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LONG-TERM ECONOMIC FLUCTUATIONS :

A SPATIAL VIEW

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Long-term economic fluctuations :

a special view

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The present paper will address the issue of long-term spatial fluctuations, with a special view of urban systems. Attention will be paid to various theories on spatial dynamics and long-term fluctuations, particularly those which are able to generate or to explain structural changes.

In this paper, fluctuations will be used as a general term to indicate any long-run trajectory of a dynamic system. Consequently, fluctuations may include discontinuous shocks, oscillatory behaviour such as smooth periodic cycles and stable random variations, and even chaotic fluctuations. Fluctuations may be regarded as a more general evolutionary pattern than cycles (periodic and stable fluctuations) and waves (regular economic oscillations with regular time intervals).

Two classes of explanations may be distinguished that aim at providing more insight into spatial dynamics:

- Theories that explain structural changes in a spatial system (a city, a region) on the basis of external factors outside the spatial system itself.
- Theories that explain structural changes in a system on the basis of internal factors causing a shift in the systems structure.

Both classes will be dealt with in this paper, but first a concise overview of some major contributions to the field of spatial (notably urban) dynamics will be given.

2. Some Theories on Spatial Dynamics

Regional and urban systems appear to pass through complicated development processes caused by structural dynamics and urban-regional-national interrelationships. Such turbulent movements reflect in each stage the interactions of different dynamics with both multiplying and dampening effects, as well as thresholds of system responses. The identification of key variables and regularities in complex dynamic spatial systems is essential for planning and adaptive management.

Pred has made a profound study of the evolution of (mainly industrial) cities with particular emphasis on cumulative and circular feedback processes. Growth of industries and growth of population appear to interact with one another, while scale and agglomeration economies and regional export orientation (via economic base multipliers) favour spatial (especially urban) economic growth processes. These processes are in turn induced by technological innovations. Therefore, adoption and diffusion of innovation is of crucial importance for spatial dynamics. Pred has demonstrated that both Western Europe and the U.S.A. exhibit industrial evolution and spatial growth patterns, in which a multiple-nuclei structure (including spatial interactions) caused by innovation diffusion and improved communication infrastructure leads to integrated spatial-urban growth processes.

Jacobs has explained urban fluctuations from shifts in the variety of functions (living, working, shopping, recreation, e.g.) in a city. In her view an optimal urban diversity should exhibit a great deal of different functions, a variable age structure of buildings, a good accessibility of urban amenities, and a satisfactory spatial concentration of the urban inhabitants. An optimal diversity may lead to an efficient use of urban amenities, while lack of diversity may cause a downward spiral movement of cities. On the other hand, if a city has too many attractive functions, a self-destruction leading to congestion, environmental decay and endless land-use competition may take place, at least in a free market system.

Norton has examined urban life cycles in the U.S.A. He claimed that stagnation or decline of older cities may be caused by a compact land use pattern, a strong social and ethnic segregation and an inadequate tax base (through which rich people are leaving the city). In his view, modern cities have a higher growth potential, as they are more spacious, less segregated and more tax-efficient. The weak base of older cities is even reinforced due to their industrial orientation which originated already in the last century, so that these cities could not compete with modern cities mainly based on the tertiary and quaternary sector. Thus lack of innovative forces has caused the decline of older urban areas in favour of modern cities.

investments in innovation. On the basis of an optimal control model, the fluctuation in the system at hand can be reduced by choosing the appropriate controls in terms of savings rates for the respective categories of capital investments.

The conclusion from the previous concise overview is that a unifying theory for spatiotemporal dynamics is still lacking. Though it has often been indicated that technological innovation is a key factor for such dynamics, hardly any attempt has been made to treat innovation as an endogenous impulse in spatiotemporal growth processes.

Some examples in a spatial context however can be found in Andersson (1981), Batten (1981), Dendrinos (1981), and Isard and Liossatos (1979). It is evident, that especially in the context of the 'long wave' debate an endogenous treatment of technology is of utmost importance.

The foregoing eight contributions to spatiotemporal dynamics may be summarized in a table indicating whether (1) innovation is regarded as a key factor for spatiotemporal growth, (2) the analysis is - at least in principle - able to generate fluctuations, (3) bottleneck factors in spatiotemporal growth processes are taken into account, and (4) a formal dynamic model has been used.

authors	(1) innovation	(2) fluctuations	(3) bottlenecks	(4) dynamic model
Pred	x	x		
Thomas	x	x	x	x
Jacobs		x	x	
Norton	x	x	x	
Van den Berg et al.		x	x	
Allen et al.		x	x	
Wilson		x	x	x
Nijkamp	x	x	x	x

Table 1. Typology of theories on spatiotemporal dynamics.

