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THE CHANGING ECONOMIC STRUCTURE OF METROPOLITAN REGIONS: A PRELIMINARY COMPARATIVE ANALYSIS*

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Contribution to the Metropolitan Study: 15

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CONTRIBUTIONS TO THE METROPOLITAN STUDY:

1. Anas, A. and L.S. Duann (1983) Dynamic Forecasting of Travel Demand. Collaborative Paper, CP-83-45. International Institute for Applied Systems Analysis (IIASA), A-2361 Laxenburg, Austria.

2. Casti, J. (1983) Emergent Novelty and the Modeling of Spatial Processes. Research Report, RR-83-27. IIASA, Laxenburg, Austria.

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4. Haag, G. and W. Weidlich (1983) An Evaluable Theory of a Class of Migration Problems. Collaborative Paper, CP-83-58. IIASA, Laxenburg, Austria.

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7. Fujita, M. (1984) The Spatial Growth of Tokyo Metropolitan Area. Collaborative Paper, CP-84-03. IIASA, Laxenburg, Austria.

8. Andersson, A.E. and B. Johansson (1984) Knowledge Intensity and Product Cycles in Metropolitan Regions. Working Paper, WP-84-13. IIASA, Laxenburg, Austria.

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FOREWORD

Contribution to the Metropolitan Study: 15

The project "Nested Dynamics of Metropolitan Processes and Policies" was initiated by the Regional and Urban Development Group in 1982, and work on this collaborative study started in 1983. This series of contributions to the study is a means of conveying information between the collaborators in the network of the project.

The foundation of the project is a systematic comparison of dynamic phenomena in a set of relatively advanced metropolitan regions. This comparison is intended to identify key factors and observable development paths which are shared by all regions, or at least by certain subgroups of regions.

In this paper, we therefore begin to assess the relative stage and speed of economic structural development in a given set of such regios. A methodology based on changing employment shares is developed to examine industrial substitution (that is, aggregate technological change) through time and over metropolitan space. The relocation and restructuring of job opportunities within or outside a metropolitan region can be interpreted in terms of industrial innovation and product cycle theory. In this way, it is possible to identify the trajectory of a global cycle of economic development in terms of each city's current economic and spatial structure and its relative speed of technological change.

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1. INTRODUCTION

The world economy has in recent years been subject to certain major shocks and structural changes. Some well-known examples are (a) the combination of two-digit inflation rates and increasing levels of unemployment, (b) substantial reductions in investment demand and construction activity, (c) excess capacity in steel and transportation equipment industries, and (d) widespread reversals of the urbanization trends in many developed countries.[1)] That the initial effects of many of these shocks are being felt in metropolitan areas is now painfully clear.

A large share of the world's metropolitan regions are consequently experiencing relatively severe processes of decline and obsolescence. Yet revitalization of these regions is fundamental since they largely constitute the environments in which new industries, new technologies and new jobs must be introduced and developed. It can be argued that metropolitan regions are basically the "driving entities" for nations. In this respect, the leading metropolitan regions in the world constitute a scale of enquiry at least as important as nations or even clusters of nations in any comparative study of contemporary economic development processes.

On the other hand, all cities cannot be as innovative as others. Global developments have quite a different impact on each metropolis owing to the geographical, social, technological and financial diversity which exists both within and between nations. Some regions are more industrious, more advanced technologically; others are at a disadvantage and are destined to lag behind. At any single point in time, each metropolitan region of the world occupies a unique place relative to all others in terms of economic development. It is with the measurement of this comparative position, together with the relative speed of the economic change process, that this paper is principally concerned.

The foundation of the IIASA project on metropolitan dynamics is a systematic comparison of dynamic phenomena in a set of relatively advanced metropolitan regions. This comparison is intended to identify key factors and observable development paths which are shared by all regions, or at least by certain subgroups of regions. In this paper, we therefore begin to assess the relative stage and speed of economic structural development in a given set of such regions. A methodology based on changing employment shares is developed to examine industrial substitution (that is, aggregate technological change) through time and over metropolitan space. The relocation and restructuring of job opportunities within or outside a metropolitan region can be interpreted in terms of industrial innovation and product cycle theory. In this way, it is possible to identify the trajectory of a global cycle of economic development in terms of each city's current economic and spatial structure and its relative speed of technological change.

One significant finding can be mentioned in advance. Although the processes of economic development and spatial dispersal of employment within different cities are rarely identical and tend to proceed at a wide range of speeds, in almost every instance the pace of economic restructuring is remarkably steady. This suggests that caution should be exercised by those who insist that the speed of technological change has increased dramatically within the last two decades.

2. MODELLING ECONOMIC CHANGE IN A METROPOLITAN REGION

Even the broad economic evolution of any metropolitan region cannot be understood meaningfully in terms of simple lifecycle concepts such as urbanization, suburbanization or deurbanization. These motive terms may certainly suffice for an analysis of spatial shifts in population and employment opportunities, but unfortunately they say nothing about changes in technology and industrial or occupational structure. However, if the stage, speed and type of structural economic development occurring within each region could be quantified analytically, some meaningful comparisons might eventuate.

For the purpose of such comparisons, we shall explore the usefulness of a simple logistic substitution model developed originally for the micro-analysis of market penetration and technological change (see, for example, Fisher and Pry, 1971; Peterka, 1977; Batten and Johansson, 1984a). This particular model turns out to be a pragmatic simplification of a more general evolutionary model of industrial dynamics in an economic system which may be self-organizing (Batten, 1982). It may therefore be linked to cycles of innovation and the learning process (Marchetti, 1981). We shall restrict our discussion to a market share version for the analysis of economic structural change, and later develop a general framework for analysing job and household dispersal as processes of substitution over metropolitan space.

2.1 Changing economic structure as a process of substitution

Although most of us still have relatively few basic needs to be satisfied - food, clothing, shelter, transportation, education, employment and the like - our economies are undergoing a rich variety of changes at the intermediate stages of production as well as in the individual choice processes of households. Irrespective of whether we consider intermediate or final users, the advancing sophistication and technological evolution consist mainly of substituting new types of customer satisfaction for old ones. The basic needs or functions rarely undergo radical change, only the ways and means of satisfying them. Under these circumstances, the notion of competitive substitution as a model for technological change is a valid one. Whenever exceptions to this view are found, the substitution model will not apply.

Experience has shown that under certain competitive conditions the dynamic processes of market penetration and product or process substitution tend to proceed exponentially in the early years but to slow down later as the market becomes saturated. In relative terms, the substitution process follows an S-shaped curve. Quite often, the logistic distribution can provide a convenient framework for modelling this process through time. Such an approach is in keeping with the theories of innovation diffusion and the product cycle. It can also be given a theoretical foundation in terms of Lancaster's characteristic model of consumer behaviour (see, for example, Batten and Johansson, 1984b).

Although the logistic function is certainly not the only one which could be adopted for this purpose, it turns out to be a very practical choice for analysing changes in relative market shares because it can be completely characterized by just two constants: the early growth rate and the time at which the substitution is half complete. Numerous studies have now been conducted which confirm the logistic property of most evolutionary (birth-death) processes.

Mathematically, the substitution process can be modelled as the differential form of the two parameter logistic function:

$$\dot{f}(t) = \alpha f(t)\{1-f(t)\} \tag{1}$$

where $f(t)$ is the fraction of the market which the new technology has penetrated at time t; $\{1-f(t)\}$ is the amount of old technology still in use; and α is the rate constant - or in Mansfield's (1961) terminology, the rate of adoption. The above equation has both the property of exponential growth - that is, proportionality to the amount of growth achieved, $\alpha f(t)$ - and the property of constrained growth - that is, proportionality to the amount of growth yet to be achieved, $\alpha\{1-f(t)\}$.

This differential equation is solved by rearranging the terms and integrating both sides (now dropping the time index):

$$f/(1-f) = \exp\{\alpha(t-t_h)\} \tag{2}$$

or

$$\log\{f/(1-f)\} = \alpha(t-t_h) \tag{3}$$

where t_h is the time when the substitution is half complete (i.e. $f=1/2$ when $t=t_h$) and the maximal rate of growth is achieved. This indicates a very convenient property of the logistic function for empirical analysis: when the substitution data are plotted in the form of $f/(1-f)$ as a function of time on semilogarithmic graph paper, the points should form a straight line (as illustrated in Figure 1). This property appears to hold with extraordinary precision for a wide range of substitution processes investigated.[4)]

It is convenient, in addition, to characterize a substitution by its "takeover time", defined as the time required to move from $f=0.1$ to $f=0.9$ (Fisher and Pry, 1971). The takeover time, t_s, is inversely proportional to the rate constant α:

$$t_s = 2\log 9/\alpha \quad . \tag{4}$$

If the dimensionless time, τ, is defined in the form

$$\tau = 2(t-t_h)/t_s \tag{5}$$

formula (3) may be written in dimensionless form. As we shall see later, this makes it possible to plot different substitution processes on the same graph.

