be included in interaction-based structural models (Wilson, 1985). There is a more fundamental clash between the neo-classical and Marxian schools. But there is some common ground between interaction-based modelling and the latter. Harvey (1973), for example, acknowledges that in areas like the modelling of transport flows,the standard interaction models could be useful - but by implication that this style of work will play very much a subsidiary role. Authors like Scott (1980) and Sheppard (1985) have integrated the two styles more directly building, for example, on the account-based work of Sraffa (1960).

However, in contemporary theory, it is possible to identify a major common concern: the analysis of stability and transformation; structure and the processes of change; dynamics, with different elements changing at different speeds; nonlinearities and high levels of interdependence; bifurcation. The terminology varies to some extent with the different schools, but the concern is identifiably - if in an unacknowledged way - the same. But there is a substantial remaining difficulty: it is all too easily possible for a Marxian theorist, for example, to argue that interaction-based dynamic models are not fully confronting the issues they have identified. This may well be true of industrial location theory, for example: Birkin and Wilson (1984-A, 1984-B) in relation to Massey (1984). But the concerns are the same, and with the addition of a higher-level idea, as a methodological contribution, it both becomes possible to see the commonalities more clearly and to make the tools of analysis more powerful in each approach. It is also possible to draw neo-classical approaches into the fold. A concept to be applied on such a scale perhaps deserves a new name: we use 'configurational analysis' and introduce it formally in the next section.

2. The idea of 'configurational analysis.

At one level all kinds of theorists are concerned with the same basic entities: people, organisations and their interrelationships which make up cities and regions. Where the differences emerge is in the way these entities are categorised. What we now need is a way of classifying the state of a system or subsystem of interest without falling foul of this particular problem at the outset. This can be achieved first by making all categorisation provisional, and secondly by allowing categories to 'overlap' - so that rather than being forced to choose between two ways of categorising entities, we simply admit both categorisations. We might even introduce 'fuzzy' categorisation, based on the probability of an entity being in a certain state, though we do not proceed any further with that possibility in this paper.

A system state can now formally be defined as an array $\underline{x}$, say. which is essentially an enumeration of all the entities (and their current states) in the system of interest, each categorised in whatever way is appropriate. This is essentially a micro-scale description and we will pursue later the consequences of aggregation. For any particular theory, key features of this detailed state description will be selected and the picture of the system of interest thus generated is defined as a configuration.

The field of configurational analysis can then be seen as concerned with two major objectives; first, the articulation of configuration descriptions which are adequate for the particular theory; and, secondly, the investigation of structure and change in relation to configurations. In the second case in particular, we will be interested in the circumstances in which there is a transformation from one kind ofconfiguration to another. But adequate analysis of this kind will not be possible unless suitable configuration descriptions have been worked out in the first place. (And this reveals one of the difficulties: to be able to predict a switch to a configuration of a type not yet experienced, the description will have to be sufficiently broad to admit the new one as a possibility. This is not easy to achieve and is a further reason for regarding both underlying categorisations and system descriptions as provisional).

3. Industrial location theory as an example.

It is appropriate to use industrial location theory as an example because it provides a dramatic illustration of both the benefits and the difficulties of configurational analysis. In urban and regional studies, we are obviously interested in representing and explaining spatial structure and so the configuration description can be assumed to have adequate spatial dimensions. There is an immediate weakness to be seen in neo-classical economic analysis for this problem, arising from its essentially marginalist nature. It is possible to investigate (say) the optimal location of a firm given the locations of its resource inputs and its markets, essentially in the manner of Weber (1909). But, at this micro-scale, it is difficult to progress to an account of the structure of the configuration as a whole. At a coarser scale, we are offered either econometric models or the inter-regional input-output model. In each case again, the endogenous variables are functions of exogenous variables which are also part of the configuration description. What we are arguing, therefore, is that whatever one thinks of neo-classical economic hypotheses, the traditional methods of the discipline do not lend themselves to configurational analysis or explanation.

To an extent, this situation can be rectified by combining economic assumptions with an interaction-based modelling approach, as in Birkin and Wilson (1984-A, 1984-B). This involves an intermediate-scale configuration description, not identifying individual firms, but only the total activity associated with the production of goods of type g in each sector m (or n), say in each zone, j, of a spatial system. This array might be denoted by $\{Z_j^{ng}\}$, for example. By defining an array of inter-zonal and inter -sectoral flows, $\{Y_{ij}^{mng}\}$, and adding a quasi-profit-maximising hypothesis that the revenues, D_j^{ng}, and costs (including 'normal' profits), C_j^{ng}, 'balance' in each zone, it is possible to predict the configuration structure $\{Z_j^{ng}\}$.