In addition, 'proofs' for the existence of long waves have usually been based on price data, so that biased conclusions are most likely to emerge. Consequently, apart from Schumpeter (1939), in the past most economists have regarded long waves as exceptional cases of economic dynamics (cf. Mass, 1980).

In recent years however, new attempts have been made to find a more rigorous empirical basis for the long wave hypothesis (see, for instance, Clark et al., 1981, Kleinknecht, 1981, and Mensch, 1979). It is clear that the identification of long waves requires a very extensive data base, which is not available in many countries (see Bieshaar and Kleinknecht, 1983).

An additional problem is caused by the question whether or not a long wave pattern is the result of endogenous forces within an economic system. Endogeneity of long waves requires a theory, which is able to explain the state of the economy at each phase of a long wave (such as prosperity, recession, depression or recovery) from economic and technological conditions from previous stages. In this regard, it is a fundamental issue whether the level of a lower turning point and its subsequent upswing can be explained from technological progress, innovation and economic conditions during the preceding downswing of the economy. It is evident, that in this respect endogeneity of technology is a basic issue (see Heertje, 1981).

Another evident problem in long wave research is the identification of the timespan of the cycles. In the economic literature, several cyclical patterns have been distinguished, such as Kondratieff cycles (40 to 50 years), Kuznets cycles (15 to 25 years), Juglar cycles (5 to 15 years) and business cycles (up to 5 years). The real-world pattern of economic evolution is evidently based on a super-imposition of all these cycles, so that it is extremely difficult to identify one specific class of cycles (though temporal cross-spectral analysis may be a helpful instrument in this respect).

profit rates) may be coped with by means of more efficient technologies, capital saving innovations or wage declines (cf. Mandel, 1980).

- capital theories : based on cyclical movements of capital costs, investments and economic growth, caused inter alia by indivisibilities, threshold effects and long gestation periods of productive capital; examples of such over- and underinvestments situations can be found in vintage and puttyclay models (cf. Clark, 1980, Graham and Senge, 1980, and Heertje, 1981).
- acceleration theories : based on multiplier and acceleration mechanisms caused by discontinuous capital stock adjustments precluding smooth adjustments, so that a fine tuning does not take place (cf. Forrester, 1977).
- innovation theories : based on lack of adjustment (or lack of diffusion) of innovations to structural economic changes (cf. Clark et al., 1981, Kleinknecht, 1981, and Mensch, 1979); this issue will be further taken up in the next section.

4. Structural Changes in Space and Time

The abovementioned theories on long waves have one feature in common, viz. the emphasis on structural changes in the economy. They offer however, different explanations for long-term economic fluctuations. In almost all theories one important element is missing, viz. attention for the element of space both as a driving and a constraining factor for economic dynamics. It has already been demonstrated in section 2 that various theories on spatial dynamics have been designed, although

Both threshold values and bottleneck factors are closely linked to innovation and to public policy, so that in the context of this article on economic fluctuations in space and time it is necessary to pay more specific attention to both innovation and public policy.

A. Innovation and Spatial Economic Dynamics

In the recent literature, innovation is regarded as a key factor for economic dynamics. Innovation will be conceived of as a phase-wide process of research, development, application and exploitation of a new technology or organization (cf. Haustein et al., 1981). This distinction into phases is useful, as usually invention, adoption and use of a new finding do not take place simultaneously, inter alia due to market structures, patent systems, monopoly situations, lack of information or lack of diffusion (see Brown, 1981, Davies, 1979, and Rosegger, 1980). Usually a distinction is made between basic innovations (new products, new industries) and process innovations (new processes in existing industries). Especially basic innovations are assumed to take place periodically and cluster-wise and hence to lead to long-term economic fluctuations.

In recent years, innovation research has increasingly concentrated on (disaggregate) behaviour of individual firms, as one has increasingly become aware of the fact that basic innovations are taking place in a few industries located at specific places (cf. Kleinknecht, 1981, Mahdavi, 1972, and Nijkamp, 1983). Especially on the basis of micro-oriented research, the driving motives of innovations and the impacts of innovations (labour saving or capital saving technology, e.g.) can be identified (see also Kamien and Schwarz, 1975, and Kennedy, 1964).