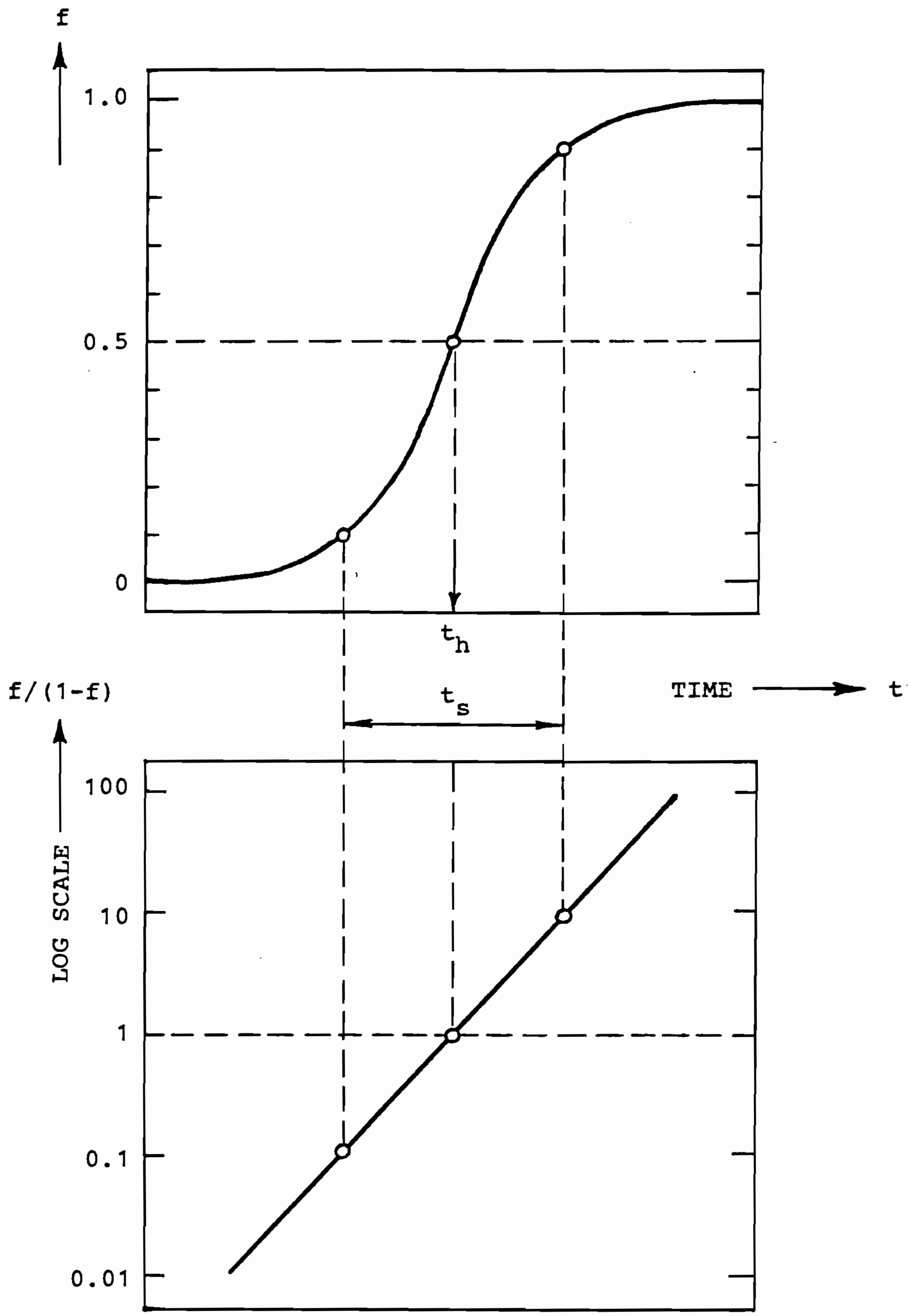


Figure 1: General Form of the Logistic Substitution Model

Plots of the form depicted in Figure 1 illustrate how the logistic function can describe technological substitution, not only at the disaggregate level for different products and technologies but also at the aggregate level for different economies. Take, for example, the changing sectoral structure of Melbourne's economy during the postwar period. Table 1 records this recent history in terms of the shares in total employment by sector of occupation. We could analyse this evolutionary pattern using a multivariate version of the logistic model (Peterka, 1977), namely

$$\log\{f_j(t)/f_i(t)\} = k_{ji}-\alpha_{ji}(t-t_h) \quad , \; j\neq i \qquad (6)$$

where $f_i(t)$ is the share of total employment held by sector i at time t (i=1,....,5) and $k_{ji}=\log\{f_j(t_h)/f_i(t_h)\}$. However, in order to simplify the analysis and facilitate comparisons between various cities of the world, we shall restrict our attention to the bivariate case (3) in which Services (sectors III, IV and V combined) are gradually penetrating the job market traditionally held by

Table 1

Sector of Occupation as Percentage of Total Economy
Melbourne Statistical Division, 1954-81

Sector of Occupation	1954	1961	1966	Year 1971	1976	1981
I. PRIMARY (including agriculture, forestry, fishing and mining)	3.2	2.4	1.9	1.5	1.2	1.3
II. SECONDARY (manufacturing)	39.3	37.7	38.2	32.4	29.8	27.0
III. TERTIARY (including utilities, construction and transport)	20.7	21.4	20.7	18.7	18.6	18.2
IV. QUATERNARY (providing all commercial services including wholesale and retail trade, finance, communications)	21.2	21.4	21.3	27.1	27.4	29.2
V. QUINARY (providing public and personal services including public administration, community services and entertainment)	15.6	17.1	17.9	20.3	23.0	24.3

Source: Batten, Newton and Roy (1984)

Manufacturing industry (sector II). Since the primary sector plays an insignificant role in metropolitan economies, this two-sector simplification seems reasonable. However, by calculating the ratio f/(1-f) for each of these two sectors, the minor effect of the primary sector may still be perceptible.

The respective ratios for each have been plotted on a log-linear scale in Figure 2. The good linear fit for both regression lines suggests that job substitution between these two sectors does indeed follow a logistic path. Figure 2 indicates that this substitution was half complete (i.e. reached t_h) around 1940, and that (in principle) the takeover time is about 190 years.

In order to assess the breadth of applicability of this type of structural change model, we have examined similar phenomena in some other cities of the developed world. The preliminary results are summarized in Table 2. In all of the cases considered, the

