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IDENTIFYING AGGLOMERATIVE/DEGLOMERATIVE TRENDS IN THE HUNGARIAN URBAN SYSTEM, 1870-1980

The Ohio State University

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IDENTIFYING AGGLOMERATIVE/DEGLOMERATIVE TRENDS IN THE HUNGARIAN URBAN SYSTEM, 1870-1980

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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DEDICATION

To Debbie

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Chapter I

INTRODUCTION

Urban geographers, long content with idiographic descriptions of individual cities, have recently begun explorations into the characteristics and growth dynamics of **urban systems,** interrelated sets of cities occupying regions and behaving as integrated socio-economic units. The urban systems approach reflects the view that cities, rather than existing in isolation, are intimately bound to larger-scale processes of spatial-temporal change. As Bourne and Simmons (1978, p. v) state:

> "The process of urbanization, once viewed simply as an inevitable consequence of development, is now seen as an integral component and a generator of economic growth and social change. To understand and influence either requires us to come to grips with urbanization at this level."

The emergence of the systems approach in urban geography parallels developments in other sub-fields of the discipline that have also adopted a more nomothetic research perspective in an attempt to foster an environment of scientific investigation of geographic phenomena. That the systems approach is firmly rooted in the **scientific geography paradigm** necessarily implies a specific research agenda. As such, a major goal of contemporary urban geography is to identify, explain, and predict the dynamic patterns associated with **urban systems development**: the progressive restructuring of population within settlement networks by differential city growth rates brought-on by, and themselves influencing, various geographic, historic, economic, demographic, and political forces. But although progress has been made on this agenda, much remairs to be learned before even a basic understanding of the characteristics and growth dynamics cf urban systems can be claimed.

The present study represents a contribution to urban systems research by focusing at the first level of analysis; specifically, on identifying the patterns of population **agglomeration** and **deglomeration** associated with the development of the Hungarian urban network over the period 1870-1980. The study finds justification in the fact that accurate and precise identification of the growth patterns exhibited by developing urban systems is necessary for an orderly progression to higher levels of understanding. As will be shown, our current understanding of the urban systems development process is incomplete, and so further studies are critically needed.

Of equal importance to theory formation and testing, though, is the need for in-depth explorations into the development dynamics of national settlement networks. This need stems both from the geographer's innate curiosity about patterns and processes occurring in specific regional settings, and from their expanding role as adviser in the public policy arena. Hungary presents an extremely interesting study in this vein, partly because it has experienced such a tumultuous developmental history; and also because the government is currently trying to reduce the level of **urban primacy** through various regional planning strategies.

Furthermore, a need exists for accurate and precise analytical tools capable of assessing the growth tendencies of urban systems through time. The stock of currently available techniques is limited, which has meant that our understanding of urban systems development processes has not progressed as quickly as might have been the case given a wider range of methodologies.

The goals of this dissertation are thus threefold: (1) to contribute to the body of theory concerning the nature of the urban systems development process; (2) to gain further insight into the specific growth dynamics in Hungary and their relation to other processes of spatio-temporal change; and (3) to offer suggestions for improving regional planning. Subsidiary to these goals is the desire to introduce a set of new techniques for the dynamic analysis of urban systems.

The dissertation is organized as follows. In the next chapter, the main models of urban systems development are reviewed in order to formalize the predicted growth patterns into testable frameworks that provide a basis for the empirical analyses that follow. This review serves to expose the limitations of the current models, and hence the need for new frameworks. A new model--the **cascading cycles model of urban systems development**--is thus proposed and its characteristics explored. Under this framework, urban systems are seen to develop by proceeding through a series of agglomerative/deglomerative cycles that begin in the largest city and then "cascade" down the urban network through time.

An overview of the geography and history of Hungary is presented in chapter 3 to provide background to the particular characteristics of the country and to help place the empirical analyses in context. A preliminary analysis of the data using traditional techniques is then given in chapter 4. The analyses include a discussion of city growth rates, concentration/primacy indices, static rank-size measures, and centrographic analysis. In chapter 5, the **expansion method** (Casetti, 1972) is used to redefine the parameters of an initial rank-size function first as quadratics of time in order to test for the occurrence and timing of **urban turnaround** in the Hungarian system; and then in terms of quadratics of rank and time to evaluate the hierarchial and spatial patterns of **polarization** and **trickle-down** occurring through time. The dissertation concludes in chapter 6 with a summary of the major findings, implications to theory and to Hungary, and suggestions for further research.

Chapter II

URBAN SYSTEMS DEVELOPMENT MODELS

The purpose of this chapter is to provide an overview of the analytical and conceptual issues underlying the empirical analyses that follow. Specifically, the goal is to establish the types of differential growth patterns that are exhibited by urban systems as they develop; and to relate these patterns to the associated economic and demographic processes, and to public policy concerns. The discussion will therefore cover: (1) the charactertistics of city-size distributions; (2) the frameworks of urban systems development; namely, the allometric, agglomerative, urban turnaround, and cascading cycles models; and finally (3) urban policy issues. The discussion, though, is by no means comprehensive: such treatment is beyond the scope of this analysis; and is clearly impossible given the limited state of understanding of urban systems and their development characteristics. However, this chapter should provide a number of signposts that will both illuminate interesting paths of investigation, and provide context for interpretating the results obtained from the empirical analyses.

2.1 CITY-SIZE DISTRIBUTIONS

A discussion of city-size distributions forms a convenient point of departure here for two reasons: (1) rank-size formulations are particularly well suited to describing the types of changing population distributions associated with the urban systems development models; and (2) the analyses presented in chapter 5 are based on variants of the basic rank-size model. The focus here is thus on the mathematics and interpretation of the parameters associated with the rank-size function.

Although the model used to describe city-size distributions has changed many times over its 70 year history (Carroll, 1982), its modern form is typically expressed as:

$$P = e^{c} r^{q} \qquad (1)$$

or, in its more familiar linearized form:

$$\ln P = c + q \ln r \qquad (2)$$

Equation (2) relates the natural logarithm of the population size of a city to the natural logarithm of its rank in the urban network when ordered from largest to smallest. The parameters c and q are the estimates of the logarithm of the population of the rank 1 center and the slope coefficient of the rank-size curve respectively. The parameter q of equation (2) is particularly useful for ascertaining the distributional characteristics of urban systems and hence for assessing growth trends.

The parameter q is the derivative of the logarithmic rank-size function as expressed by equation (2), and as such evaluates the percentage rate of change in population associated with a percentage rate of change in rank. In other words, q measures the elasticity of city population within urban systems. A value of q equal to -1 indicates a special condition of the rank-size curve, where the population of each center is a decreasing function of the rank 1 center (P_1) of the form:

$$P_i = P_1/r_i; \quad i = 1,N \tag{3}$$

The particular distribution expressed by equation (3) is considered by many to be the "ideal," and is referred to as the **rank-size rule, lognormal distribution,** or **Zipf distribution** (Zipf, 1949). That the rank-size curve with slope of -1 is taken as the ideal is also a reflection of two observations: (1) applications of rank-size functions to national settlement systems have repeatedly yielded values close to -1 (Carroll, 1982); and (2) a slope of -1 has been shown to be the steady-state outcome of random (stochastic) city growth, notably the so-called **Gibrat process** (Gibrat, 1957; Marshall and Smith, 1978).

The value of q equal to -1 thus provides a benchmark for evaluating the distributional characteristics of population within urban systems. Values of q more negative than -1 ($-\infty < q < -1$) indicate a larger percentage of the urban population living in the higher ranking centers than would be the case under rank-size conditions. Values of q less negative than -1 ($0 < q < -1$) indicate that the lower ranking centers are relatively more populated than predicted by the rank-size rule.

Leading directly from these observations, a further interpretation of the parameter q of equation (2) is as a measure of population **concentration** in an urban system. The term concentration is being used here, as throughout the study, in a very precise manner; namely, as a measure of relative proportion. For example, the concentration of a solution is the proportion of dissolved solute present in the liquid. Likewise, relative humidity is the ratio of vapor pressure to saturation vapor pressure in air, which is also a measure of relative proportion and hence concentration. The fact that the parameter q of the rank-size function evaluates the relative distribution of population contained within an urban system thus qualifies it as a measure of concentration. In fact, this interpretation is in keeping with the original use of the rank-size function as expressed by Auerbach (1913).

Furthermore, two types of concentration can be identified, corresponding to the two positional attributes possessed by cities. The first type is called **hierarchial concentration,** and refers to the level of population concentration contained within an **urban hierarchy.** In this instance, the term hierarchy is defined as the arrangement of cities into a graded series, and is thus equivalent to city-size distribution. However, hierarchy is more commonly used to refer to an organization of city sizes into distinct levels or categories each subordinate to the one above it. This second definition derives mainly from **central place theory** (see Berry, 1967), which is based on hierarchial levels of cities in urban systems. In this dissertation, though, the term hierarchy, and hence hierarchial concentration, is used according to its first connotation despite the fact that the Hungarian urban network possesses a highly stratified structure. Leading from this definition, the parameter q of equation (2) can be further specified as a measure of hierarchial concentration. The second type of concentration is called **spatial concentration,** and refers to the relative proportion of some phenomenon contained wihtin an area or generalized across space. Although spatial concentration is usually calculated with respect to specific areas, especially core regions (see Ullman, 1958), the parameter q of the rank-size function can be mapped to provide a spatial portrait of concentration as will be shown in chapter 5. For the remainder of this dissertation, the term concentration will be used in the general sense to imply both hierarchial and spatial aspects; however, each type will be specified when needed.

Besides its static meaning, an interpretation can be given to the change of q over time. For example, if the value of q for a particular urban system grows more negative through time, this implies that population is becoming relatively more numerous in the larger sized centers. An increase in the level of population concentration denoted by a steepening rank-size curve is termed **agglomeration.** The opposite situation--a declining rank-size slope--is termed **deglomeration.** Note that the terms agglomeration and deglomeration: (1) refer to the urban system in its entirety; and (2) are relative terms in that both can be produced in several ways. For example, hierarchial agglomeration can be the result of faster than average growth of the largest centers; slower than average growth of the smallest centers; or even no growth of the largest centers and absolute decline of the small centers. Furthermore, an important distinction is made between the terms concentration and agglomeration/deglomeration: concentration refers only to the static state of the distribution of population within an urban system; agglomeration and deglomeration both refer to dynamic population restratification within urban systems. Concentration, though, is often used as a verb (cf. Smith, Huh, and Demko, 1983), which can lead to problems since ambiguities arise over whether the static or dynamic aspect of population distribution is being referred to. By regarding concentration strictly as a measure of relative proportion, and thus analogus to density, the problem referred to here can be avoided.

The interpretation of the parameter q as a measure of population concentration has thus far been predicated on the fact that population and rank data for urban systems display linear trends when plotted on double logarithm paper. This situation is not always realized, however, since some city-size distributions do not conform to straight lines (Nader, 1984). Deviations from the linear can occur at both the high and low ends of the rank-size curve. The first instance is associated with **primate cities**: cities that grow considerably out of proportion to the rest of the system (Jefferson, 1939). A hierarchy characterized by primacy exhibits a non-linear trend in the upper portion of its rank-size curve that is better described by a quadratic variant. Another source of skewness is associated with the tendency of some rank-size curves to "drop-off" at their lower ends because of a lack of small sized centers (Baker, 1969). The rank-size rule predicts the presence of only a few very large cities but many very small cities in urban systems. When few very small cities are present in a particular distribution, the rank-size curve will be pulled downward at its lower end faster than would be the case under more normal conditions. The situation described here also warrents use of a quadratic model. When both urban primacy and too few small cities occur simultaneously in an urban system, the population and rank data are best fitted by a third degree polynomial rank-size function to capture deviations from the linear at both ends of the spectrum.