Basic innovations are generally assumed to cause cyclical economic developments (growth → saturation → recession). In this regard, two different viewpoints may be distinguished:

- the depression-trigger hypothesis. This hypothesis claims that the struggle for survival necessitates firms to adopt radical innovations leading to radical changes (Mensch, 1979).

for an accelerated growth process in a particular location, especially because a diffusion of growth impulses from propulsive to other sectors will favour an integrated regional development (see Nijkamp and Paelinck, 1976).

It should be noted however, that in growth pole theory innovations are mainly regarded as exogenous tools for obtaining an accelerated growth, while in the Schumpeterian viewpoint innovation is regarded as an endogenous tool in a free-enterprise economy, so that fluctuating economic growth patterns may be expected. Despite these differences, innovation may be regarded as a key factor in spatial and sectoral development processes (see also Dasgupta and Stiglitz, 1980, Mansfeld, 1968, and Nelson and Winter, 1977).

B. Public Policy and Spatial Economic Dynamics

Public policy may have a twofold impact on spatial economic dynamics, viz. by creating a breeding place for innovations favouring an accelerated growth in space and time (Rosenberg, 1976), and by providing the public overhead capital (infrastructure) that is necessary for a balanced development (Nijkamp, 1982b). Both elements will briefly be discussed here.

A breeding place policy assumes adequate educational facilities, communication possibilities, market entrance, good environmental conditions, a good social climate and a satisfactory locational profile (cf. Olson, 1982). The existence of breeding places favouring innovative activities also indicates that monopoly situations and industrial concentrations (including patent systems) are often characterized by a higher technological and innovative potential (in the field of electronics, petrochemicals and aircraft, e.g.), although it has to be added also small firms tend to be an increasing source of various innovations, for instance, in the area of micro-processors (see Rothwell, 1979, and Thomas, 1981).

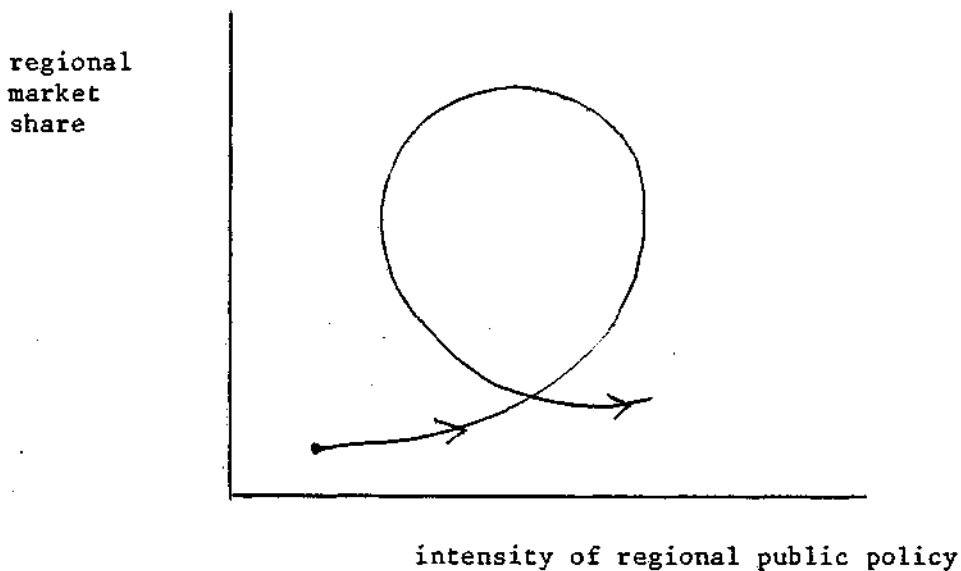


Figure 2. Trajectory of regional market share and public policy.

Combination of Figures 1 and 2 leads to the evident conclusion that innovation policy and public policy require a fine tuning in order to be fully effective. Spatial economic fluctuations may be induced or stimulated in case of a lack of coordination between these two policies, so that innovative potential, agglomeration size, regional locational conditions and intensity of infrastructure policy are simultaneously determining the structural economic change of cities and regions.