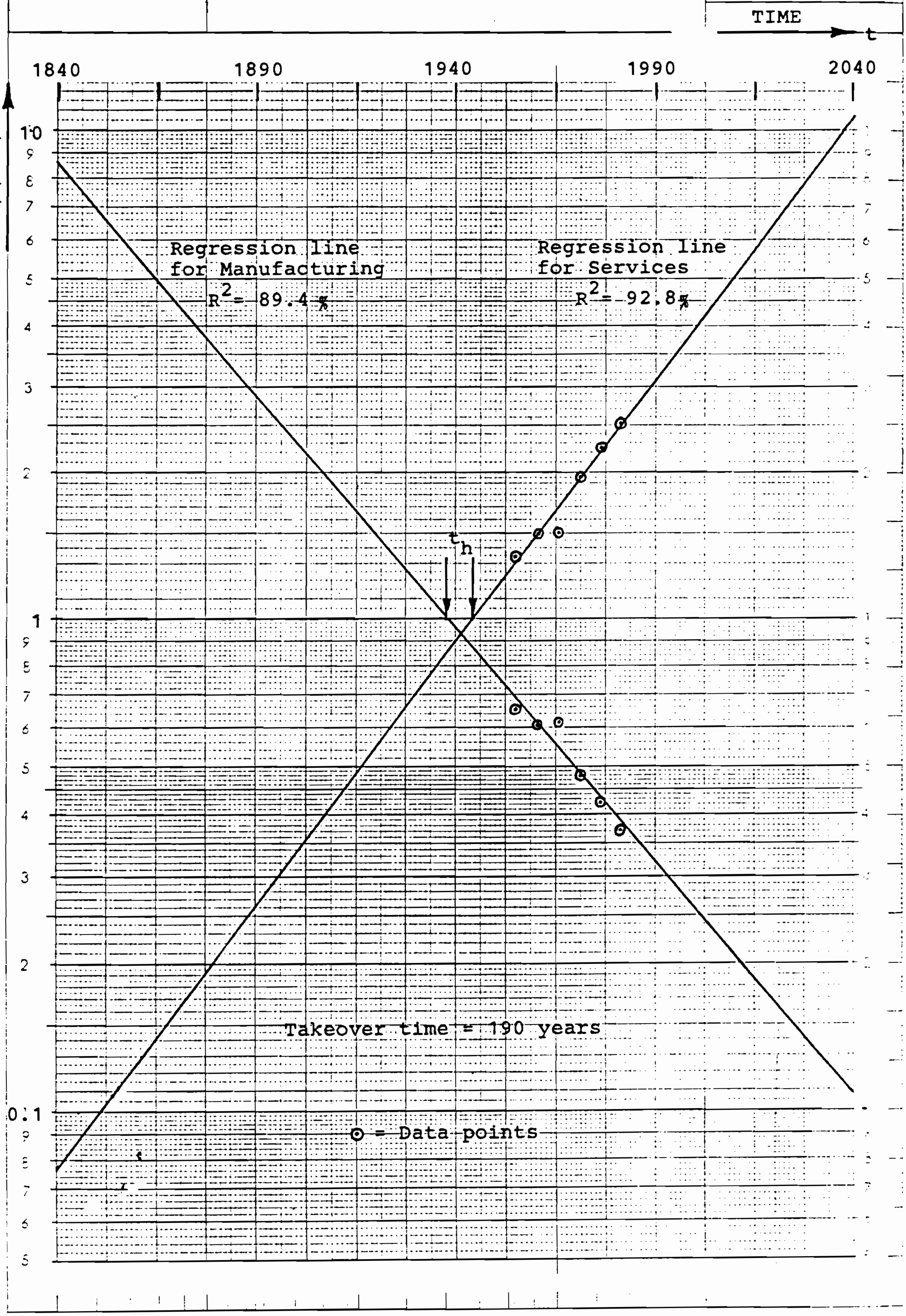
Table 2
Job Substitution in Some Major Cities

CITY	SECTOR	t_h (year)	SPEED OF CHANGE (% per year)	R^2
Amsterdam	Manufacturing	1932	-0.67	99.1
	Services	1933	+0.70	98.8
Chicago	Manufacturing	1915	-0.26	94.7
	Services	1918	+0.25	92.0
Helsinki	Manufacturing	1932	-0.62	97.9
	Services	1933	+0.64	99.0
Leeds	Manufacturing	1961	-1.03	91.6
	Services	1963	+1.11	93.8
Melbourne	Manufacturing	1939	-0.38	89.4
	Services	1943	+0.42	92.8
Nagoya	Manufacturing	1960	-0.32	100.0
	Services	1978	+0.89	97.3
San Francisco*	Manufacturing	1846	-0.32	99.4
	Services	1850	+0.30	96.2
Turin§	Manufacturing	2003	-0.30	100.0
	Services	2005	+0.31	100.0

*The t_h values for San Francisco are notional only since this city has always been service-dominated.

§The t_h values for Turin are forecasts.

Figure 2 : Substitution of Service Jobs for Manufacturing Jobs in Melbourne



linear fit of log{f/(1-f)} versus time is excellent, suggesting that the model has good potential. Although the change process proceeds at a wide range of speeds, the pace is a steady one.

2.2 The cycle of tecnological development

From the results in Table 2, we may speculate on the possible relationship between the stage of urban development, the speed of structural change and observed job losses in urban areas. For example, one may classify the various cities on the basis of their stage in a general technological development cycle as follows:

(a) Leader if the transition to a service-dominated economy ($t_h \geq 0.5$) occurred prior to the First World War;

(b) Early Follower if this transition occurred bewtween the two wars

(c) Late Follower if it occurred after the Second World War.

If one also classifies their speed of structural change into three groups, namely Slow ($r<0.5$), Medium ($0.5 \leq r \leq 1.0$) and Fast ($r>1.0$), then the cities may be grouped as shown in Table 3. The + or - sign assigned to each city in this table indicates the current direction of absolute change in employment, and the year in parentheses signifies the point at which Manufacturing ceased to dominate each economy.

Table 3

Stage in Technological Development Cycle and Speed of Structural Change in Some Major Cities

RATE OF STRUCTURAL CHANGE	STAGE IN DEVELOPMENT CYCLE		
	Leader	Early Follower	Late Follower
Fast ($r>1.0$)			Leeds - (1961)
Medium ($0.5 \leq r \leq 1.0$)		Helsinki - (1932) Amsterdam - (1932)	Nagoya + (1960)
Slow ($r<0.5$)	San Francisco + (1846) Chicago + (1915)	Melbourne + (1939)	Turin + (2003)

A most interesting feature of these results is that the speed of structural change appears strongly associated with job loss tendencies. In other words, those cities which have lost jobs in Manufacturing and/or gained jobs in Services at a rapid rate are also the ones who are currently experiencing absolute job losses within the metropolitan region as a whole (i.e. deurbanizing in the terminology mentioned in the Introduction). Further work is of course needed to substantiate this possibility. It does however suggest that those cities who are changing their economic structure at a slower rate stand a better chance of averting the deurbanization problem.

In order to understand the lifecycle of technological development implied in the table, and each cities relative position in a hierarchical sense, we can plot them together on the same graph (Figure 3). The abscissa in this figure is the dimensionless parameter τ defined in (5), which normalizes all of the data to a single mathematical form. The result is a global "snapshot" of technological development in terms of the stage which each city has reached. We shall elaborate further on the theory underlying this lifecycle pattern in Section 5.

To see how the structural change model can be used for forecasting purposes, we recall that only the historical data between 1950 and 1983 were taken to estimate the model parameters for each city. The projections obtained in this way are given as general trends for the past and the future in Figure 4. This type of economic structural development fits most of the cities concerned, although there are certainly some interesting exceptions.

3. Suburbanization as a Process of Spatial Substitution

The above analysis of economic structural change within a small group of metropolitan regions is only one part of any comparative analysis of decentralization. The spatial dimension remains. It turns out that the logistic substitution model introduced in the previous section is also a convenient tool for analysing the redistribution of both jobs and population over metropolitan space. We shall therefore introduce this spatial substitution version in the following paragraphs and later link it to the earlier model of economic change in order to provide a unified treatment of the change process.

For example, we may divide each city into three distinct zones: (i) the <u>Inner</u> or Core zone; (ii) the <u>Middle</u> or Intermediate