In urban systems exhibiting non-linearities in their rank-size curves, values of q, and hence levels of population concentration, vary with respect to rank. For example, in situations characterized by urban primacy, the slope of the rank-size curve is steeper at the top end than it is for the rest of the system. If the slope is greater in this portion of the city distribution, then the magnitude of q must be greater here, and hence levels of concentration must be proportionally higher. The same holds for low end deviations, since if fewer cities than expected exist at this level, their relative population concentration must be proportionally higher than under rank-size conditions. The concept of concentration--as evaluated by the parameter q of the linear rank-size model--thus can be extended to apply to each rank position in the urban hierarchy in non-linear cases. The same argument holds equally for the hierarchial and spatial cases.

Changes in the degree of non-linearity exhibited by rank-size curves through time indicate greater than proportional population restratification within the urban system. A situation involving population restratification into the largest centers occurring at such a pace so as to produce upward skewing of the rank-size curve is referred to as **polarization**. A reduction in the degree of non-linearity associated with a rank-size curve would indicate **trickle-down** effects. These terms also apply to skewness at the low end of the curve, but for the opposite reason. During the early phases of economic development, the very small cities, which possess limited economic base to begin with, become even less viable due to the pull of the larger centers. The result is often rapid out-migration that reduces the population of the small cities, thereby skewing the rank-size curve downwards (see Olevy, 1972; Salvatore, 1984; Brown and Stetzer, 1984). In the case of small cities, then, polarization implies non-proportional decline of population; however, this decline still results in an increase in the slope of the curve and hence in the level of local population concentration. Likewise, trickle-down implies a reversal of polarization, which occurs after the magnet effect of the largest cities diminishes. The interpretations given to polarization and trickle-down thus apply to non-linearities at both ends of the city-size spectrum; furthermore, their use here is consistent with the generally accepted meanings of the terms but extended to an urban systems development frame of reference.

One final point concerning city-size distributions remains. Growth of national urban systems is one of the most obvious reflections of progression toward modernization, and as such geographers have naturally assumed that characteristics of city-size distributions for particular countries should mirror the overall level of economic development. Berry (1961; 1969), for example, proposed that developing countries first exhibit a primate distribution, but then progress through time to a rank-size arrangement. However, after examining conditions in 95 countries, he concluded (1961, p. 588) that there was "...no relationship between type of city size distribution and either relative economic development or the degree of urbanization of countries." (see also Rosing, 1966; Lasuen, Lorca, Oria, 1967; Lasuen, 1973; Richardson, 1981, p. 18).

Berry's finding of course questions the assumption that city-size distributions necessarily tend toward rank-size conditions through time, and hence the validity of the log-normal distribution as the ideal form. In light of this finding, no normative qualities can be attributed to the rank-size function. However, the relationship expressed by equation (2) is meaningful as an analytical tool used to assess the changing characteristics of population distribution within urban systems (see Boal and Johnson, 1965). It is this aspect of the rank-size function that is utilized throughout the dissertation.

2.2 THE DEVELOPMENT MODELS

The previous section served to illustrate the types of growth dynamics that can occur within developing urban systems, and how these patterns are reflected in the rank-size curves. In this section, the actual urban systems development frameworks are explored and related to the underlying economic and demographic theory.

2.2.1 Allometric Growth

The simplest model of urban systems development is known as allometric growth, and holds that city growth is constant with respect to rank. The relationship is typically expressed as (see Aitchison and Brown, p. 23):

$$\frac{P_t - P_{t-1}}{P_{t-1}} = E_t \qquad (4)$$

where P_t is the population of the city at time t, and E_t is the mean growth rate between t-1 and t of individual cities or size classes of cities. The process associated with this type of growth is called the **Law of Proportionate Effect** (Richardson, 1973B, p. 244), which implies that all parts of the rank-size system grow in unison. Hence, no population restructuring occurs within the system, and so there is no agglomeration or deglomeration. In terms of the rank-size function, allometric growth is indicated by a constant increase in the value of c, with no change in q. The model thus predicts parallel outward shifts of the rank-size curve, except in the unlikely event of equal decline of every city in which case the curve would shift inward.

Allometric growth is essentially a stochastic framework. As stated previously, the rank-size curve with slope -1, and by extension allometric growth, is considered to be the steady-state outcome of random growth processes (Parr and Suzuki, 1973). The model is thus based on the assumption that all demographic processes--births, deaths, immigration, and outmigration--are uncorrelated with city size

(Simon, 1955). These assumptions, though, are rarely met. For example, Danta (1984) found an inverse relationship between city growth rate and rank for Hungarian cities, along with strong correlations between the various components of growth. Likewise, a substantial body of economic theory, as presented in the next section, suggests a relationship between growth and city size. Furthermore, the very idea of allometric growth runs counter to the philosophy underlying the sub-field of urban systems geography; namely, that differential city growth is bound to larger scale processes of change. The allometric growth model is thus best regarded as the null form of urban systems development. In fact, if allometric growth is identified for a particular set of cities, this finding would perhaps call into question the validity of the criteria used to define the urban system.

2.2.2 Agglomerative Growth

The second model is referred to here as agglomerative growth, and states that the rate of city growth is an increasing function of city size. In other words, the larger the city, the faster its growth rate. This type of development pattern necessarily results in restratification of population into the larger centers, which is reflected by increasing magnitudes of the parameters c and q of the rank-size function. A steepening rank-size curve in turn denotes increasing levels of concentration, and hence agglomeration.

Unlike allometric growth, agglomerative growth is supported by a substantial body of theory. First are the so-called **forces of urban centralization**, which Hoyt (1941) lists as: centralized government power, defense, religion, amusement, trade, industry, transportation, finance and banking, and utilities (see also El-Shakhs, 1972; Alonso, 1968). Second is the principle of **urban agglomeration economies**, which posits increasing returns to scale of industry for larger urban centers (Isard, 1956, pp. 182-188; Carlino, 1982; Kawashima, 1975; Alonso, 1971). Scale economies are in turn related to such factors as inter-industrial linkages, availability of investment capital, pools of skilled labor and managerial talent, access to transportation networks, and prestige location. The spatial dimension of this type of growth is related to Myrdal's (1957; see also Richardson, 1973B, pp. 29-34; Gaile, 1980) model of **circular and cumulative causation**. Essentially, this framework describes how agglomeration economies produce a self-perpetuating "geography of concentration" (Ullman, 1958) in core regions of nations. Finally, this framework is supported by demographic theory. Virtually all migration theories, from the earliest **gravity**

models (Ravenstein, 1885) through Zelinsky's (1971) **hypothesis of the mobility transition** and including the **Development Paradigm of Migration** (Brown and Sanders, 1981), are based to some extent on the premise that migration flows tend to move up the urban hierarchy, at least during initial phases of development/industrialization (see also Dorn, 1938; Latuch, 1973). Furthermore, migrants tend to possess higher fertility rates, which produce even larger growth effects in the urban destinations (Andorka, 1978, pp. 281-288; Greenwood, 1973; Goldstein and Goldstein, 1981; Keyfitz, 1980; Korcelli, 1982; Ledent, 1982; Morrison, 1973).

2.2.3 Urban Turnaround

The latest model of urban systems development is referred to as urban turnaround. Under this framework, urban systems experience first an agglomerative phase, characterized by increasing levels of concentration; followed by deglomeration and a trend toward more even population distribution. In terms of the rank-size function, urban turnaround is indicated by a switch in the temporal trend of q from increasing to decreasing magnitude.

Although urban turnaround has become a popular research topic only within the last few years, the idea of spatio-hierarchial population deglomeration is much older. Gaile

(1980) traced the concept of spread to the classical economists, and Hoyt (1941) explained how the same forces of agglomeration can also act to produce deglomeration. An early statement of both agglomerative growth and urban turnaround is provided by Tisdale (1942, p. 311):

> "Urbanization is a process of population concentration. It proceeds in two ways: the multiplication of points of concentration and the increase in size of individual concentrations. It may occasionally or in some areas stop or actually recede, but the tendency is inhibited by adverse conditions. Whether or not a saturation point, an 'urban maturity,' followed by stabilization or subsidence of the process, can or will be reached is not known. There is some evidence that points toward such a development, but the contingent and derivative nature or (sic) urbanization makes this a difficult question to answer."

The process of population deglomeration was also recognized by Gibbs (1963) in his model. Zelinsky (1962) identified decentralizataion of American industry during the middle part of this century. However, studies of deglomeration as a separate phenomena did not begin in earnest until the late 1970s. For example, Berry and Dahmann (1977) identified fundamental changes occurring in the population dynamics of the United States in the 70s. These changes consisted of a slow-down of the growth of large cities, especially those located in the industrial core region, and the rapid growth of suburban and exurban areas outside the core. Berry (1978) referred to the process of population deglomeration as **counterurbanization** (see also Dean et al., 1984). A series of studies by Vining (Vining and Strauss, 1977; Vining and Kontuly, 1977; Vining, 1982; Vining and Pallone, 1983) identified the changing patterns of migration flows away from metropolitan core areas in the U.S. and other advanced countries. Gordon (1979), however, suggested that the so-called 'clean-break' hypothesis advanced by Vining and Strauss (1977) was no more than a statistical artifact brought-on by suburbanization across metropolitan boundaries. Morrill (1979), advancing Gibbs' (1963) earlier work, also identified basic changes in U.S. demographic patterns: the continued centralization and small-scale urbanization in peripheral areas; continued metropolitan suburbanization throughout the country and exurban development in the industrial core; and the general movement of people to the environmentally attractive areas of the West and South. Long and DeAre (1983) also discuss this type of population redistribution in the United States. Only a few empirical studies, though, have explicitly identified deglomerative trends within developing urban systems. For example, Marshall and Smith (1978) found that the growth of large cities in Ontario had slowed and the small cities had begun to grow faster by the 1960s, thus producing deglomeration. Smith, Huh, and Demko (1983) identified both hierarchial and spatial deglomeration in Korea's urban system beginning in the late 1960s. Townroe and Keen (1984) demonstrated a reversal of increasing levels of concentration in Brazil. Finally, Myklebost (1984) documented urban turnaround in Norway. Each of these studies based their analysis on concentration indices (see section 4.3).

Other studies have examined the mechanisms underlying urban turnaround and related processes. For example, Richardson (1980) cites congestion costs and rising land values in the core, and the emergence of scale economies at selected peripheral locations as factors involved in polarization reversal (see also Clarke, 1983). Bourne (1980) identified five clusters of ideas related to urban decline and population deconcentration:

1). Structural/technological change. Technological innovation, footlooseness of the tertiary sector, international trade, plant obsolescence, raising production costs, shifting consumption, and higher attractiveness of smaller centers leads to decline of the largest centers.