It can be deduced from Massey (1984) that she would argue that this kind of extension misses the point. It fails to recognise that represent the full range of 'agents' involved in the processes of industrial production and hence industrial location. In particular there is a failure outside Marxian analysis to integrate accounts of the social processes involved with the spatial dimensions. (Indeed, within many Marxist analyses, there is an opposite failure: theory based exclusively on the analysis of socio-economic processes without any spatial dimension). It will typically be agreed that this is a failure of theory - as indeed it may be. But the main point to argue now is that an extension of method within any of these paradigms will facilitate further theoretical development; and that extension is based on the ideas of configurational analysis which we must now develop further for the industrial location case.

We proceed as follows. We assume that the essence of the neo-classical economic paradigm can be embedded within an interaction-based model through suitable combinations of assumptions. We then begin by taking some of the points made by Massey on the processes of industrial production and explore what is involved in developing a configuration description which can be related to these points. We then investigate the possibility of using this new configurational base in an interaction-based framework before exploring the contribution which these models can contribute to Massey style analysis - thus taking us full-circle. Finally, we explore what is involved in operationalising a configurational-interaction model of the type discussed.

Let us begin, then, by considering some of the ways in which industrial configurations are being restructured along with the kinds of process which generate these changes. These examples are largely taken from Massey (1984).

(i) The shift from single-plant to multi-plant structures. This can arise for a number of reasons. One involves the breaking down of production processes into smaller units so that each can be carried out by less-skilled labour. Branch plants can then be used in areas of cheap labour for component manufacture or product assembly. This restructuring reduces labour costs and hence increases profit.

(ii) Mergers and takeovers often allow a spatial restructuring of production patterns.

(iii) There has been a shift of manufacturing employment from inner city areas to the suburbs.

(iv) All these phenomena and processes are taking place within an international context and multi-national configurations of firms are now highly significant within national economies.

(v) There is a rapid rate of technological change.

(vi) There are many differences within what are usually taken as standard industrial groups (even within 'minimum list headings') because of different patterns of ownership within those headings, and the fact that different kinds of owners have different kinds of objectives.

In most current analyses, it is customary to characterise production in terms of (implicitly or explicitly) a production function at each possible site. This will be in terms of a sector; or, at the finest scale, the production of a type of good within a sector. These examples show that we have to distinguish ownership (and hence sources of capital) but above all to distinguish finer-scale elements of the production function: to allow the production of a good to be broken down into a series of alternative activities. It would then be possible to distinguish clearly single-plant from multi-plant production, for example. However, it is here that we hit the first major obstacle: even within a sector, there will be large numbers of possible configurations; and there are further complications because sectors will share various inputs and there will be high degrees of interdependence in that form. A further complication (introduced earlier when the idea of a configuration was presented) is that it is necessary in principle to know all possible configurations, not simply those which exist at present.

So far, we have implied that the configuration description should apply to firms and individual plants - very much a micro-scale approach. It would be possible in principle to work at a coarser scale, provided a wider range of production activities can still be identified. We return to this possibility in the context of operational models later.

The next step in the argument is to explore the possibility of using the kind of configuration description sketched above within an interaction-based structural model. It is useful to begin by recalling the form of that argument. Let D_j^{ng} and C_j^{ng} be the revenues and costs associated with the production of good g in sector n in zone j at a level of 'activity', Z_j^{ng}. Then the essence of the structural argument is given by the set of simultaneous equations

$$\frac{\partial Z_j^{ng}}{\partial t} = \varepsilon^{ng} \left(D_j^{ng} - C_j{}^{ng}\right) \tag{1}$$

with equilibrium conditions

$$D_j^{ng} = C_j^{ng} \tag{2}$$

These equations are deceptively simple because the D_j^{ng}'s are complicated nonlinear functions of the input and output flows to and from the production process (n,g).