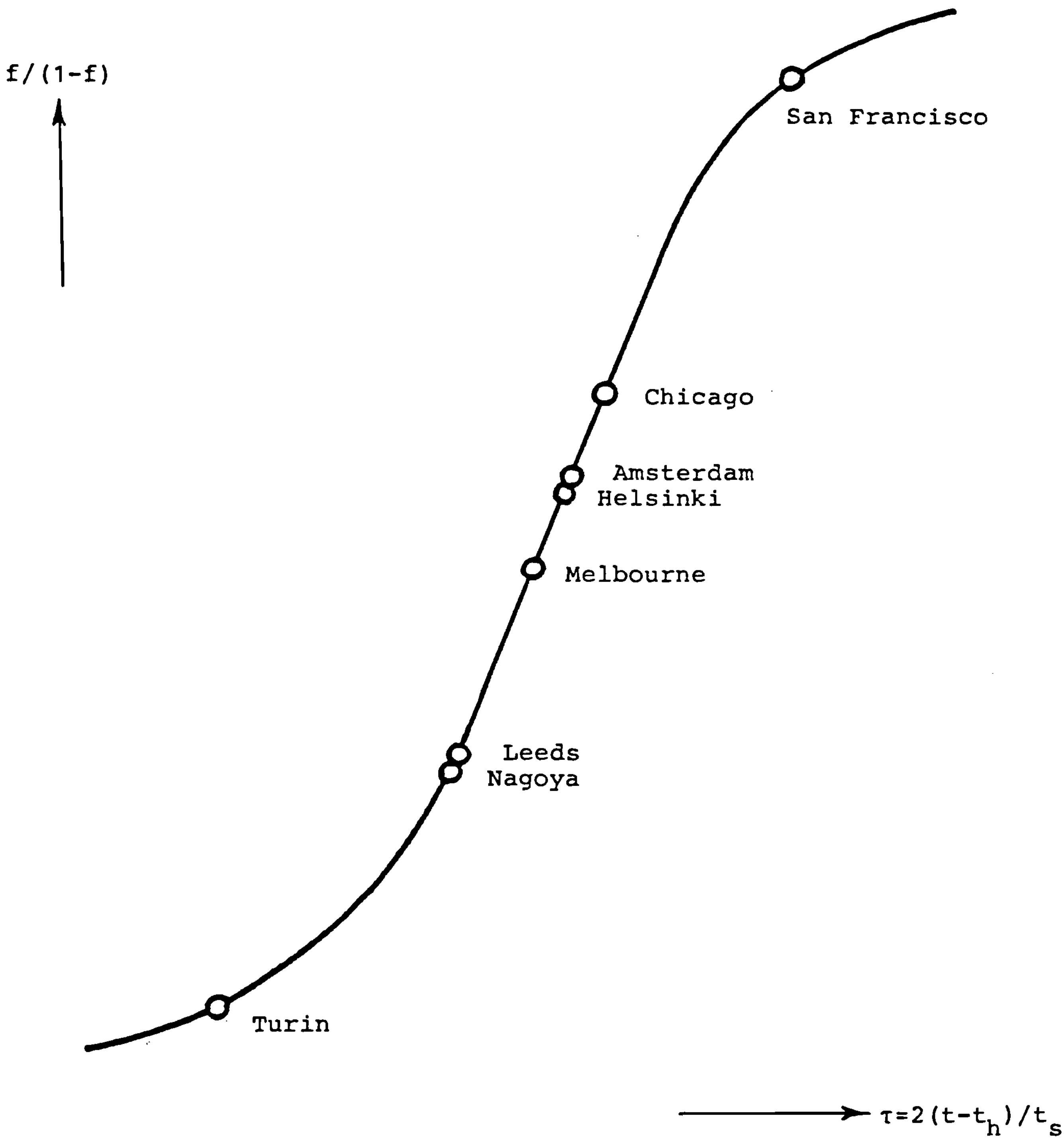


Figure 3 : Global "Snapshot" of the Technological Development Cycle and each City's Stage of Development

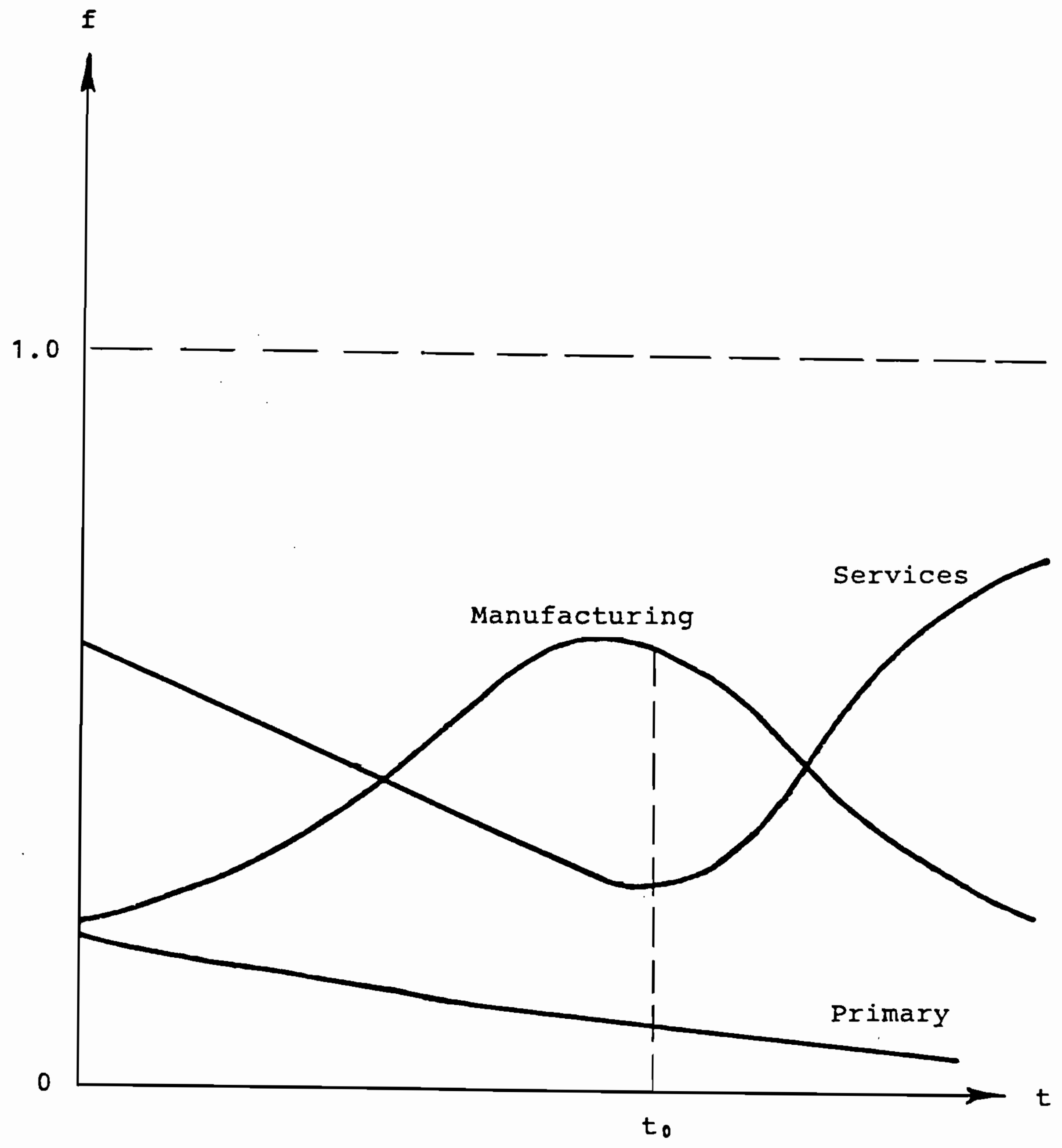


Figure 4 : General Form of Economic Structural Change in Developed Metropolitan Regions

zone; and (iii) the Outer or Peripheral zone. If we redefine the share parameter, $f_i(t)$, as the fraction of total metropolitan jobs or population which are contained in zone i at time t, then it is possible to evaluate the potential of the logistic function as the basis of a spatial substitution model.

We have done this for a similar collection of cities and the results are summarized for population and job dispersal in Tables 4 and 5, respectively.

Table 4

Population Dispersal in Some Major Cities

CITY	ZONE	t_h (year)	SPEED OF DISPERSAL (% per year)	R^2(%)
Budapest	Inner	2089	-0.17	99.7
	Middle	2075	+0.20	99.1
	Outer	-	-0.03	82.6
Chicago	Inner	1966	-0.92	95.3
	Middle	2005	+0.49	88.2
	Outer	2015	+0.43	99.2
Helsinki	Inner	1960	-1.69	96.3
	Middle	∩	+0.81	80.5
	Outer	1990	+0.88	99.2
Leeds	Inner	1920	-0.48	99.2
	Middle	1945	+0.12	91.2
	Outer	2012	+0.36	93.0
Melbourne	Inner	1921	-0.54	98.9
	Middle	∩		
	Outer			
Nagoya	Inner	1926	-0.31	99.9
	Middle	2006	+0.40	98.6
	Outer	-	-0.09	94.0
Prague	Inner	-	0	80.0
	Middle	-	-0.02	87.0
	Outer	-	+0.02	89.9
Stockholm	Inner	1946	-0.87	99.5
	Middle	∩	+0.25	96.2
	Outer	1997	+0.62	93.0
Warsaw	Inner	1826	-0.14	83.5
	Middle	1935	+0.23	93.0
	Outer	-	-0.09	97.9

Note: t_h denotes either a forecast or a backcast of the year (if any) when each zone contained 50% of all population.