2). Amenities/disamenities. Decline of large cities seen as an extension of suburbanization brought on by the same desire for more space and privacy; and by a repulsion from the high taxes, pollution, congestion, and racial strife of inner city/core regions.

3). Unintended policies. Policies on investment, taxation, trade, transportation, defense, housing etc. can bring about unintended spatial deglomeration.

4). Systematic exploitation. Similar factors as in (1), but seen from a capital logic perspective; namely, rational exploitation of more cost efficient locations, less unionization etc.

5). Random spatial economy. The observed urban pattern is the result of random spatio-temporal processes.

Taking a slightly different track, Casetti (1968) demonstrated that during the course of economic development the site of optimal investment productivity shifts from the core to peripheral locations, which in turn reinforces deglomerative trends. In a similar study, Casetti and Jones (1984) have shown that recent snowbelt/sunbelt shifts in the U.S. conform to **Verdoom's Law**: the tendency for capital to move to regions where its marginal productivity is greatest, which in advanced economies is often in peripheral locations (see also Kaldor, 1970).

The urban turnaround model is also supported by demographic theory. For example, Zelinsky's (1971) model posits a change in the dominant migration flows from rural-urban to urban-urban and even urban-rural in advanced economies. Also, the diffusion of technology to small towns reduces the comparative advantage of large cities, thereby lessening the impetence to migrate. Falling rural fertility rates further reduce rural push factors.

2.2.4 Cascading Cycles

The three models presented thus far represent the current state of urban systems development theory.[1] However, they fall short of accounting for the complete range of urban systems development scenarios. Within the framework of urban turnaround, for example, the urban system is seen to proceed through a cycle of agglomeration/deglomeration AS A WHOLE. But what if this is not the case? That is, what if the switch from agglomerative to deglomerative trends does not occur evenly across the urban hierarchy, but rather is itself some function of urban size? Both contemporary theory and the techniques avaialable for analyzing such trends are largely incapable of dealing with this kind of complicated development pattern. However, there is reason to believe that such patterns exist. For example, a recent study by Hart (1983) showed that the spatial and hierarchial deglomeration currently being experienced in cities in the Great Lakes Region is the result of long-standing

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[1] Another important emerging line of thought deals with catastrophic frameworks of urban development; see Papageorgiou (1980), Dendrinos and Mullally (1981), Mees (1975), Renfew and Poston (1979), and Wagstaff (1978). These approaches, however, lie outside the frame of reference adopted in this study and are thus not pursued.

trends rather than a post-70s turnaround phenomena. What is needed, then, is some new framework that on the one hand incorporates (or at least acknowledges the possibility of) complex agglomerative/deglomerative development dynamics operating within the urban system itself; and on the other can be empirically verified.

In this dissertation, a new model of urban systems development--referred to as cascading cycles--is proposed. Under this framework, urban systems are seen to develop through a series of agglomerative/deglomerative cycles that begin in the largest center and then "cascade" down the urban hierarchy through time. Essentially, the model extends the urban turnaround framework to incorporate non-linearities; in other words, polarization and trickle-down. In this regard, the cascading cycles model is similar to the growth center model, which is based on the occurrence of polarized growth at selected sites in peripheral locations (see Casetti, King, and Odland, 1971; Odland, Casetti, and King, 1973). The cascading cycles framework merely makes explicit the idea of a continuation of the trickle-down behavior from the largest to next largest center that is associated with the growth center model. Also, although the framework applies primarily to the largest centers in an urban hierarchy, the same type of pattern would supposedly be mirrored in the small towns as described previously. The occurrence of cascading cycles would thus be indicated by a switch in the trend of q in the rank-size model from increasing to decreasing magnitude that begins in the largest/smallest centers and progresses through time down/up the urban hierarchy. The economic and demographic theory discussed in reference to the agglomerative growth and urban turnaround models support this type of development pattern; better, in fact, than for the other frameworks. Also, this type of development pattern has already been expressed by some authors. For example, Daroczi (1984, p. 73) states the hypothesis that "...the higher the hierarchial level of an urban centre, the sooner its growth starts to decline...." Elliot (1984, pp. 234-235) speaks of the process of "cascade migration" in relation to urban capture. Krakover (1983) has recently identified spatiotemporal patterns of spread and backwash occurring within the Philadelphia urban field that seem to represent small scale versions of the cascading cycles phenomena. However, the development patterns associated with this framework await empirical verification; one of the goals of this study is thus to test for the occurrence of cascading cycles in the developing Hungarian urban system.

2.3 URBAN POLICY CONCERNS

Concern over the goals and impacts--intentional and unintentional--of various public policy measures has increased tremendously in recent years among both government officials and academics. This concern, though, rather than crystalizing understanding of the problems and means of solution, has tended to cloud the issues with a morass of views and unsubstantiated goals. The purpose of this section is thus: (1) to provide an overview of the types of urban public policy issues that have been addressed in the literature; (2) to explore aspects of socialist planning philosophy and practice; and (3) to identify some key research questions.

The underlying goal of public policy is to somehow maximize total social utility while minimizing total social cost. Translating this general, egalitarian goal into more precise terms applicable to urban systems has produced several streams of thought. First is the debate over optimal city size (Richardson, 1972; Thompson, 1972; Singell, 1974). The central issue here, which can be traced to the Greeks (Hansen, 1978, p. 1), was to try and identify the ideal size of cities; namely, the size that maximized utility for its inhabitants at the least overall cost in terms of congestion, public facility availability etc. The basic outcome of this debate was stalemate: a realization that on the one hand optimal city size is not constant across regions and cultures; and that the functioning of a city, regardless of size, is tied to its relations with other cities of the urban system (cf. Richardson, 1973, p. 45; 1981, p. 10-11).

The second part of the debate adopted a larger perspective, centering on optimal city-size distributions. The result, however, was the same: that even if governments could somehow fine-tune their urban systems, no compelling theory exists for guiding such tuning; and each situation is different, so solutions are largely non-transferable. The debate over city-size distributions was closely tied to the larger issues of regional economic development, especially the tradeoffs between overall efficiency versus regional equity, and centralization versus decentralization policies (Brutzkus, 1975). However, these largely idealistic debates were soon overshadowed by concerns over more specific problems existing in national settlement systems.

A fourth stream of thought concerns the problem of urban primacy existing in many developing and even industrialized countries. As Richardson (1981, p. 11) states:

> "The deceleration of the growth of the primate city is almost a universally proclaimed goal in developing countries, regardless of whether the population is 10 million or 500,000."

The concern over large cities stems from the observation that various problems exist in primate cities: job market saturation; strain on public facilities and the infrastructure; overcrowding and squatter settlements (Mountjoy, 1976); and, although disagreement exists (Mera, 1973; Alonso, 1971), diseconomies of scale in very large cities. Concern over problems related to primate cities is usually translated into a growth center (Darwent, 1969; Parr, 1970; Hansen, 1972; Richardson, 1978; 1976) or secondary city (Rondinelli, 1983) planning framework. The idea behind these strategies is to reduce the rate of growth of the largest center, and to stimulate growth in selected cities located in peripheral regions thereby evening-out the urban hierarchy. The actual policy instruments used to achieve these goals, and some of the underlying assumptions made in connection with this strategy, can be described in relation to socialist planning philosophy.

A discussion of socialist planning philosophy is relevant here since it is well developed, applies to Hungary, illustrates many of the planning instruments used by non-socialist countries, and it highlights the basic problems inherent in urban systems planning. The main concern of socialist planning is to provide a structure conducive to economic growth and development, while reducing remnant regional and social inequities (see Pleskovic and Dolenc, 1982). As Fuchs and Demko (1979B, p. 440; see also Fuchs and Demko, 1977B; Ronnas, 1982, pp. 143-145; Fuchs, 1980; Khodzhaev and Khorev, 1973; Offer, 1976) explain, socialist planning calls for:

> "...a greater equalization of the distribution of large-scale industry and of population over the country; the distribution of industrial production evenly throughout the country in order to utilize all human and natural resources in all regions; harmonious and proprtional rates of regional development; abolition of the 'contradiction' between cities and rural regions; and the overcoming of excessive concentration of population in large cities."

Given their divergent epistomologies, these goals are surprisingly similar to those adopted by western and developing nations.

The actual instruments used to achieve these goals involve both incentive and disincentive measures (Fuchs and Demko, 1979B, Table 1, p. 444). The first category is intended to encourage growth in peripheral areas, and includes State investment in new industrial and nonindustrial enterprises; expansion of existing enterprises; investment in public and industrial infrastructure; adjustments in transport rate structures; increased availability of housing and social services; educational opportunities; regional wage bonuses; relocation allowances; and active recruitment of labor. Disincentive measures are aimed-at reducing the growth of the largest cities: bans on new industrial investment; restrictions on industrial expansion; plant relocation; investment in labor-saving equipment; raising rents; residency requirements; controls on inmigration; and job transfers.

These instruments, which appear quite comprhensive and therefore should be effective at producing deglomeration, have been found to be only marginally successful. For example, Huzinec (1978) found that policies for controlling the growth of large cities in the USSR have simply not accomplished the task (see also Rowland, 1983; Fuchs and Demko, 1979A). Berentson (1981) found that regional inequalities are actually increasing more rapidly in East Germany than in Austria; while Ronnas (1982) was able to document only mixed results for Romania. Musil and Rysavy (1983), however, found a halt to both suburbanization and polarization in the case of Czechoslovakia during the socialist period.

Why the failure? Kansky (1976, p. 261) points out that despite the best intensions by planners in East European countries, most urban planning directives still emanate from the Soviet Union in the form of military, political, and associated economic interests. Also is the idea that if sectoral planning dominates over regional planning, as is often the case in East Europe, agglomeration will result. But perhaps larger issues are involved. Fuchs (1980), for example, raises questions concerning the egalitarian principles underlying urban planning goals in light of economic realities. Perhaps Townroe (1984), though, is closer to the mark when he calls attention to the continuing high level of ambiguity present in policy objectives and uncertainty in the pattern of underlying market forces.

The basic problem to urban systems planning is the lack of clear understanding of urban systems development patterns. For example, implicit in the growth center strategy is the idea that at some point in the development process deglomerative trends set in. However, the urban turnaround process is still little understood. Furthermore, timing of intervention is critical: if measures are implemented too soon, they will be ineffectual; if too late they are superfluous (Richardson, 1980, pp 69-72). What is needed, then, is a return to the basic scientific research agenda of identifying the patterns of urban systems development, formulating more accurate models, and integrating them with other processes of spatio-temporal change (see Bourne, 1974). After all, description and explanation still must preceed prediction and prescription. The study presented here represents a step in this direction.

2.4 SUMMARY

This chapter has reviewed the analytical and conceptual issues underlying the dissertation. The major points arising from the discussion are as follows:

1). The familiar rank-size model $\ln P = c + q\ln r$ is a useful tool for capturing the static distributional characteristics of population within an urban system, and for assessing change through time and within the hierarchy itself. An increase in the magnitude of the parameter q indicates increasing levels of concentration, or agglomeration; a decrease in q denotes falling levels or deglomeration. An increase in the degree of non-linearity exhibited by the rank-size curve at either the high or low end indicates polarization; a decrease indicates trickle-down.

2). The models of urban systems development predict patterns of population change through time. Allometric growth calls only for population growth with no restructuring within the system. Agglomerative growth calls for increasing levels of concentration in the urban system. Urban turnaround refers to a switch in the growth dynamics from agglomeration to deglomeration. Cascading cycles is a new model, which predicts polarization then trickle-down.