In the literature on agglomeration economies it is often suggested that large scale industrial concentrations and city size favour innovative ability due to higher productivity, more business diversification and better breeding ground for technological progress (see Alonso, 1971, Carlino, 1977, Kawashima, 1981, Nelson and Norman, 1977, and Thompson, 1977). Malecki (1979) however, has recently demonstrated that the innovative potential of traditional large agglomerations is declining, so that apparently innovative activity is suffering from diseconomies of size (cf. also Sveikauskas, 1979). Due to filtering down effects caused by agglomeration diseconomies, the innovative capacity of economic centers may be affected and moved to other areas, as soon as a critical bottleneck level (congestion, e.g.) in the initial centre has been reached. In this regard, we may refer back to the abovementioned notions of threshold values and bottleneck factors.

$Y^{\min}$ reflects a minimum threshold level of the regional production volume which has to be reached before a self-sustained growth will take place, while $Y^{\max}$ reflects a bottleneck level (or maximum capacity level), beyond which congestion factors lead to a negative marginal product. Consequently, the following conditions hold:

$$\left. \begin{array}{l} \text{if } Y \leq Y^{\min}, \text{ then } \beta, \gamma, \delta = 0 \\ \text{if } Y \geq Y^{\max}, \text{ then } \beta, \gamma, \delta \leq 0 \end{array} \right\} \quad (3)$$

By assuming now a time-dependent quasi-production function, the shifts in the regional share of the national production volume can be written as:

$$\Delta Y_t = (\beta \tilde{C}_t + \gamma \tilde{S}_t + \delta \tilde{R}_t) Y_{t-1} \quad (4)$$

with:

$$\Delta Y_t = Y_t - Y_{t-1} \quad (5)$$

and:

$$\tilde{C}_t = \frac{C_t - C_{t-1}}{C_{t-1}} \quad (6)$$

$$\tilde{S}_t = \frac{S_t - S_{t-1}}{S_{t-1}} \quad (7)$$

$$\tilde{R}_t = \frac{R_t - R_{t-1}}{R_{t-1}} \quad (8)$$

The economy reflected by (4) will exhibit a stable growth path without structural changes within the range $(Y^{\min}, Y^{\max})$. The lower limit $Y^{\min}$ is in the present context of innovation and capacity limits less interesting, so that we will focus our attention mainly on the effect of the bottleneck value $Y^{\max}$.

This bottleneck value reflects congestion phenomena due to too high a concentration of productive capital in a certain area leading to diseconomies of scale, environmental decay, and inefficient land use.

and by its growth rate (depending on $\tilde{Y}_t$), but in principle this model is able to generate a wide variety of dynamic growth patterns. Consequently, in a spatial context long-term fluctuations depend on the initial values of a spatial system and on its growth rate (which is co-determined by the production elasticities of productive capital, overhead capital and R&D capital).

The growth rate however, is a time-dependent variable, which can also be controlled by (private and public) policy measures. If the model is used in the framework of optimal control theory, generalized geometric (signomial) programming algorithms can be used to identify optimal controls (see Duffin and Peterson, 1973, and Nijkamp, 1972).

A next step may be to introduce an additional relationship for R&D investments, given the assumption that R&D may serve as a tool to remove bottlenecks (the so-called depression-trigger hypothesis). Then we may hypothesize the following relationship, as soon as an area has reached its critical bottleneck level $Y^{\max}$.

$$\tilde{R}_t = \tilde{R}_t(Y_{t-1} - \pi Y^{\max})/Y^{\max}, \quad (12)$$

where $\tilde{R}_t$ is the rate of change in R&D capital beyond the value $Y^{\max}$. Substitution of (12) into (10) yields:

$$\Delta Y_t = \left\{ \tilde{Y}_t^* + \hat{\delta} \tilde{R}_t(Y_{t-1} - \pi Y^{\max})/Y^{\max} \right\} (Y^{\max} - \kappa Y_{t-1}) Y_{t-1} / Y^{\max} \quad (13)$$

with:

$$\tilde{Y}_t^* = \hat{\beta} \tilde{C}_t + \hat{\gamma} \tilde{S}_t \quad (14)$$

The latter relationship is a nested dynamic model. This model may exhibit even more complicated dynamical growth patterns, depending on the superimposition over two dynamic phenomena. The perturbations caused by the bottleneck factors may be neutralized or reinforced by R&D investments, pending on the fine tuning of new technology investments and spatial fluctuations.

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