Table 5

Employment Dispersal in Some Major Cities

CITY	ZONE	t_h (year)	SPEED OF DISPERSAL (% per year)	R^2 (%)
Chicago	Inner	1969	-1.13	99.6
	Middle	1997	+0.61	95.0
	Outer	2010	+0.52	99.8
Helsinki	Inner	1983	-1.15	99.8
	Middle	2034	+0.33	97.2
	Outer	1997	+0.82	99.6
Melbourne	Inner	1964	-1.42	97.5
	Middle	∩	-0.06	-
	Outer	1990	+1.48	92.1
Nagoya	Inner	∩	-0.07	-
	Middle	2057	+0.18	87.5
	Outer	-	-0.11	95.4
Stockholm	Inner	1974	-0.57	99.1
	Middle	2077	+0.17	88.9
	Outer	2030	+0.40	100.0

Note: The symbol ∩ denotes a maxima within the statistical time-series (at which $f<0.5$)

Once again, the linear fit is excellent suggesting that the model is indeed promising. Although the processes of spatial dispersal for population and employment proceed at a wide range of speeds and do not always spread outwards, in each case the pace of overall change is a steady one. The general pattern of spatial diffusion is depicted in Figure 5. This basic projection fits the majority of cities with the consistent exception of the Eastern European nations (in which the Inner and Outer zones are declining simultaneously).

It is interesting to compare the relative speeds and extent of suburbanization of employment opportunities with that of population. While there is certainly considerable similarity between each with respect to the directions of movement, differences in stage and speed are apparent. While population losses from many inner areas may have commenced before jobs began to decline, the faster dispersal of job opportunities in recent years suggests that any leader-follower patterns will be inconsistent.

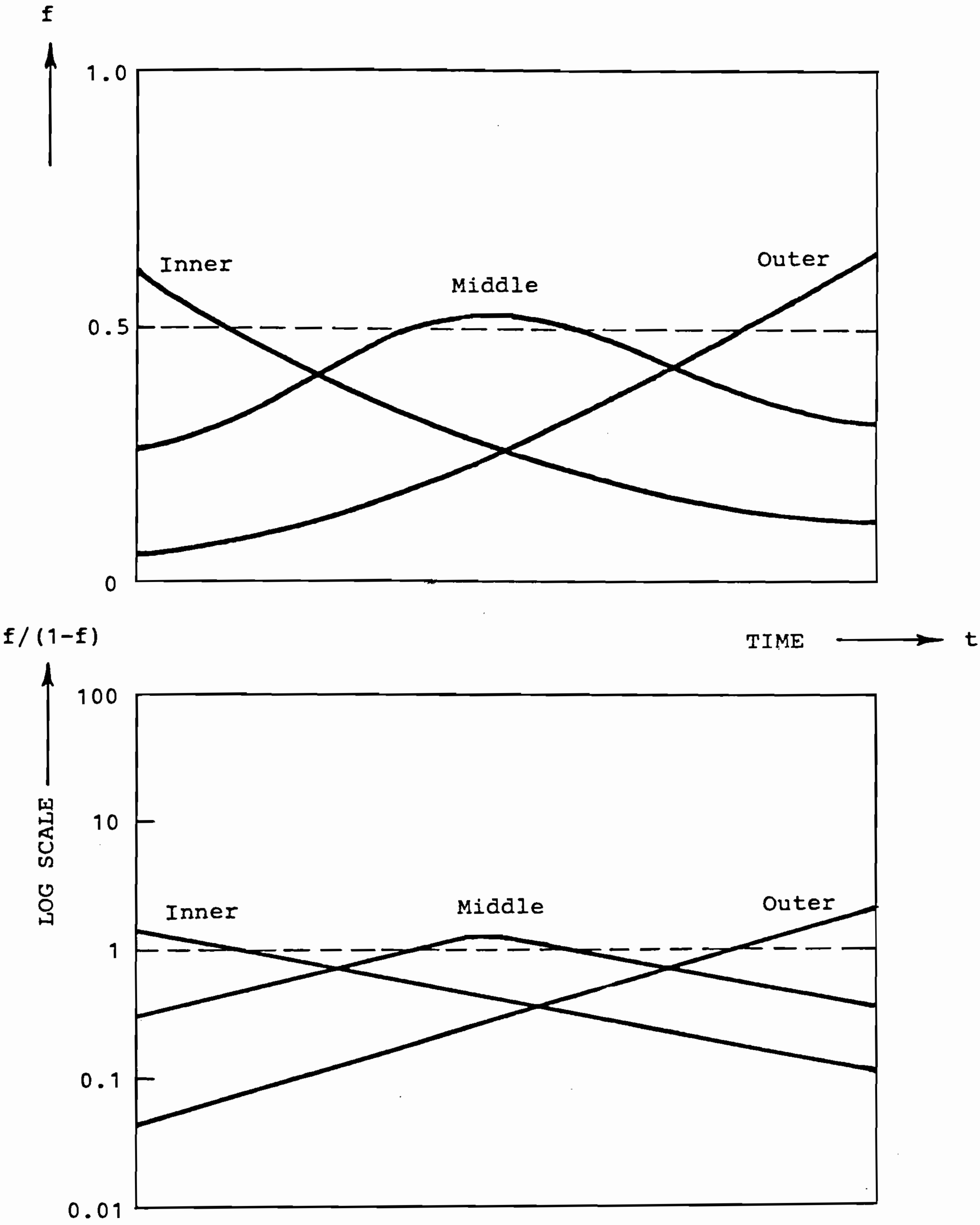


Figure 5: General Form of the Spatial Substitution Model

4. Spatial Redistribution of Economic Activity

In this section, we present some preliminary findings which result from a synthesis of the economic and geographical dimensions discussed in Sections 2 and 3. For this purpose, the share parameter (f) is assigned three indexes, $f_{ij}(t)$, to denote the share of employment engaged in sector i within zone j at time t. Analyses have been conducted with respect to both sectoral and spatial totals so that each type of substitution may be assessed. The sectoral definitions are those given in Table 1. Owing to a lack of comparable data at the stage of writing, the results are currently restricted to two cities only: Chicago and Melbourne.

The declining importance of manufacturing activity for each economy is depicted graphically in Figure 6 . In terms of spatial structure, Chicago has maintained a relatively even distribution of its manufacturing workers among all three zones, whereas Melbourne has favoured the Middle Zone for manufacturing activity. The latter city is generating more of its new economic activities in the periphery (Middle and Outer Zones), although the proportion of Service activity (sectors IV and V) is also rising in the Inner Zone (Table 6).

Table 6

Spatial Redistribution of Economic Activity, Melbourne, 1961-1981

ECONOMIC SECTOR	GEOGRAPHICAL ZONE	t_h (year)	SPEED OF DISPERSAL (% per year)	R^2(%)
Manufacturing	Inner	1953	-0.73	95.2
	Outer	2010	+0.93	99.3
Retail Sales	Inner	1960	-1.05	99.1
	Outer	1996	+1.33	99.9
Quaternary	Inner (as % of all Quat.)	1972	-0.77	98.2
	Inner (as % of all Inner)	2002	+0.49	82.5
Quinary	Inner (as % of all Quin.)	1969	-0.70	97.6
	Inner (as % of all Inner)	2050	+0.27	69.0

Source: Batten, Newton and Roy (1984)