3). Most urban planning strategies call for reducing growth in the largest cities, and stimulating growth in peripheral regions, and are therefore based on growth center strategies. However, efforts to redirect growth have been largely unsuccessful due to a lack of understanding of the basic patterns and processes of urban systems development. A need for further studies to help identify the patterns and formulate new frameworks thus exists.

Chapter III

BACKGROUND TO HUNGARY

The purpose of this chapter is to provide background material to Hungary, which is intended to set the stage for the empirical analyses that follow. The discussion consists of three sections: (1) an overview of the geography and history of Hungary; (2) the patterns of economic development and regional structure; and finally (3) the characteristics and development trends of the Hungarian urban network. The discussion serves to place into focus the ingredients that make Hungary such an attractive case for urban systems analysis; namely, its interesting patterns of regional economic development, the aspects of "belated urbanism," the extremely primate nature of the urban system, and the government's recent efforts to curb the "Budapest problem." Furthermore, this study contributes to a better understanding of a country that on the one hand is increasingly being recognized as an innovator in the areas of economic management and regional policy, while on the other is located in an area that has received little attention from geographers in recent years (Turnock, 1984).

3.1 OVERVIEW

Hungary, officially The Hungarian People's Republic, is a small (93,030 sq. km.; about the size of the State of Kentucky) East Central European country (Figure 1). Hungary's location in East Europe places it in a **shatter-belt:** a "Zone caught between stronger cultural-political forces, under stress and frequently broken up by aggressive rivals." (deBlij, 1981, p. 565). Also, Hungary's inland location denies direct sea access; however, throughout its history Hungary has been at the center of important north-south and east-west trade routes. Hungary's location has thus had a significant impact on the development of its regional economic structure, settlement system, and even the character of its people.

Hungary lies in the heart of the Carpathian Basin, which is actually the bed of the ancient Pannonian Sea.[2] As such, the major topographic feature of the country is flat to undulating plains, but low hills or mountains are found in the northern and central parts of the country. The main physiographic features are (see Figure 2): the Great Hungarian Plain (Nagy Alfold), which covers most of the eastern and southeastern half of the country; the Little Plain (Kis Alfold) found in the extreme northwest; the Matra and

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[2] The discussion on the physical geography of Hungary is drawn largely from Enyedi, 1976, pp. 55-102, and Pecsi and Sarfalvi, 1977, pp. 13-136.

__Figure 1__: The Location of Hungary

Bukk Mountains in the north; the Bakony Mountains in the west central part of the country; and the Mecsek Mountains in the south center. The major hydrologic features are: the Danube River (Duna), which flows north to south through the center of the country including Budapest, and which forms an important transport route; the Tisza River, which also runs north to south but is located in the Great Plain; and Lake Balaton, the largest inland body of water in Europe and an increasingly important tourist area. The climate of Hungary is mild continental, with January and July temperatures averaging 0° C and 22° C respectively; and rainfall averaging 64 cm. per year. Average insolation ranges from 1800-2200 hours per year, which allows for a sufficiently long growing season for most crops. Soils in Hungary, particularly in the Great and Little Plains, are generally quite good; in fact, 60% of the land area of Hungary is cultivated, with another 15% used as pasture. Natural vegetation consists mainly of grass and oak woodland on the plains; and hornbeam-oak, beech, pine, and firspruce forests in the mountains. In general, Hungary is a resource poor country, but economically significant deposits of coal, oil, gas, manganese, iron ore, copper, bauxite, and clay are found mainly in the northern and central mountainous regions.

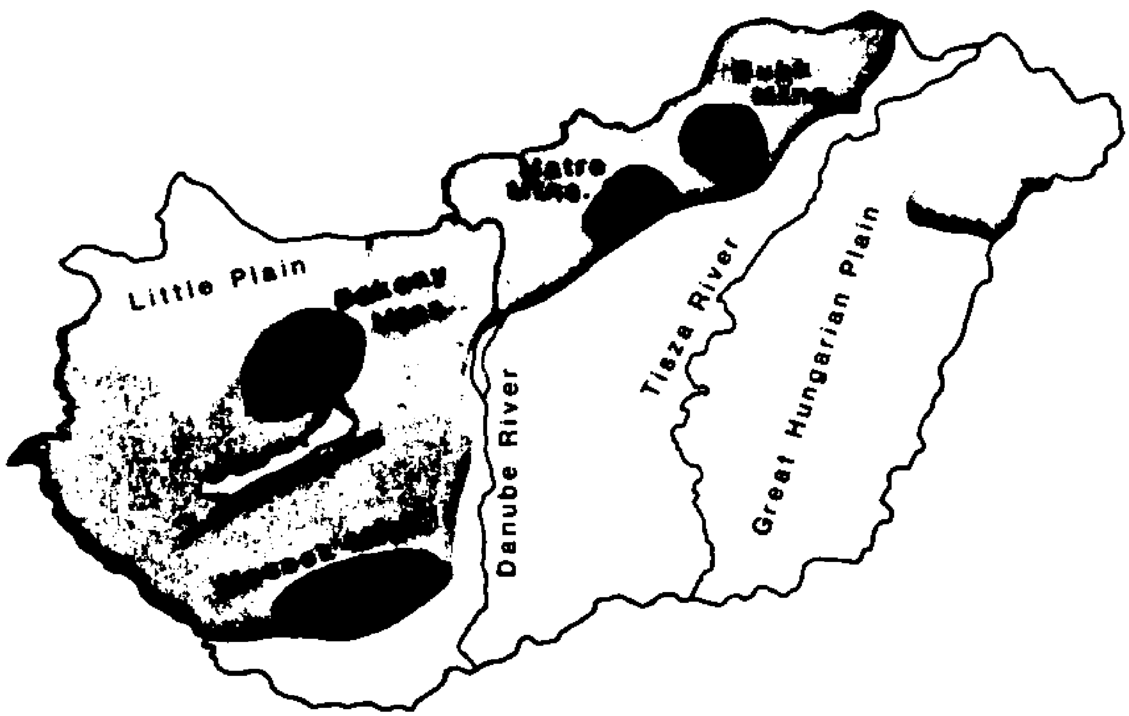

Figure 2: Physical Features of Hungary

Settlement of the present site of Hungary by Magyar tribes began in the 9th Century, but it was not until the year 1000 that King Stephen unified the country and thereby established the first Christian Kingdom in Eastern Europe. During the middle ages, particularly the 14th and 15th centuries, Hungary rose in power, soon rivaling even England and France in wealth (Enyedi, 1976, p. 5). However, the situation changed dramatically in 1526, when the Hungarian army, along with most of the Nobility, was annihilated by the Turks at Mohacs (Kosary, 1941, p. 91). The Turkish occupation of Hungary lasted for the next 150 years, during which time political, economic, and social development was retarded. No sooner were the Turks finally expelled, though, that Hungary again fell under outside domination, this time at the hands of the Austrian Hapsburgs. This essentially political and economic association lasted nearly 200 years, but was punctuated in 1848-49 by an unsuccessful Revolution (Kosary, 1941, pp. 219-347). However, conditions did improve afterwards, and Hungary finally received a measure of political freedom by the Compromise of 1867. Following the Compromise, which helped give rise to the development of capitalism, Hungary quickly expanded its territory, notably by the addition of Transylvania in the east and Slavic lands to the north and south. The association with Austria continued, though, and Hungary soon became embroiled in World War I.

Following the defeat of the Austro-Hungarian Empire, the Treaty of Trianon (1920) reduced Hungary 67% in size and removed 40% of its population (see Jaszi, 1929; MaCartney, 1937). This was a crippling blow, effectively isolating Hungary from its former trading partners. Hungary's economy thus generally stagnated during the inter-war period, except for a brief surge under Nazi domination.

Following the Second World War, and Liberation from Facism by the Red Army, the Hungarians established a coalition government headed by the Smallholders Party. After two years, however, the Communist Party gained control and set-up a Socialist State and centrally planned economy (Benes, 1966, p. 142). Hungary quickly became closely aligned with the Soviet development model, which is characterized by heavy industrialization. Rapid transformation of the economy, coupled with austere economic policies, led to popular unrest that erupted in the 1956 Hungarian Revolution. Since the 60s, however, Hungary has enjoyed relative prosperity under the leadership of Janos Kadar. Certainly, various problems have been associated with the operation of the centrally planned economy, such as the production of superfluous stocks of some items, and the shortage of other high demand goods. But as Friss (1978, p. 24) states:

> "It must not be forgotten that the economic insecurity which afflicted millions has entirely ceased, that earlier unknown opportunities for learning and self-improvement have opened up, that the working week has become shorter and leisure time longer, that culture has become accessible to the masses and that these masses have increasing opportunities to consciously shape their own everyday lives and future: these, in combination, have remoulded the entire society."

The population of Hungary is currently 10.7 million, and has been growing at the remarkably slow average rate of 0.7% per year since 1870, when the figure stood at just over 5 million (Kozponti Statisztikai Hivatal, 1982, p. 20).[3] However, the growth rate has been uneven: a peak of 1.3% per year was registered for the last decade of the 19th century, while 1.2% of the population (111,275 people) was lost during the war years 1941-49. Demographic patterns in the post-WWII period have been particularly interesting. The crude birth rate, which had been averaging about 14.0/1,000, increased rapidly between 1974 and 1975 to 18.3/1,000 (Hungarian Central Statistical Office, 1983, p. 19). This increase is largely a result of various pronatalist policies initiated at this time by the government (Compton, 1977; Szabady, 1974, 1977; Klinger, 1974). However, after reaching the peak in 1975, the crude birth rate has steadily dropped and in 1982 stood at only 12.5/1,000. Demographers typically point-to the general aging of the

[3] All figures qouted here refer to the population according to the current boundaries of the country.

population and increased female labor force participation as underlying factors of this drop. The crude death rate, on the other hand, had averaged a little over 10.0/1,000 after the war, but has been steadily increasing since 1966; in 1982 the figure stood at 13.5/1,000 (Hungarian Central Statistical Office, 1983, p. 22). Underlying factors are again the general aging of the population, but violent deaths and suicide remain high, and there has been an increase in cardio-vascular disease. Since 1981 the overall rate of natural increase has been negative; a fact that has led to fears of the Hungarian race eventually dying-out. Rates of natural increase, though, show important spatial variations: areas of natural increase are confined to the northeastern and northwestern parts of the country (Counties Szabolcs-Szatmar, Borsod-Abauj-Zemplen, Hajdu-Bihar; Komarom, Gyor-Sopron, Veszprem, Fejer); while the remaining 12 counties plus Budapest registered natural decrease during 1982 (Hungarian Central Statistical Office, 1982, p. 13). Also, natural increase is inversely related to city size (Danta, 1984). Another characteristic of Hungarian population is that it is remarkably homogeneous: 97% are ethnic Hungarian, with minorities of German, Slav, and Gypsy.

The economy of Hungary has been traditionally based in agriculture. For example, in 1900 58% of the workforce was engaged in agriculture, 15% in industry, and the remaining 27% in tertiary activities (Enyedi, 1976, Figure 7, p. 43). By 1982 the figures had changed to 21% in agriculture, 40% in industry, and 39% in tertiary (Hungarian Central Statistical Office, 1983, p. 28). However, agriculture remains an important sector of the economy; in fact, Hungary is the only net exporter of foodstuffs in East Europe.