Let us now switch to a configuration basis and suppose the vector $\underline{x}$ consists of a set of characteristics which denotes a configuration. Then, formally, equations (1) and (2) become

$$\frac{\partial Z(\underline{x})}{\partial t} = \varepsilon(\underline{x})\{D[Z(\underline{x})] - C[Z(\underline{x})]\} \tag{3}$$

and

$$D[Z(\underline{x})] = C[Z(\underline{x})] \tag{4}$$

where $Z(\underline{x})$ is now an activity level associated with the configuration $\underline{x}$ as a whole - and assuming efficiency within a configuration. It is clear from the earlier analysis that there will be far more possible $\underline{x}$ - configurations than (n,g,j) combinations, if only because a larger list of characteristics will be involved. At any one time, $Z(\underline{x})$ will be zero for most possible $\underline{x}$'s. The task of configurational analysis is to find the $\underline{x}$'s for which this is not the case and to explore possible development paths for the system.

Shortly, we will pursue the task of adding more detail and making the approach less formal. First, however, there are some general conclusions which can be drawn about virtually any theoretical analysis associated with industrial location. These turn on the fact that even when the analysis is presented in qualitative form, something like equations (3) and (4), with particular specifications of the functions and the configuration space, $\underline{x}$, will be operative. If a merger takes place, it will be because the owners of capital associated with two configurations $\underline{x}_1$ and $\underline{x}_2$ note that a new configuration $\underline{x}_3$ can be formed for which $D[Z(\underline{x}_3)] > C[Z(\underline{x}_3)]$ when $D[Z(\underline{x}_1)] = C[Z(\underline{x}_1)]$ and $D[Z(\underline{x}_2)] = C[Z(\underline{x}_2)]$, whatever words are used to describe this.

Some general conclusions can be drawn because of the non-linearities and high degrees of interdependence which characterise systems of this type. These features guarantee the existence of multiple equilibria, and even if the system is in an environment such that equilibrium is never reached, the dynamics will be partly governed by the patterns of underlying equilibria. At critical parameter values, some of these equilibria can appear or disappear; and it is at such points that, for instance, a merger might take place. The complexity of the overall system, and the range of possibilities available, mean that particular instances of types of events will not be precisely determined; but it may be possible to identify 'circumstances' - parameter values - at which particular <u>types</u> of configurations are more or less likely. And, therefore, to anticipate certain types of change.

We have thus identified in principle the broad character of a configurational system and moved towards providing more powerful insights and methods for theory-building than have been available before. If analyses can be carried out more or less explicitly within such a framework, then it becomes possible to focus on <u>theoretical</u> differences between approaches and not methodological ones.

The argument so far has been relatively formal. It may help to pursue it one stage further, still in the context of industrial location, and to see what is involved in making it operational.

We have to find a way of moving beyond our present representations of $\{Z_j^{ng}\}$ as the locational variables and $\{Y_{ij}^{mng}\}$ as the flows. We have so far emphasised two new features which have to be introduced : ownership, and a finer account of production processes than is involved in traditional sector-labelling. We particularly want to associate the first of these with the configuration associated with that owner. At the micro-scale, let $\underline{x}^q$ be the vector of characteristics associated with the configuration maintained by the qth owner. We will begin to specify shortly what this vector might consist of. The most obvious way to try to deal with processes at a finer scale is to add a subdivision within a sector. Then $Z_j^{n\ell g}$ would be an activity measure associated with the use of process ℓ for the production of good g within sector m at j. However, this multiplies the number of indices very rapidly, and not necessarily very usefully. This is particularly since a focus on ownership involves a redefinition of the idea of a sector anyway : one owner's conglomerate (as a configuration) may well involve elements of many traditionally-defined sectors. It may be more effective, therefore, to redefine our labels m and n to be processes and to leave the definition of 'sectors' to be tackled at a later stage, probably involving non-traditional aggregations across ownership and process indices.

It may also be useful to subdivide the flows Y_{ij}^{mng} (with the new process definitions of m and n) into those which are wholly internal to the configuration, say $Y_{ij}^{(1)mng}$, and those involving an 'external' link (that is, with either m or n in another owner configuration), say $Y_{ij}^{(2)mng}$. (Note that these definitions also suggest we need ultimately to interpret an owner configuration in the broadest possible way - for instance to include households as examples, so that a group of n's could represent consumer markets).