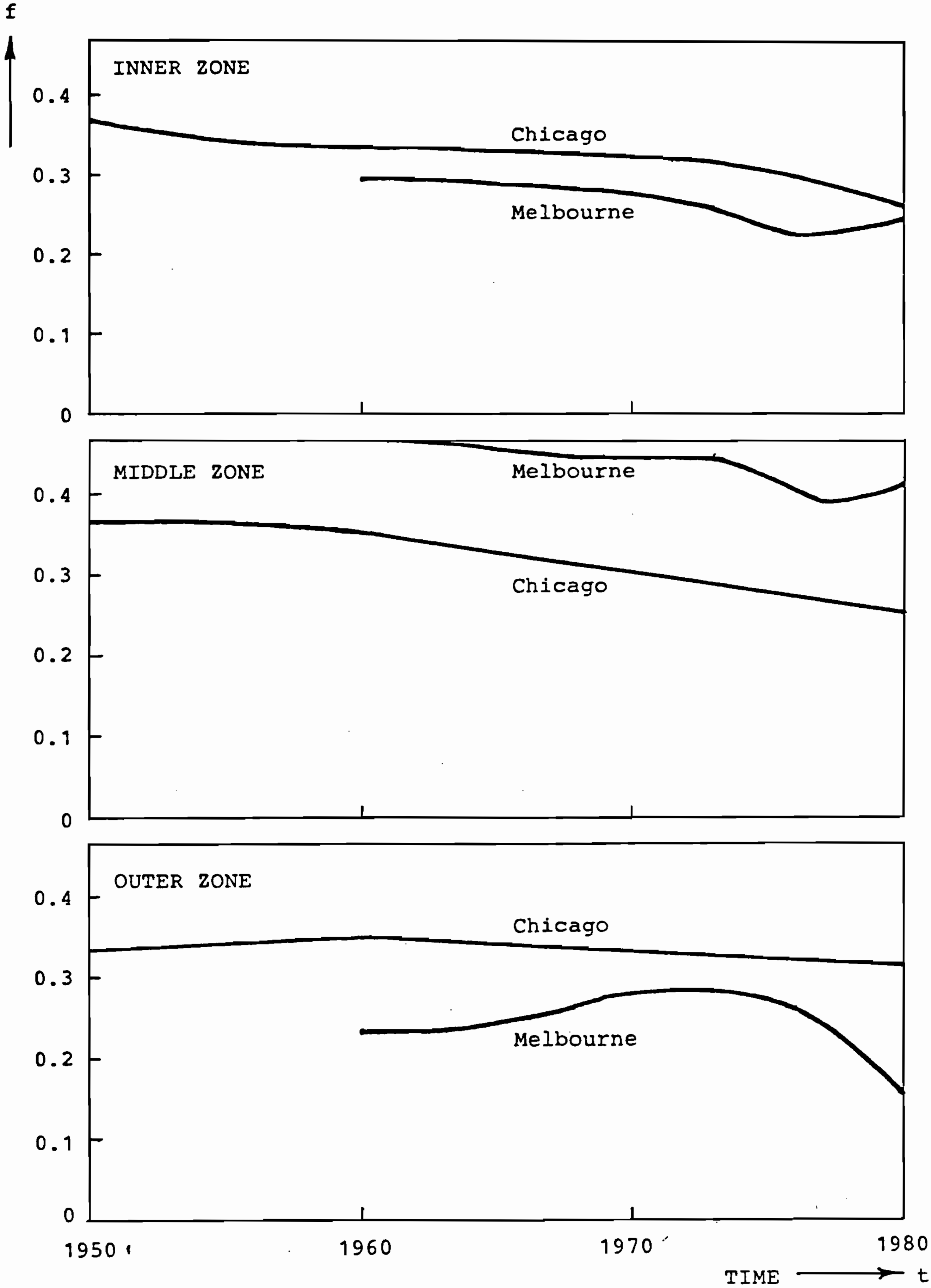


Figure 6 : Ratio of Manufacturing Jobs to Total Employment in Each Zone, Chicago and Melbourne, 1950-1980.

Of all economic functions, the retailing sector has usually been the most responsive to the changing location of consumers. Because of its role as a population-serving activity, it has frequently been governed by population movements. However, a glance at Tables 4 and 6 reveals that retail jobs have been leaving the Inner Zone at about twice the rate of population dispersal during the last 20 years. Although the emergence of large regional shopping centres has played an important role in this decentralization process, it is now the influence of changing technology which reasserts this trend. Automated checkout and distribution facilities are reducing the need for patronizing the city centres.

Technological changes manifest themselves in many different forms within metropolitan areas. The communication and computer revolution has facilitated large increases in the efficiency of information collection, processing and distribution. This has undoubtedly contributed to the suburbanization process. It is, however, doubtful if this revolution has had any profound impact on the development of knowledge, technical competence and creativity (Andersson and Johansson, 1984). The social dimension of knowledge and competence communication seems to be extremely strong, with a fundamental need for face-to-face exchanges.

From the above, we might conclude that persons involved in the transfer of knowledge and technical expertise, and in other creative activities, will tend to cluster and grow in metropolitan areas and in centres of high accessibility. Examination of recent changes in Melbourne's economic and occupational structure confirms this trend (Figure 7). The professional and technical persons have been increasing steadily, particularly in the core area. Furthermore, the transportation and telecommunication revolution has primarily had a suburbanization effect on those occupations involved in producing and transporting goods (sector II) and in the routinized transmission of information (sector IV).

In summary, those industries and occupations which made Melbourne a thriving city during the industrial period (1947-71) have suffered serious job losses during the seventies and early eighties. There has been a steady decline in the inner city population and economic activity, with extensive suburbanization of households and industry. Although new economic opportunities in the Quaternary and Quinary sectors are resulting in a growth

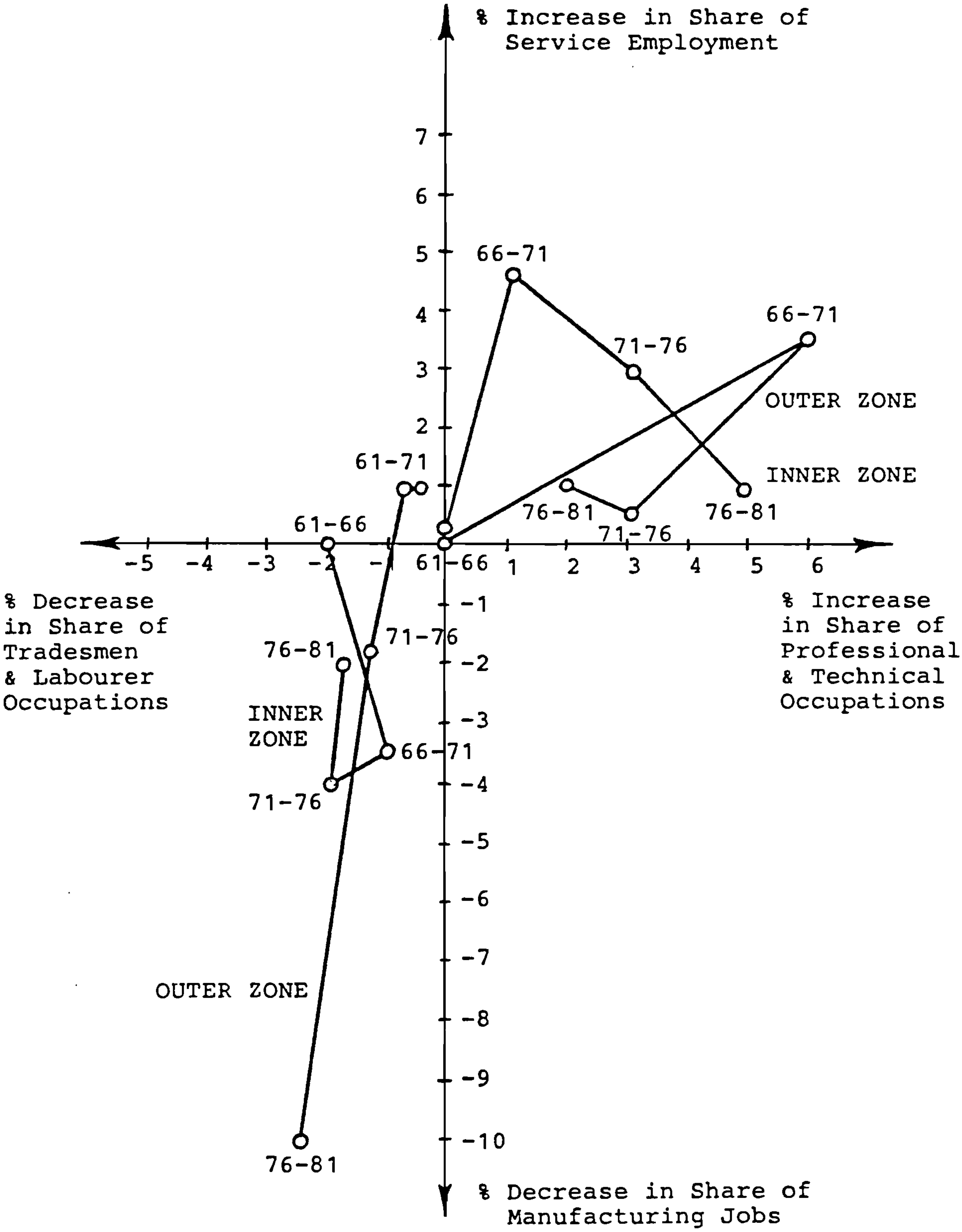


Figure 7 : Per Annum Changes in Economic and Occupational Structure, Melbourne, 1961-1981

of Service employment throughout the metropolitan area (Figure 7), it is uncertain whether this new activity can compensate for the declining comparative advantage held in Manufacturing.