By way of summation, the historic development of Hungary since 1870 can be broken into three periods: (1) 1870-1910 (actually 1867-1913), the period of the rise of capitalism, industrialization, and urbanization; (2) 1910-1949, the war years characterized by political fragmentation, economic stagnation, and severe physical destruction; and (3) 1949-1980, the socialist period characterized by heavy industrialization and remoulding of society. These three periods form convenient sub-divisions of the time horizon under study, and will thus be used throughout the dissertation.

3.2 REGIONAL ECONOMIC DEVELOPMENT

Undoubtedly the most important factor in the economic development of Hungary has been trade. For example, Hungary at one time supplied most of Europe with gold, which helps explain its early rise to power. However, with the discovery of North America, Western European trade routes soon became re-oriented away from the East, which effectively stranded Hungary (Roman, 1982, p. 104). Hungary was thus not able to participate in long-distance trade and the comensurate wholesaling activities that are recognized as important features in the early development of economies (Vance, 1970). The occupation by the Turks further retarded industrialization and thus helped to prolong Feudalism well into the 19th century (Bies and Tekse, 1980, p. 1). Trade was not re-established to any significant degree until the mid-1800s, this time under the auspices of the Hapsburgs.

The second half of the 19th century marks an important period in the development of Hungary, since it was then that capitalism first emerged (Berend and Ranki, 1979, pp. 62-109). During this time, Hungary was mainly a supplier of raw materials (mineral and foodstuffs) to Austria, but an important textile industry was also started in Budapest by 1850. Another significant event was the construction, mainly between 1867-1873, of a radial train network that brought raw materials to Budapest and thence to Vienna and Bratislava (Bencz and Tajti, 1972, p. 12). The transport network further reinforced Budapest's comparative advantage over the rest of the Hungarian system, and thus set in motion centripetal growth trends and hence agglomeration. Other important industries soon emerged in Budapest, despite the deliberate hampering by the Austrians who were intent on keeping Hungary merely a supplier of raw materials and a market for their finished products. These included heavy manufacturing industries (especially machinery and rolling stock), food processing (mainly flour milling), textiles, handicrafts, ship building, and electrical engineering (Bencze and Tajti, 1972, pp. 12-14). Industrial development, strongly focused on Budapest, continued to expand rapidly until the outbreak of World War I. The period 1867-1913--from the Compromise to WWI--can thus be regarded as the first phase of Hungarian industrial development.

The second phase, though, did not begin until after World War II. This lag was due on the one hand to post-Trianon economic stagnation; and on the other to the severe war damage wrought by two World Wars (see Enyedi, 1976, pp. 16-21). The introduction of Soviet-style central planning, nationalization of industry, and collectivization of agriculture after 1949 obviously had a great impact on regional development (Enyedi, 1976, pp. 105-118; 1979). The dominant thrust of economic planning during the early phases of socialist development was toward heavy industrialization and away from agriculture. These actions necessarily led to a restratification of the economy from traditional sectors, which in turn resulted in rural outmigration to the industrial cities, mainly Budapest (see Compton, 1972). However, it is important to note that an objective of the government from the beginning was to even-out the regional distribution of productive forces according to socialist planning philosophy. For example, in the first Five-Year Plan, four-fifths of all industrial investment was directed toward the provinces, and 59 of 75 new plants were established outside Budapest (Bencze and Tajti, 1972, p. 25). However, agglomerative trends apparently still dominated in Budapest and a few industrial towns in the northern and central portions of the country (Fodor and Illes, 1968).

The decline of regional equity, plus falling productivity in most sectors of the economy, called attention to the need for economic reform. Such reform came in 1968 with the New Economic Mechanism (NEM). Basically, NEM was a liberal plan, designed to decentralize the decision making process and thus make the economy more efficient. More reforms in 1977 and 1980 have liberalized the economy still further, and have helped to re-establish agriculture as an important component of the economy (Balasa, 1981, 1982; Knight, 1983).

The contemporary economic structure of Hungary is characterized as follows. Industry--especially heavy industry--is presently the leading sector of the economy. The engineering industry is particularly important, specializing in transport machinery such as trains and buses (Maksakovsky, 1979, p. 119). Another important branch is the chamical industry, which specializes in pharmaceuticals and fertilizers. The mining and smelting industries are also important sectors of the economy, but their expansion has been limited by a lack of mineral wealth. Agriculture specializes in the production of grains (mainly wheat and corn), sugarbeets, tomatoes, grapes, orchard crops, dairy products, beef, pork, and poultry (Pecsi and Sarfalvi, 1978, pp. 186-195). Agriculture also supports an important milling and food processing industry. Foreign trade, two-thirds of which is conducted with other socialist (CMEA) countries, is based mainly on the export of foodstuffs and the import of raw materials, especially ores, coal and coke, oil, and natural gas (Enyedi, 1976, pp. 217-228; Maksakovsky, 1979, p. 119). The regional structure of the country consists of two broad areas: an industrial axis centered on Budapest and extending northeast-southwest from Miskolc to Ajka, with corridores running south of Budapest through Dunaujvaros to Pecs, and northwest to Gyor; and the economically backward, predominantly agricultural areas occupying the entire eastern, southern, and western fringes of the country. This spatial distribution reflects a schism between the Great and Little Plains, and the northern and central mountainous regions.

One of the primary goals of regional economic development policy is to alleviate the problems of these backwards areas (see Koszegi, 1969; Sebestyen, 1969).

3.3 DEVELOPMENT OF THE HUNGARIAN URBAN SYSTEM

Although cities long had existed in the Carpathian Basin (Pounds, 1970; Beynon, 1943, p. 256), their importance had declined by the time of Hungarian conquest. The new inhabitants thus established a settlement pattern consisting mainly of isolated farmsteads and small groups of buildings called Tanya (Lewis, 1938). This type of dispersed settlement pattern was of course most evident on the eastern Plains (Puszta), reflecting the pastoral lifestyle.

The first true towns appeared in the 10th and 11th centuries, mainly in the western, mountainous regions of present-day Hungary (Pecsi and Sarfalvi, 1977, p. 160). These towns, examples of which are Gyor, Sopron, Szolnok, Szekesfehervar, and Pecs, differed from the smaller, eastern market towns (e.g. Szeged, Hodmezovasarhely, Debrecen, Kecskemet, Baja, and Bekescsaba) in that they were seats of royal and ecclesiastical power, or commercial centers (Perenyi, 1964, pp. 342-346). The distinction between the two types of settlement is important, because it marks the beginning of the east/west schism in Hungary: the western centers aligned themselves with European trade and thus prospered; while the eastern cities never grew much beyond their local market functions. Essentially, the development paths of Hungary were established by the 1400s, long before any industrialization occurred. The normal evolution of the cities located on the Great Plain was further hampered during the Turkish occupation by two sets of factors: (1) external pressure from the occupiers, which resulted in the evaporation of many small towns; and (2) internal pressure from estate lords intent on gaining greater control over the peasants through consolidation into selected sites (Peryeni, 1964, p. 347). The Great Plain is still characterized by a lack of small towns (Toth, 1980).

The next phase of urban development occurred during the middle of the 1800s with the rise of Austrian economic involvment. The fact that Hungary became mainly a supplier of raw materials, especially foodstuffs, tended to maintain the stability of the feudal system--and hence market town networks--within agricultural territories. Some towns, though, managed to develop handicraft industries (Pecsi and Sarfalvi, 1977, p. 144). Also, the construction of the railway network around 1860 stimulated growth in some terminus and break-of-bulk points (see Borai, 1978, p. 73). However, the major development of the second half of the 19th century was the rapid growth of Budapest. In fact, Budapest grew three-fold from 1870 to 1910, becoming one of Europe's most dynamic large cities (Dienes, 1973B, p. 25).

Following World War I, the Treaty of Trianon severed Hungary from its former trading partners Bratislava, Timisoara, Oradea, Cluj, and Zagreb, thus removing an important level of the urban hierarchy (Beluszky, 1978, p. 50). A further impact of the Treaty was to remove large parts of the hinterlands from key cities (e.g. Szeged, Debrecen, Pecs), which further exacerbated the imbalance of the settlement network. The hierarchial structure remained largely unchanged during the inter-war period. However, during World War II Hungarian cities suffered considerable damage. For example, 75% of Debrecen was destroyed during the war (Sapi, 1972, pp. 83-87); even in downtown Budapest war damage is still plainly visible.

The settlement system following World War II is characterized as follows (Figure 3). Budapest, which occupies a central location in the country, dominates the urban system to an extent unparalled in Eastern Europe (Kosinski, 1974, p. 141). As Dienes (1973A, pp. 356-357; see also Radio Free Europe, 1974) explains, Budapest in 1970 contained one-fifth the total, and one-half the urban population; two-fifths of the country's industrial employment; one-half the value added; and 87% of the research personnel. It is also the destination of most migrants in the country (Compton, 1970, 1972). The dominance of Budapest on social and cultural values is even more pronounced. For example, in

Figure 3: The Hungarian Urban System

Hungary one either lives in Budapest, or in the "videk": a somewhat condescending term meaning "the country" (see Dienes, 1973B, p. 29). The second tier of the urban system is composed of the five regional centers: Debrecen, Gyor, Miskolc, Pecs, and Szeged. These centers, which form a ring around Budapest in classical central place fashion, contain between 100-200,000 inhabitants and perform secondary manufacturing and administrative functions. For example, Miskolc and Gyor are the largest iron and steel producing centers outside of Budapest, and Pecs, Debrecen, and Szeged have developed varied industrial bases and are important university and research centers. The next level of cities is composed of places between 30,000 and 70,000 population. These centers generally assume administrative roles in their counties, but some are important mining, processing, and manufacturing centers. For example, Salgotarjan and Tatabanya are important coal mining centers; Ozd, Dunaujvaros, and Szekesfehervar are engaged in metalworks; Ajka and Mosonmagyarovar are the centers of the alumina industry; and Sopron, Szombathy, Papa, Godollo, and Gyongyos are engaged in light industries (Borai, 1978, pp. 74-78). Below this level are the towns containing 15-20,000, which fulfill mainly local market functions. The lowest recognized category of town is 10,000 population (Enyedi, 1976, p. 234). In addition to these categories are the so-called socialist towns: originally very small places that were selected for rapid expansion in the post-War period. One such town, Dunaujvaros ("Danube New City"), grew from less than 4,000 in 1949 to over 60,000 by 1980 (see Appendix A). Other socialist towns are Komlo, Leninvaros, and Oroszlany.