The whole configuration could now be represented as

$$\underline{x} = \{\underline{x}^{(1)}, \underline{x}^{(2)}, \ldots \quad \underline{x}^{(Q)}\}$$

with

$$\underline{x}^{(q)} = [\hat{\underline{x}}^{(q)}, \{Z_j^{(q)ng}\}, \{Y_{ij}^{(1)(q)mng}\}, \{Y_{ij}^{(2)(q)mng}\}]$$

where $\hat{\underline{x}}^{(q)}$ is a set of variables which characterise the 'shape' of the q-configuration - such as HQ/ branch structures, processes to be chosen and so on (and adding q-labels to the Z's, $Y^{(1)}$'s and $Y^{(2)}$'s). We can also introduce $Z^{(q)}(\underline{x}^{(q)})$as an activity level associated with the configuration $\underline{x}^{(q)}$. In terms of the agents involved, we might then assume that the owners make the decisions about $Z^{(q)}(\underline{x}^{(q)})$ and the shape of the configuration $\hat{\underline{x}}^{(q)}$, and that the managers optimise the internal activity variables such as $Z_j^{(q)ng}$. For later purposes, it is also useful to define $K^{(q)}$ as the amount of capital associated with owner q. Ultimately, an important part of any theory will be an account of the dynamics of capital accumulation.

It is now beginning to be clear that we have the apparatus to confront most of the problems listed earlier - certainly the ways in which owners may reshape their configurations. But there is one obvious gap which is difficult to fill : that of mergers, when two or more owners group together so that a new and more profitable joint configuration can be formed - something which is more than the sum of the parts. At the most micro level, this problem, could be tackled if we identified the sets of individuals (and, to complicate matters, other institutions and companies) who own companies. But assume that this is not possible and that owners relate to parent companies. Then, we will have to assume that the possibilities for merger are continually reviewed (in a way we will be more explicit about below) and, when a merger (or indeed a splitting-up) takes place, the list of owners, q, should be revised. We are thus distinguising processes which can be represented as

$$Z(\underline{x}) \rightarrow Z(\underline{x}) + \Delta Z(\underline{x}+\Delta\underline{x}) \tag{5}$$

from

$$Z(\underline{x}^{(1)}),\ Z(\underline{x}^{(2)}) \rightarrow Z(\underline{x}^{(new)}) \tag{6}$$

say.

It is difficult to move to a more aggregate representation, as is often required for modelling, and still retain the essence of the 'ownership' categorisation. It may be possible to achieve this through the notion of 'ownership type' and simply to reinterpret q, in the notation introduced above, in this way. However, it is then difficult to retain the concept of the $\hat{\underline{x}}^{(q)}$ vectors and that element of spatial structure. It may well be that we have to proceed for relatively special cases at such scales.

In broad terms, we can expand the principles of anaylsis sketched earlier to the situations which can be represented in the new notation. Equations (3) and (4), for example, should be intepreted for a particular owner (or owner type) as

$$\frac{\partial Z^{(q)}\ (\underline{x}^{(q)})}{\partial t} = \varepsilon^{(q)}(\underline{x}^{(q)})[D[Z^{(q)}(\underline{x}^{(q)} - C[Z^{(q)}(\underline{x}^{(q)})]] \tag{7}$$

with equilibrium conditions

$$D[Z^{(q)}(\underline{x}^{(q)})] = C[Z^{(q)}(\underline{x}^{(q)})] \tag{8}$$

The implication of this formulation is that different configurations should be examined and (7) will give the direction of change. The approach retains the emphasis of earlier aggregate analyses of examining in detail the revenue and cost functions, D and C, respectively.

A more general formulation still, which connects to the only other use of the notion of 'configuration' in the urban modelling literature, is to introduce $P^{(q)}[Z^{(q)}(\underline{x}^{(q)}),\ \underline{x}^{(q)}]$ as the probability of the configuration $\underline{x}^{(q)}$ occurring at level of activity $Z^{(q)}$ and then to use a master equation approach (cf. Weidlich and Haag, 1983, Haag, 1985, Haag and Wilson, 1985) for the rate of change of this probability:

$$\frac{dP[Z^{(q)}(\underline{x}^{(q)}),\ \underline{x}^{(q)}]}{dt}$$

$$= \sum_{\underline{x}^{(q)'}} w(\underline{x}^{(q)'},\ \underline{x}^{(q)})\ P[Z^{(q)}(\underline{x}^{(q)'}),\ \underline{x}^{(q)'}]$$

$$- w(\underline{x}^{(q)},\ \underline{x}^{(q)'})P[Z^{(q)}(\underline{x}^{(q)}),\ \underline{x}^{(q)}] \tag{9}$$

where $w(\underline{x}^{(q)},\ \underline{x}^{(q)'})$ is the transition rate from configuration $\underline{x}^{(q)}$

to $\underline{x}^{(q)1}$ for owner (type) q.