In order to understand all the economic change processes discussed above from a theoretical point of view, it is necessary to go beyond the theory of comparative advantages (typically a static approach relating to specialization based on costs alone) to a more general dynamic analysis of product cycles and innovation diffusion. In the final section, we shall briefly outline a descriptive explanation of product cycles and their influence on the location of birthplaces for new products and economic activities as well as the successive relocation of existing activities.

5. PRODUCT CYCLES AND TIME-SPACE HIERARCHIES OF ECONOMIC DEVELOPMENT

Much of the discussion in Section 2.2 concentrated around the notion of a general technological development cycle (see Table 3 and Figure 3). To facilitate this endeavour, economic structural change has been measured in an extremely aggregated fashion. In order to identify the real agents of change, we must descend to the more detailed level of a competitive market. As a complement to the analytical results presented earlier, we shall elaborate on the leader-follower notions associated by Vernon (1966) with the stage of a product's life cycle in the competitive marketplace.

Vernon's basic position can be understood most fruitfully in a spatial context (see Figure 8). Each new product undergoes an initial development phase, during which it enters the most advanced regions of the world after a period of research, development and testing. The product is then primarily produced in a few regions with a comparative advantage in terms of high R & D capability and access to employment categories with the necessary profile of competence. These regions constitute the "leaders" of the product cycle in geographical space. The new product is gradually exported from these regions to other importing regions (followers). When the product has matured in terms of process development (design of production techniques) and market penetration, the original "leader" region loses its

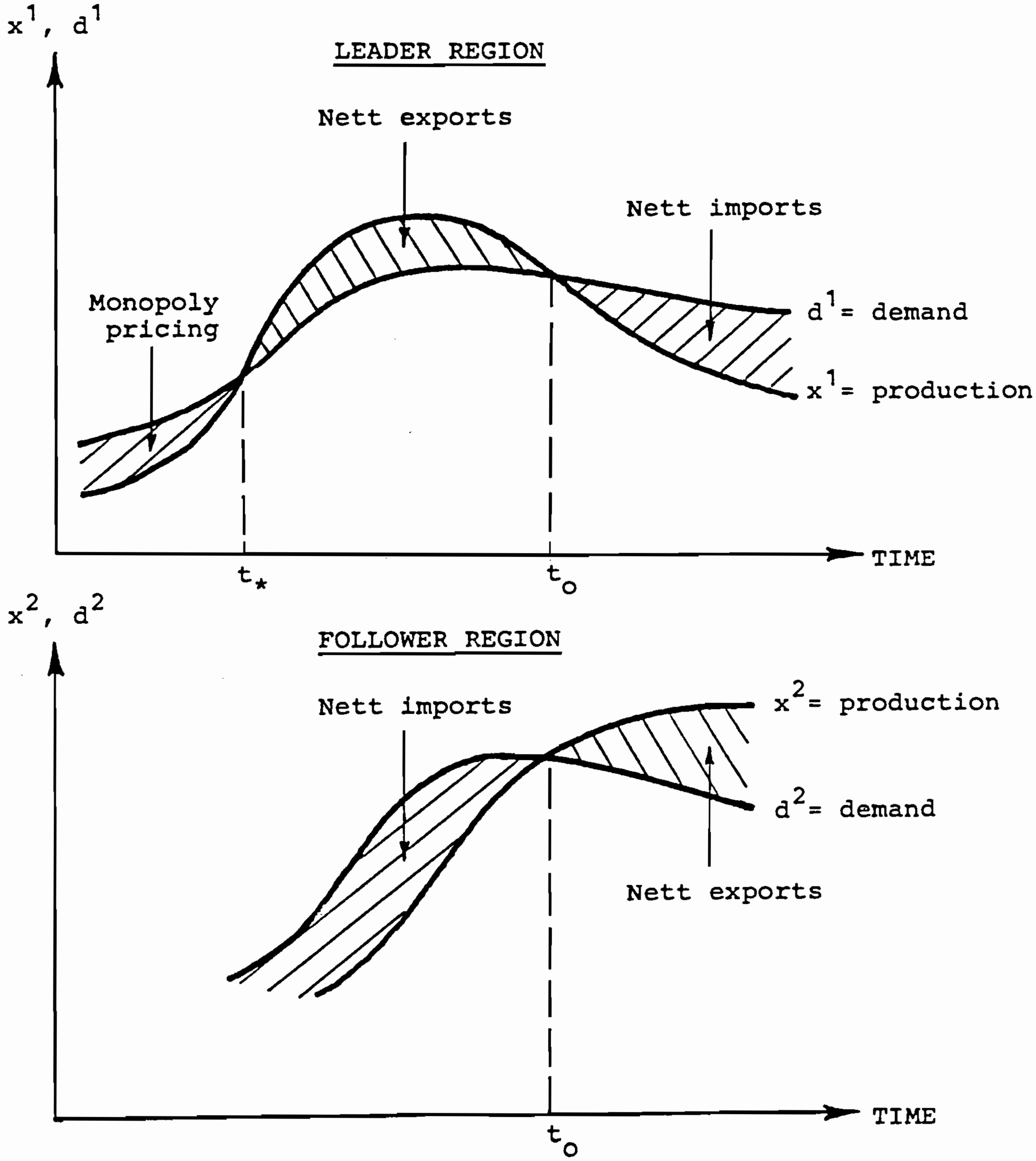


Figure 8 : Production and Notional Demand of "Leader" and "Follower" Regions

comparative advantage and production decentralizes.

The shape and speed of the development cycle of a specific product is contingent upon if and when a competitive substitute enters the scene. In the absence of product substitution, the development cycle may be characterized by spatial substitution of the following nature:[5)] As the technology is improved (through process change) and the technological knowhow spreads, it becomes easier to replicate it at other locations. With increasing scale and a corresponding technological maturity, production costs are reduced. The product becomes standardized and new production units can be placed closer to distant markets. At the stage when the production technique has become automated and standardized, its relocation to initially less favorable locations (which may now provide more advantageous economic conditions) becomes viable.

In this way, the theory predicts a time-space hierarchy of comparative advantages and sequential relocations for a given technological solution (see Andersson and Johansson, 1984). It is with the more detailed analysis of this changing hierarchy that later phases of the comparative study may be concerned.

6. CONCLUDING REMARKS

The foregoing analyses encourage speculation on a number of scores. For example, the persistence of peripheral demoeconomic growth in all the metropolitan regions under scrutiny suggests that agglomeration diseconomies emerge in central locations as the metropolis matures. As soon as plants begin to decentralize, as they inevitably do on reaching maturity, the centres of (larger) cities lose their "incubator" function and begin to decline. This is related to another Vernon hypothesis (Vernon, 1960), namely that central cities are hospitable to innovation and new industrial processes only so long as they are the scene of external economies. Yet, as firms grow, they desire scale economies rather than external economies and may therefore seek the cheap land in peripheral areas. Thus they leave the centre and add to its decline by no longer providing external economies to newcomers.

One may also speculate on the relative speed of apparent economic change at different scales of industrial focus within a metropolis. The preliminary results obtained in Section 2 suggest that it can take somewhere between one hundred to three hundred years for a metropolitan region to restructure its employment base in terms of major sectoral shifts such as manufacturing to services. At the level of individual industries or markets, however, the pace of competition and substitution is much faster in relative terms (10-50 years).[4] There appears to be a nesting of many faster substitution processes (firms entering, competing, losing their market share) within an apparently slower job restructuring process (see Figure 9). Being largely an aggregation problem, this result emphasizes the sensitivity of apparent speed to the scale of analysis involved.

Our final speculation is both significant and controversial. Although the processes of economic restructuring and job dispersal within different regions are rarely identical, and proceed at a wide range of speeds (as noted above), in almost every case the pace of the change is surprisingly steady. It would appear that irrespective of the scale of observation, and despite the existence of external discontinuities and perturbations, many structural demoeconomic changes may proceed at quite an orderly rate when measured in relative terms. An optimistic explanation is that, structurally speaking, certain metropolitan patterns of socio-economic change operate in a fashion akin to learning systems. In the midst of a plethora of suggested economic shocks, structural instabilities, and bifurcations, it is refreshing to encounter even this small whiff of possible regularity.