The structure of the Hungarian urban system is obviously not in keeping with socialist planning philosophy as outlined above. Pressure to reduce the "Budapest Problem" mounted in the 1960s, and in 1971 the National Settlement Network Policy was instituted (Body, 1976). The purpose of the plan was to balance the urban hierarchy by reducing the size of Budapest and stimulating growth in the provinces, mainly in the regional centers. Essentially, the plan adopted a counterpole strategy (Enyedi, 1979, pp. 116-117). The actual policy instruments included government investment in industry in outlying areas; improvements in infrastructure and housing in backward regions; tax breaks in peripheral areas; building restrictions in Budapest; and the relocation of selected industrial plants outside of Budapest (Bora, 1976; Tatai, 1978). Whether these policies have had an impact is still debatable. Certainly, they have contributed to an increase in the level of industrial activity in provincial areas. However, the policies have also helped to accelerate the suburbanization process in

Budapest (Enyedi, 1978); also, due to lack of housing in the Capital (see Belley and Kulcsar, 1977; Hegedus and Tosics, 1983) and elsewhere, commuting has increased dramatically in recent years (Fuchs and Demko, 1977A). Furthermore, residency requirements for subsidized housing imposed by the Town Councils in the regional centers in the 70s reduced the attractiveness of these towns as alternatives to Budapest. So, the view prevails that no amount of planning can change the current structure. For example, Compton (1977, p. 285) states that "...there is little likelihood of the provincial centers ever being able to counteract the pull of the capital." Beluszky (1978, p. 51) echoes this view:

> "New functions that are qualitatively different from those of the capital have hardly been adopted by the regional centers. It seems that the inner dynamics and opportunities of these cities themselves, are not adequate for the kind of development that would propel these cities to become counterpoles to Budapest and to fulfil the roles demanded of them in this type of development pattern."

Studies of the growth dynamics of the Hungarin cities paint a different picture, though. For example, Daroczi (1983), in her excellent study of the growth of functional urban regions, has identified several interesting trends. In particular, she found that rapid agglomeration occurred between 1870 and 1910, but since 1949 the dominance of the capital has diminished and medium and small-sized towns have experienced rapid development. It thus appears that the Hungarian settlement system is becoming more evenly distributed. However, popular concern over the depopulation of very small cities and villages still exists (Major, 1984).

3.4 SUMMARY

This chapter has provided a background sketch to Hungary, particularly its regional economic structure and urban systems development. The main points arising from the discussion are as follows:

1). Hungary is a small, land-locked, generally low-lying central European country that has been subjected to outside domination for most of its history.

2). Hungary's economic development was severed from Western Europe early in its history, and was further retarded by first Turkish occupation, and then Austrian domination. The first phase of rapid industrialization began following the Compromise of 1867, and continued until World War I. The Treaty of Trianon in 1920 severely disrupted Hungary's development. Post World War II socialist development was based largely on heavy industrialization and de-emphasis of agriculture. The New Economic Mechanism (1968), though, introduced more flexibility into the economy.

3). Outside dominance likewise retarded development of the Hungarian urban system. Capitalist development during the late 1800s occurred almost exclusively in Budapest, causing it to grow substantially. The Treaty of Tiranon increased Budapest's primacy, and reduced the viability of the provincial towns. Post World War II industrialization led to further agglomeration in Budapest and the northern and central industrial and "socialist" towns. Comprehensive restructuring of the settlement system began in 1971.

Chapter IV

PRELIMINARY ANALYSIS

In this chapter, the actual data analysis begins with a discussion of: (1) the data set; (2) city growth rates; (3) concentration/primacy indices; (4) rank-size measures; and (5) centrographic analysis. These analyses represent what can be called the traditional approach to studying the development of urban systems, since the measures used here have been applied more or less routinely in various empirical case studies. Each of the measures, though, offers a slightly different perspective on urban systems development. For example, examining city growth rates, especially after they have been standardized, can be a useful first step for gauging growth trajectories of individual cities, and for capturing changes occurring both within the different segments of the urban hierarchy and across space. The concentration/primacy indices and rank-size measures, on the other hand, provide more precise tools for assessing hierarchial change in urban systems, while centrographic analysis captures the spatial component of development. The purpose of using these measures in this dissertation is threefold: (1) to gain an initial impression of the types of development dynamics present in the Hungarian urban system; (2) to substantiate using the more sophisticated analytical techniques that are presented later; and (3) to help prevent misinterpreting the results obtained from the subsequent analyses.

4.1 THE DATA

Data for the analyses come from the 1980 Hungarian Census of Population,* and consist of population totals for the 96 Hungarian towns for the years 1870, 1900, 1910, 1920, 1930, 1941, 1949, 1960, 1970, and 1980. See Figure 3 for the locations of towns, and Appendix A for the raw data. The cities cover all parts of the country adequately, and careful inspection of the data revealed no obvious inconsistencies.

A few notes regarding the data deserve mention. First, even though it has occupied a much larger territory in the past, all of the cities appearing in the data set are located within the present boundaries of Hungary. It can be argued that certain cities--especially those now located in western Transylvania (e.g. Oradea) and northern Yugoslavia (e.g. Subotica)--were functionally integrated into the Hungarian urban system during the later part of the 19th

* Kozponti Statisztikai Hivatal (1981), 1980 evi Nepszamlalas, 28 korte: A Varosok fobb adatai, pp. 822-823.

and early part of the 20th Centuries. However, ties with these cities were severed following WWI and the Treaty of Trianon. Their inclusion in a study such as this, which spans the period 1870-1980, is therefore unwarranted. Also, the same set of cities are used throughout the time horizon, even though these particular 96 towns may not necessarily represent the largest places at each point in time (especially for earlier years). On the one hand, a data set consisting of the largest cities for each time period may be theoretically preferable; however, any advantage to be gained from this approach is outweighed by the need for maintaining consistency to help minimize systematic data bias. Besides, the problem referred to here is perhaps minimized (or eliminated) by the imposition of a minimum threshold size for entry into the analyses; see below.

Another important issue concerns the definition of city boundaries. The population totals for each city in the data set were enumerated to constant 1980 boundaries for each time period. The problem with this approach is that rural population may have been included in city counts for the earlier time periods and so totals may be inflated. However, experience has shown that the problem of over enumeration in this context is miniscule compared to the inconsistencies that result from allowing city boundaries to change during the study period. Any contemporary analysis of urban systems based on data using non-constant city boundaries would be received with considerable skepticism (see Bourne and Simmons, 1978, pp. 28-41). Therefore, rather than being a problem, the fact that the boundaries are constant across the time horizon is considered a plus.

One irregularity, though, is present in the data. The problem concerns the counting proceedure used to enumerate the populations: up to 1949, the de facto (present) population of each city was counted; thereafter, the de jure (resident) population was counted. Since some people currently live in outlying areas but commute to work in Budapest, this change means that population counts now may be artificially high for towns outside the capital. This problem is largely untrackable, though, given the limited data sources on employment necessary to overcome the inconsistencies.

One final point, alluded to above, remains. In empirical analyses of urban systems development, it is common practice to impose a minimum threshold size for entry into the sample (see Malecki, 1981, pp. 50-51). This practice is intended to eliminate the sporadic ("noisy") growth patterns often exhibited by very small sized cities. Also, an argument can be made that small cities are not functionally integrated into the urban system and so should not be included in analyses of urban systems development.

Whatever the rationale, the selection of the actual threshold size is a difficult and largely arbitrary task. In this study, a threshold of 10,000 population was used. The choice of this value reflects both conceptual and empirical considerations: conceptual in that places less than 10,000 population in the contemporary Hungarian urban system are not considered as cities (Enyedi, 1976, p. 234); empirical from the fact that the rank-size curves for the Hungarian data (see Figure 7) tend to quickly drop-off for cities less than 10,000 for most time periods. Essentially, the imposition of the threshold level is intended to maintain a more stable, consistent data set for analyses. Because of this threshold value, the sample size of qualifying cities ranged from 45 in 1870 to 93 in 1980, providing a combined total of 712 observations. The threshold value is used in all of the analyses reported in this dissertation except for the calculation of growth rates discussed in the next section.

4.2 CITY GROWTH RATES

Appendix B presents the simple growth rates for the 96 Hungarian cities for each representative time period 1870-1980 and for the entire period. The figures are largely unremarkable except for the extremely rapid (double digit) growth shown by certain cities, especially the "socialist" towns Dunaujvaros, Komlo, Leninvaros, and Oroszlany, after 1949.

More interesting trends emerge when the cities are grouped into rank categories. Figure 4 shows that although the overall growth rate for the system remained fairly constant (except for the war periods 1910-1920 and 1941-1949), not all segments of the system grew evenly. In particular, the growth rate for Budapest has been steadily declining since the earliest period, while the other city categories have experienced generally increasing rates over the time horizon. However, accurate comparisons are difficult to make from the simple growth figures.

A much clearer picture of relative growth patterns can be gained from examining standardized growth rates (Appendix C). Standardized growth is obtained by subtracting the mean rate for a given period from the individual city rate, and then dividing the result by the standard deviation. Some interesting trends emerge when these rates are plotted by rank category as before (Figure 5).[5] First, the decline in Budapest's rate of growth over time becomes much more apparent: it begins the study period with a rate 2.2 standard deviations above the grouped average, but ends 2.0 below after experiencing a fairly steady decline. The regional centers, on the other hand, grew at nearly the

[5] Budapest's standardized growth rate is different in Figure 4 than in Appendix C due to the different means and standard deviations associated with the grouped data.