It may help to fix ideas to consider a simple and familiar example: say the distribution of newsagents shops in a city. Suppose there is a sufficiently fine zone system that there cannot be more than one shop in a zone. Let $W_j^{(q)}$ be the scale of provision of owner q in zone j. In this case

$$\underline{x}^{(q)} = \{W_1^{(q)}, W_2^{(q)}, W_3^{(q)}, \ldots\} \tag{10}$$

is a representation of the q owner-configuration. This will be determined by a scrutiny of

$$\sum_j D_j^{(q)} - \sum_j C_j^{(q)} \tag{11}$$

for each q. If we assume that consumer behaviour is determined by the usual interaction model parameters such as α and β, we can assume that owner behaviour is determined by the revenue which can be attracted in different configurations and then mainly be the form of cost function. It is in relation to the latter that we might identify situations where owners with more capital available to them (large national 'chains') then have scale economies available which may allow them to dominate the market. By experimenting with different forms of cost function, it may well be that different kinds of interesting configurations can be identified. What is unusual about this analysis, relative to the traditional one, is that D-C would have to be calculated for different configuration types and for different ownership types and groupings (particularly to take account of the possibility of mergers). Thus the traditional type of dynamic retail model would have to be embedded within a broader framework which allowed this extended combinatorial space to be explored. This might be a suitable initial experiment for these kinds of ideas.

4. Concluding comments

A number of preliminary conclusions can be drawn from this analysis, and then it is possible to look ahead to its future uses.

We have shown that it is possible in principle to extend the typical system description and notation used in urban modelling - by using the concept of a 'configuration' - in such a way that it is then possible to address issues of theory building of the type raised by Massey (1984). However, to achieve this most effectively in principle involves a shift to a micro scale, though existing coarse and new 'intermediate' representations (such as that used for the 'newsagents' problem) can be seen as useful approximations.

It is then possible to return to issues of theory building - from any of the perspectives discussed in section 1- by focusing on revenues, costs and the possibilities of change and restructuring (all in an ever changing environment). The developments outlined here therefore provide a framework for such developments. However, there are a number of useful general conclusions which can be drawn at this stage: new insights are obtained in relation to both urban modelling and alternative theoretical and methodological perspectives.

First, what bedevils the development of general theory from which the geographical structures of particular places can be deduced is a combinatorial problem: the configuration space - particularly when the possibilities of restructuring ownership are allowed - is vast. The best we can often hope to do is to take the insights from the general theory, generate a detailed historical account of development in a particular place within the framework, and outline some of the likely possibilities for future development.

Secondly, we can note that what creates much of the combinatorial problem which causes these difficulties is competition between owners and the way this is resolved. This shows itself in analytical terms because the procedure in (7) and (8) for determining $Z(\underline{x}^{(q)})$ and $\underline{x}^{(q)}$ itself will depend on $Z(\underline{x}^{(q^1)})$ and $\underline{x}^{(q^1)}$ for all $q^1 \neq q$. In other words, the response of an owner q depends on all other owners. This is a generalisation of the backcloth problem noted in the context of spatial competition by Wilson and Clarke (1979).

Thirdly, the general results of spatial dynamic modelling (following Harris and Wilson, 1978) that nonlinearities and high levels of interdependence in dynamic urban models generate bifurcations and sudden changes in structure apply also to the new and more general situation. One of the aims of future analyses within this framework should be to identify the kinds of change of this type which have occurred and which could occur. Many, if not most, of the structural changes in industry identified by Massey are likely to be of this type.

Fourthly, there is always likely to be a problem of aggregation, but we must new seek new ways of achieving this to develop 'approximate' model formulations which offer insights into the most important structural changes. Much of the recent dynamic modelling work on retailing can be interpreted as being of this type.

The way ahead, therefore, lies in extending the range of urban modelling by using the new notation and the concept of configurations, being imaginative in defining possible configurations, finding new ways of aggregating and seeking to generate new insights into structural change. More broadly, this approach could provide a framework for integrating, or at least clarifying the differences between, alternative theoretical approaches.

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