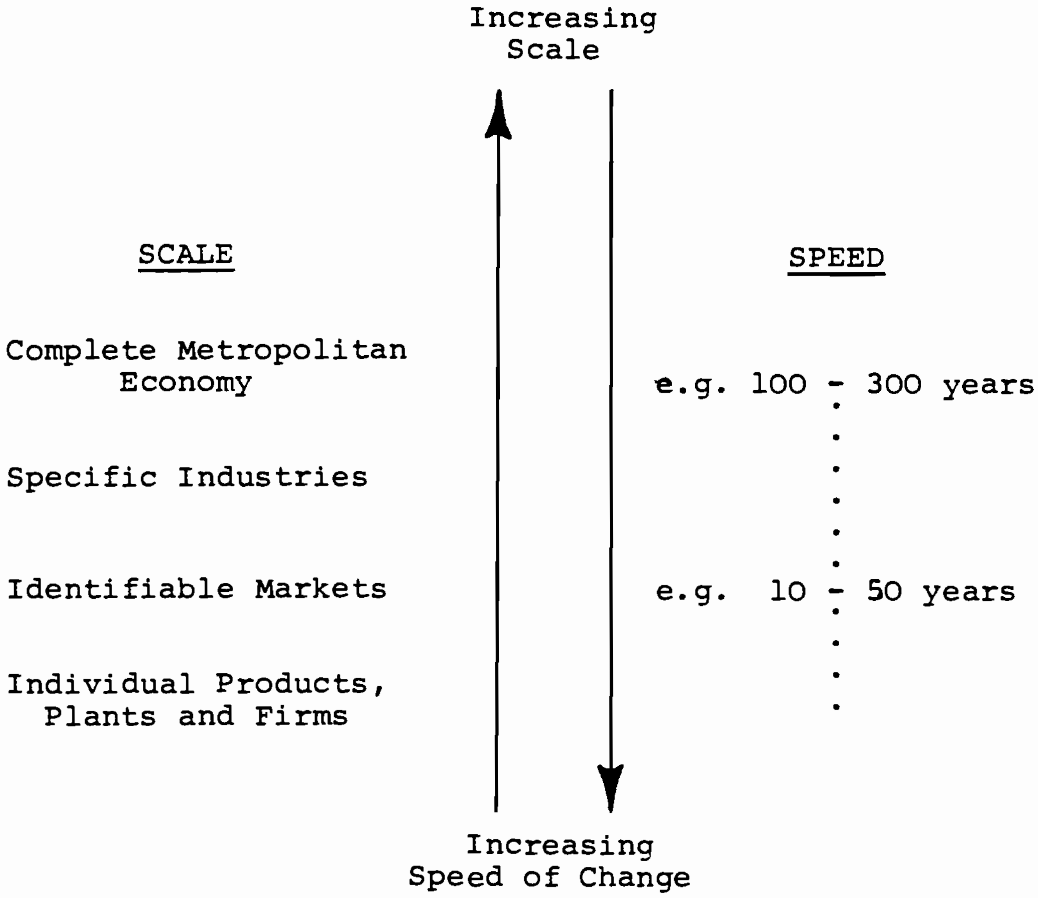


Figure 9: The Relationship between Speed of Structural Economic Change and Scale of Observation within Metropolitan Regions

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NOTES

1. For a review of the possibilities of modelling large scale structural changes such as those which have occurred during the seventies, the reader's attention is directed to a special issue of the journal, Regional Science and Urban Economics, and its introduction by Andersson (1981).

2. In this and other respects, the current IIASA project differs substantially from earlier comparative analyses of urban change. For example, previous IIASA research undertaken within the Human Settlement Systems Task concentrated on functional urban regions (that is, the changing physical urban settlement patterns) and aggregate population shifts (see, for example, Hall and Day (1980), Hansen (1978), Kawashima and Korcelli (1982)). Comparative work associated principally with the Netherlands Economic Institute has dwelt on the identification of lifecycle stages of urban development (urbanization, suburbanization, deurbanization and reurbanization) - principally in terms of population movements and, to a lesser extent, job dispersal (see, for example, Klaassen et al. (1981), van den Berg et al. (1982), Drewett and Rossi (1984)). Neither of these studies examined relative employment structure or speed of technological change from a comparative viewpoint.

3. This type of market share analysis is not foreign to regional science. For example, Beckmann (1973) developed a three-sector growth model for a region in which the decreasing share of total income held by the agricultural and transportation sectors, and the increasing share commanded by a new "growth industry", were each described by a logistic curve.

4. See, for example, Fisher and Pry (1971), Linstone and Sahal (1976), Marchetti and Nakicenovic (1979), and Batten and Johansson (1984).

5. In broad terms, a product cycle can be viewed as the result of both product substitution and spatial substitution proceeding in combination.

ACKNOWLEDGEMENTS

The author is very grateful for the various suggestions made by Åke Andersson, Börje Johansson and Michael Wiseman during the preparation of this report. Furthermore, sincere gratitude is expressed to all members of the project's international network who have generously provided the background information on which most of this report is based.

Appendix: Future Project Plans and Databases

The following data sets are currently being collected to allow more detailed comparative studies of industry and workplace dynamics in metropolitan regions. This information will also facilitate interactive studies which concentrate on the inter-dependencies between changes in the economic subsystem and changes in other subsystems (eg. population, housing, transport-ation).

I. BASIC DATA SET

a. Economic Structure- Proportions of (i) total production, (ii) exports and (iii) imports (in value terms); Number and percentage of employees that are engaged in

1. PRIMARY, i.e. Agriculture, Forestry, Fishing, Mining, etc.
2. SECONDARY, i.e. Manufacturing industry.
3. TERTIARY
   a. Construction
   b. Infrastructure Services:
      1) Transport
      2) Utilities
      3) Communications
4. QUATERNARY
   a. Commercial (Business) Services
   b. Wholesale Trade
   c. Retail Trade
   d. Finance, Insurance, Real Estate
5. QUINARY
   a. Personal Services
   b. General Social Services
   c. General Government

b. Occupation Structure- Number and percentage of employees that are

1. KNOWLEDGE BASED, i.e. Professional, Technical, Crafts, Laboratory, etc.
2. SERVICE-BASED, i.e. Management, Administration, Clerical etc.
3. GOODS-BASED, i.e.

c. Participation rates- Percentage of population aged 15 or over who are actively employed.

1. MALE
2. FEMALE
3. TOTAL

d. Levels of Unemployment

1. RECORDED in statistical sources
2. HIDDEN, i.e. informal, part-time, retired (may be estimates based on gaps between trend and recorded participation rates).

The TIME-SERIES covered for each of the above is roughly 1950-80, The SPATIAL DELINEATIONS for each of the above are

(i) National totals
(ii) Metropolitan totals
(iii) Core, Intermediate and Peripheral zones of your metropolitan area.

One of the basic tenets of the IIASA core group associated with the Metropolitan Study is that certain metropolitan regions possess a definite or potential comparative advantage as a place for introducing new economic activities (e.g. Shinkansen region, San Francisco Bay, Ruhr conurbation). This advantage can be lost (i.e. transferred to other regions) over time. In order to facilitate the dynamic analysis of changing comparative advantages among the network of participating cities, it will be necessary to explore in more detail (among other things) the changing nature and intensity of research and development (R & D) activities in each metropolis. The following set of additional data is designed to assist in this endeavor and may form the basis of some comparative studies designed to identify (i) leads and lags in product or process cycles (ii) differential rates of technological change and innovation diffusion (over space), and (iii) their relationship to the intensity of R & D activity in the network of metropolitan regions.

II. ADDITIONAL DATA

a. R & D Intensity- Amount spent on R & D activity as a proportion of value added

1. NATIONALLY
2. IN YOUR METROPOLIS
3. IN EACH INDUSTRY (see Part 1a).

b. Incidence of High Technology Industries

A clear definition of the term "high-technology" industry is, in itself, a difficult task. Some industries may be regarded as high product technology operations, such as computers, electronics, or scientific and industrial instruments. Others may be considered as high process technology industries, such as chemicals, automobiles and machinery. One way to alleviate this problem is to adopt a system-analytic stance, and to classify industries on the basis of whether they produce component parts for the system or whether they assemble the system itself. Combining this distinction with the degree of R & D intensity, the following disaggregation of economic activity would result

1. R & D Intensive Goods or Components
2. R & D Extensive Goods or Components
3. R & D Intensive System Assembly
4. R & D Extensive System Assembly
5. Producer Services (basically Quaternary in Part Ia).
6. Consumer Services (basically Quinary in Part Ia).

This R & D oriented, system-analytic representation of industry structure would be a valuable addition to the data provided by each city group.

c. <u>Other Items of Special Interest or Importance</u>

1. Dominant industry in the region
2. Average number of hours in a working week
3. Average weekly earnings
4. Consumer price index