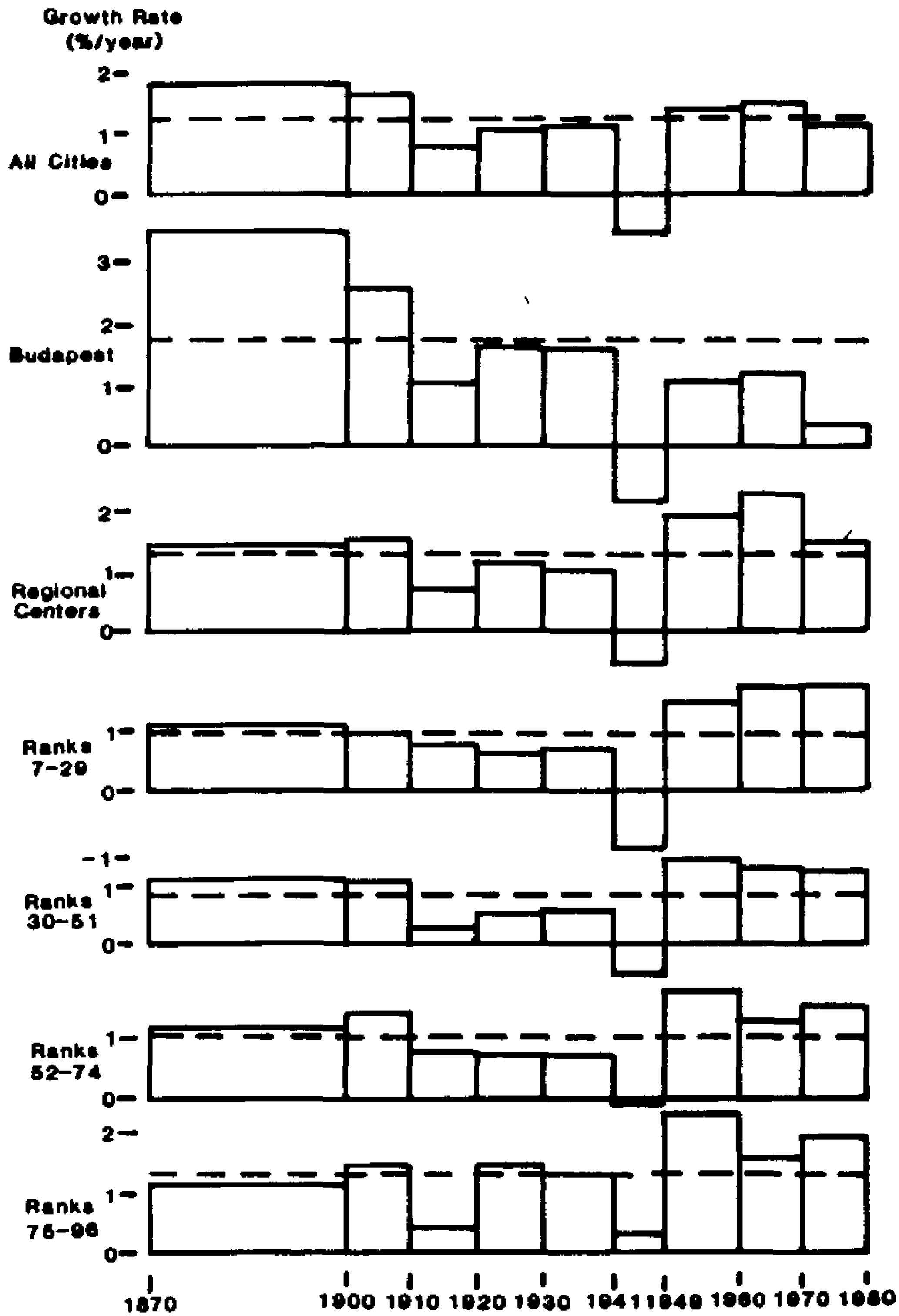

Figure 4: Simple Growth Rates by Rank Category

average rate over the entire 110 years except for a sharp jump during the 1960s, a time of rapid industrialization in Hungary. The three middle categories (ranks 7-74) all grew at slower than average rates over most of the time horizon. Surprisingly, the smallest city category (ranks 75-96) has shown strong growth tendencies since 1920. This last observation, though, may simply reflect the meteoric growth during the post-WWII period of some of the formerly very small cities; this finding reinforces the desirability of imposing a minimum threshold size for entry into the subsequent analyses. It appears from this analysis, though, that the overall growth rates for each rank category tended toward the average. In other words, the urban system now seems to be growing more evenly--closer to allometric--than was the case in the 19th century.

This conclusion, though, is not supported by the changing spatial patterns of growth. The maps in Figure 6 show the territories occupied by cities growing at a faster than average rate (white area) and those growing below average (shaded area) for three periods spanning the time horizon. In the early (capitalist) period (1870-1910), the pattern is largely indistinct: areas containing cities of above and below average growth appear almost randomly distributed across the map. For the middle (War years) period (1910-1949), a central ridge of above average growth

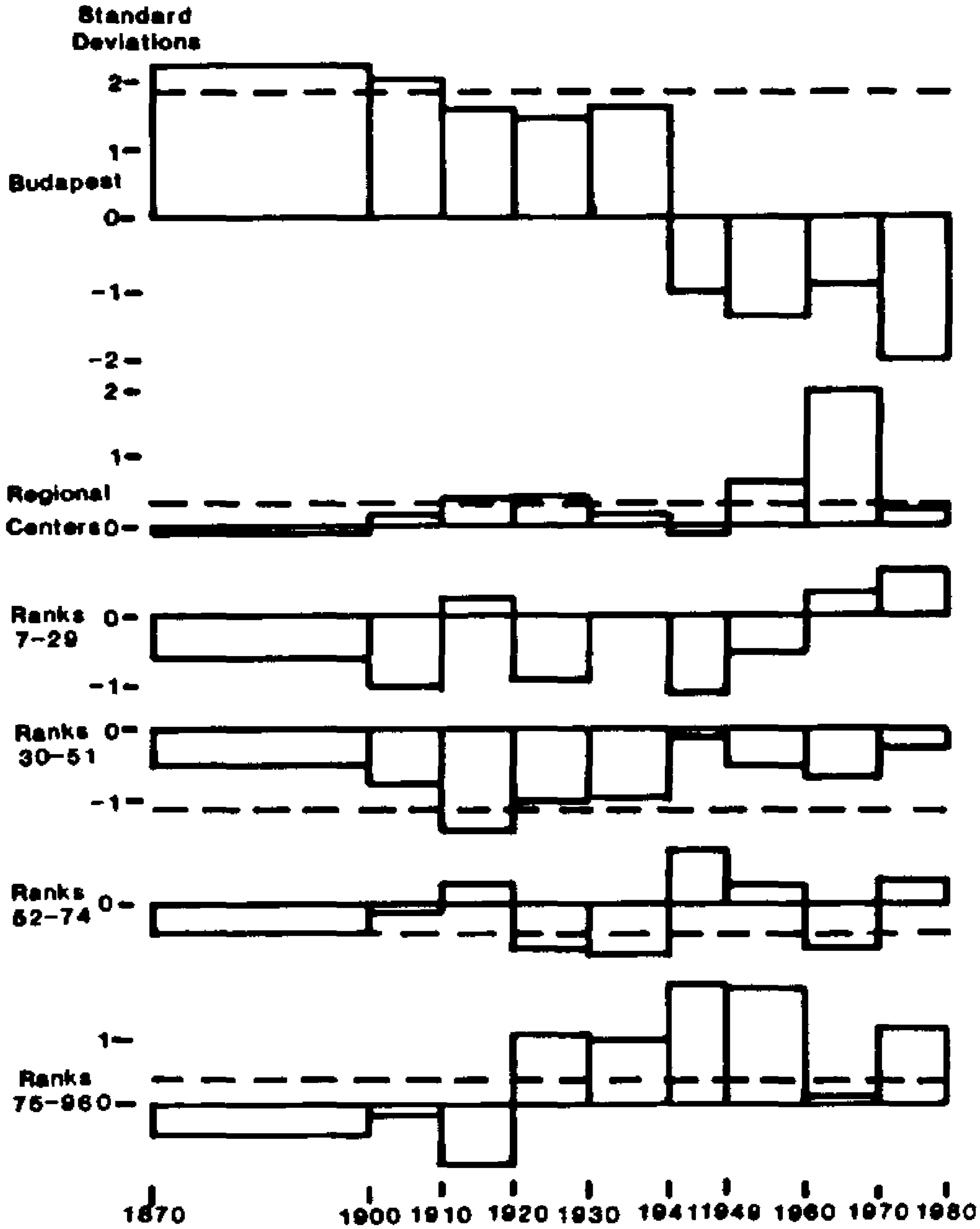

Figure 5: Standardized Growth Rates by Rank Category

appears, but still the general appearance of the map is random. By the later (socialist) period (1949-1980), however, the above average growth areas have consolidated in the northern and central mountainous/industrial regions; while the slow-growth areas remain in the Great and Little Plains, the predominantly agricultural regions. This pattern seems to reflect a growing rather than declining spatial growth disparity related to the division of the economy between industrial and agricultural regions.

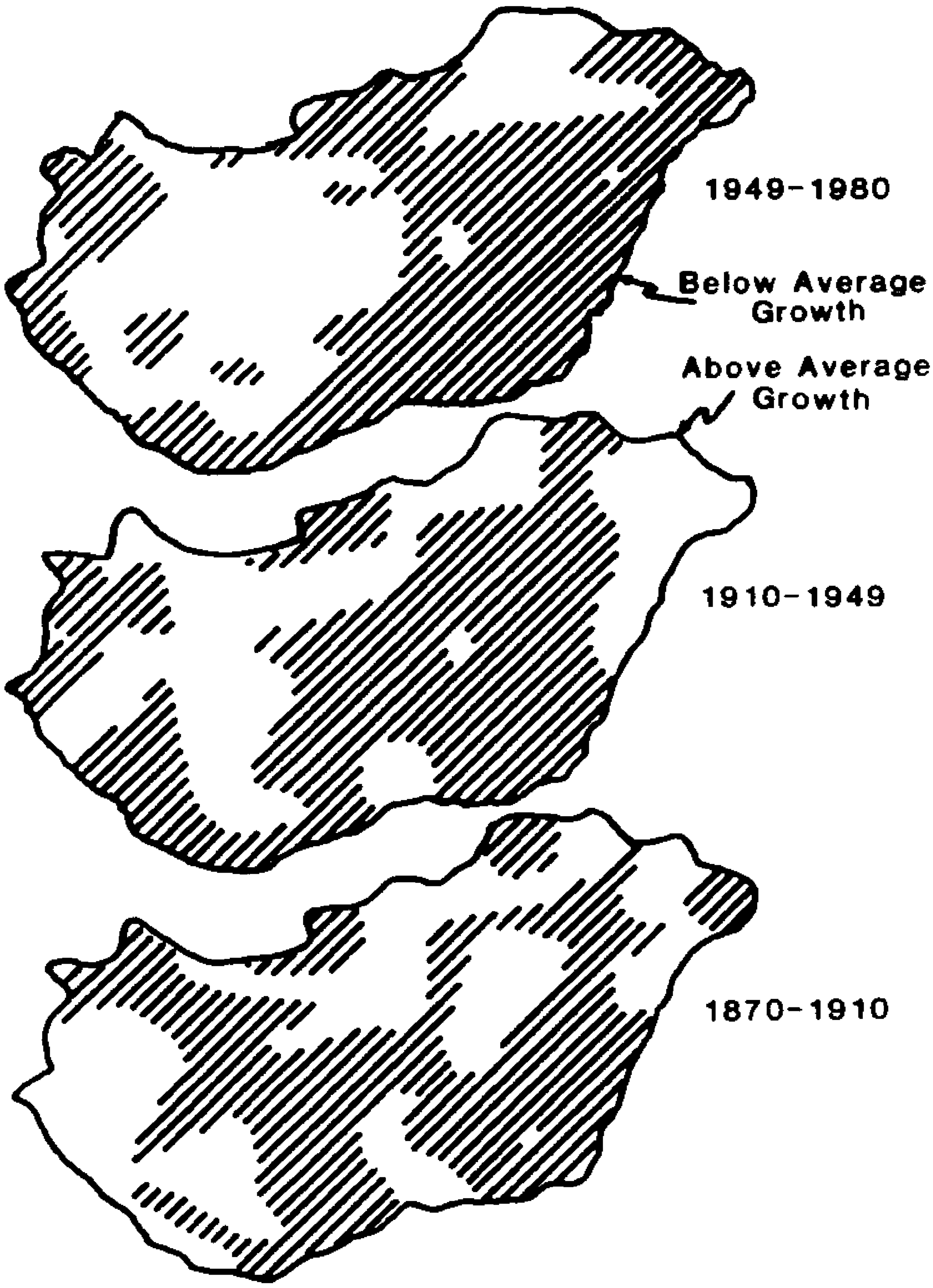

Figure 6: Spatial Distribution of Standardized City Growth Rates

4.3 CONCENTRATION/PRIMACY INDICES

By far the most commonly used method for assessing change in urban systems involves the so-called concentration/ primacy indices. These indices measure, in various ways, the relative distribution of population in urban systems. In other words, they assess levels of hierarchial concentration. Trends in the measures through time thus indicate any hierarchial population restratification that may be occurring between the different sized cities and hence agglomerative and/or deglomerative trends. Although several such indices exist (see Marfels, 1971, Subramanian, 1971, and Townroe and Keen, 1984, pp. 47-50 for excellent reviews), only four are used here. The first three are simple ratios of the population of the largest city to: (1) the next largest city; (2) the next 5 cities (e.g. the regional centers); and (3) the rest of the cities in the system.* The fourth index is the **gini coefficient** (Gini, 1921; Marshall and Smith, 1978, pp. 33-34), defined as:

$$N^{-2} \sum\sum(X_i - X_j)/2\overline{X} \qquad (5)$$

where N is the sample size; X_i and X_j are the populations of cities i and j; and $\overline{X}$ is the mean population size. The gini coefficient is a measure of dissimilarity, and as such evaluates deviations from the rank-size in urban systems.

* In this case, cities above 10,000 population.

Since it is calculated with respect to each city in the system, the gini coefficient is perhaps more sensitive to change than the other measures, and therefore is of greater utility in systems analyses. Values for the four indices for each time period are presented in Table 1.

Table 1

Concentration/Primacy Indices

Year	Budapest/ Next City	Budapest/ Next 5 Cities	Budapest/ Rest of System	Gini Coeff.
1980	9.934	2.388	0.569	0.628
1970	11.081	2.677	0.658	*0.641*
1960	12.663	2.975	0.697	0.630
1949	*14.332*	3.252	0.765	0.631
1941	14.320	*3.358*	*0.785*	*0.642*
1930	12.869	3.165	0.740	0.619
1920	11.926	3.035	0.690	0.597
1910	11.185	2.946	0.672	0.584
1900	10.025	2.666	0.620	0.545
1870	5.047	1.456	0.336	0.413

**Denotes value of maximum concentration.

Though the measures reported in Table 1 are calculated differently, each points to the same general trend: namely, rapid increase in hierarchial concentration (agglomeration) during the late 1800s up-to the 1940s; followed by steadily declining levels (deglomeration) except for a secondary peak in concentration shown by the gini coefficient for

1970. Certainly the destruction of human life and property, coupled with the exodus of refugees, are significant contributing factors to the large drops registered by these indices for the 1941-49 period. However, the fact that the measures continue to decline during the socialist period suggests a fundamental restructuring of the Hungarian urban system. In fact, three of the four measures indicate concentration levels to be lower in 1980 than they were in 1900. These measures thus strongly indicate the presence of urban turnaround; however, this conclusion must be tempered in view of the behavior of the gini coefficient.

4.4 RANK-SIZE MEASURES

Another method of assessing the characteristics and development dynamics of urban systems is through analysis of the rank-size distributions of cities through time. Figure 7 shows plots of the Hungarian data for selected years. This figure illustrates some of the characteristics of the Hungarian urban system: the extreme primacy of Budapest; the secondary tier of cities comprised of the regional centers; the generally even ("rank-size") distribution of the middle sized cities; and the rapid "falling-off" of the curves for the small cities (e.g. those below 10,000 population for the later periods). As for the growth trends, it appears from visual inspection of the curves that the growth rate

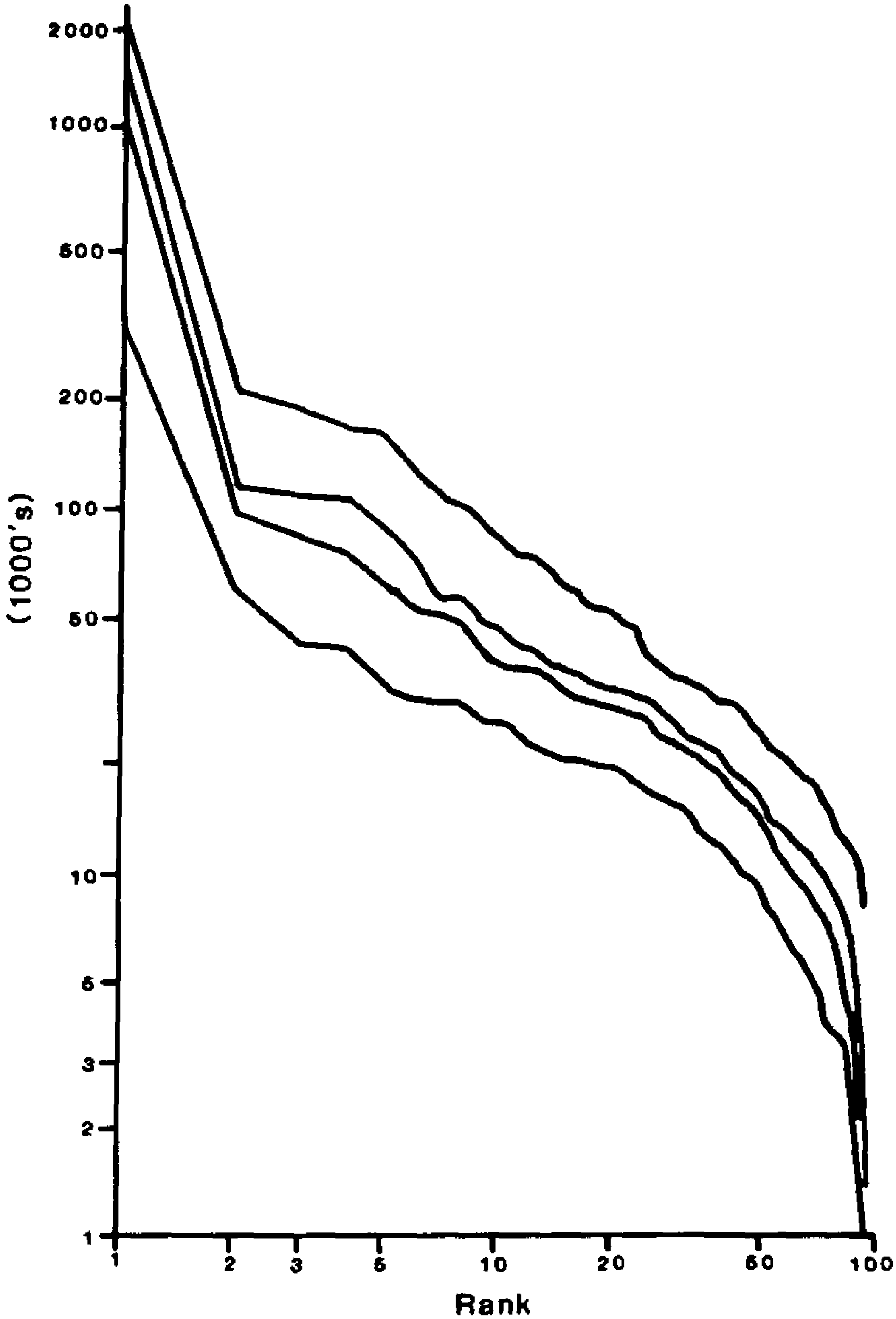

Figure 7: Rank-Size Distributions of the Hungarian Cities

of Budapest has steadily declined over the time horizon, whereas the rest of the system has experienced a fast-slow-fast growth trend over the three time periods shown here.[7] However, it is difficult to gauge accurately the growth dynamics from mere visual inspection of the rank-size plots.

Change in rank-size distributions can be more precisely assessed through application of the rank-size function to the data (see Carroll, 1982 for a review of such studies). As discussed previously, the linearized form of the rank-size function is usually expressed as:

$$\ln P = c + q \ln r \qquad (6)$$

where lnP and lnr are the natural logarithms of population and rank; c is the logarithmic population estimate of the rank 1 center; and q is the slope coefficient. The parameter q is of particular interest in studies of rank-size change since it measures relative system-wide hierarchial population concentration and so can be used to assess trends: q becoming more negative indicates agglomerative trends; q becoming less negative indicates deglomerative trends. Table 2 presents the rank-size coefficients

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[7] The years selected for plotting in Figure 7 are representative of the overall trends and so all 10 curves need not be shown.

estimated from the Hungarian data for cities greater than 10,000 population obtained through least-squares regression analysis.

Table 2

Static Rank-Size Estimates

Year	c (intercept)	q (slope)	R^2	DF	Prob. Level
1980	13.481	-0.884	0.963	1;92	0.0001
1970	13.316	-0.878	0.953	1;87	0.0001
1960	13.042	-0.834	0.941	1;83	0.0001
1949	12.839	-0.819	0.925	1;74	0.0001
1941	12.945	-0.841	0.929	1;75	0.0001
1930	12.792	-0.813	0.920	1;68	0.0001
1920	12.657	-0.789	0.914	1;65	0.0001
1910	12.547	-0.771	0.904	1;62	0.0001
1900	12.310	-0.721	0.886	1;53	0.0001
1870	11.691	-0.625	0.903	1;44	0.0001

The results show that the parameter estimates are all highly significant, and that the R^2 values are also quite high indicating good fits of the estimated rank-size curves with the data. The results also show that values of both c and q increased in magnitude over the 110 year time horizon except for sharp drops between 1941 and 1949. The trend of c is largely unremarkable given the previous analysis of Budapest's growth rates. The trend of q, though, is somewhat surprising, since it does not follow the pattern of post-WWII deglomeration observed in the previous analyses of the concentration indices. However, the results obtained here are not necessarily contradictory: the rapid increase in q from 1949 to 1970 may simply reflect a sorting-out period following the War. Furthermore, it will be noticed that the rate of increase in q between 1970 and 1980 is extremely small. In fact, the 1980 value may represent a decline from a peak reached sometime in the 1970s. So rather than invalidating the results obtained so far, these findings merely highlight the need for more precise analyses designed to better ascertain the growth dynamics.

4.5 CENTROGRAPHIC ANALYSIS

Centrography is the study of measures of bivariate (spatial) central tendency and dispersion. Essentially, centrography forms the basis of a spatial statistical methodology comparable to the set of standard descriptive statistics designed to analyze linear distributions. The two most commonly used measures are the centroid, mean point, and standard deviational ellipse, area containing one standard deviation of the phenomena under study. Centrographic measures have long been used in the analysis of population distributions (see Svaitlovsky and Eells, 1937; Caprio, 1970); their application to urban systems, though, is somewhat novel.

Table 3 presents the centroids and areas of the standard deviational ellipses for the Hungarian city data (cities greater than 10,000 population) for the years spanning the study period.

Table 3

Centrographic Measures

Year	Centroid N Lat	Centroid E Long	Area of Standard Deviational Ellipse
1980	47.296	19.293	1.945
1970	47.306	19.314	1.846
1960	47.306	19.352	1.797
1949	*47.314*	*19.403*	*1.737*
1941	47.314	19.394	1.767
1930	47.300	19.434	1.794
1920	47.288	19.449	1.842
1910	47.276	19.474	1.875
1900	47.244	19.506	1.945
1870	47.138	19.653	2.147

Coordinates in decimal degrees.

The results show that the centroid--and hence the "average" location of population of the Hungarian urban system--migrated northwest toward Budapest until 1949, but then changed directions and began moving west then southwest. The area of the standard deviational ellipse grew smaller, indicating spatial concentration of population, until 1949; thereafter, it grew larger indicating population spread. In fact, the degree of population dispersion present in

1980 was the same as it was in 1900. This finding is comparable to the concentration indices that also found similar measures for 1980 and 1900. Overall, the centrographic analysis, like the concentration indices, strongly suggests a fundamental change in the growth dynamics of the Hungarian urban system during the early part of the socialist period. Figure 8 shows the locations of the centroids and the semi-major and semi-minor axes of the standard deviational ellipses for the years 1870 and 1980.

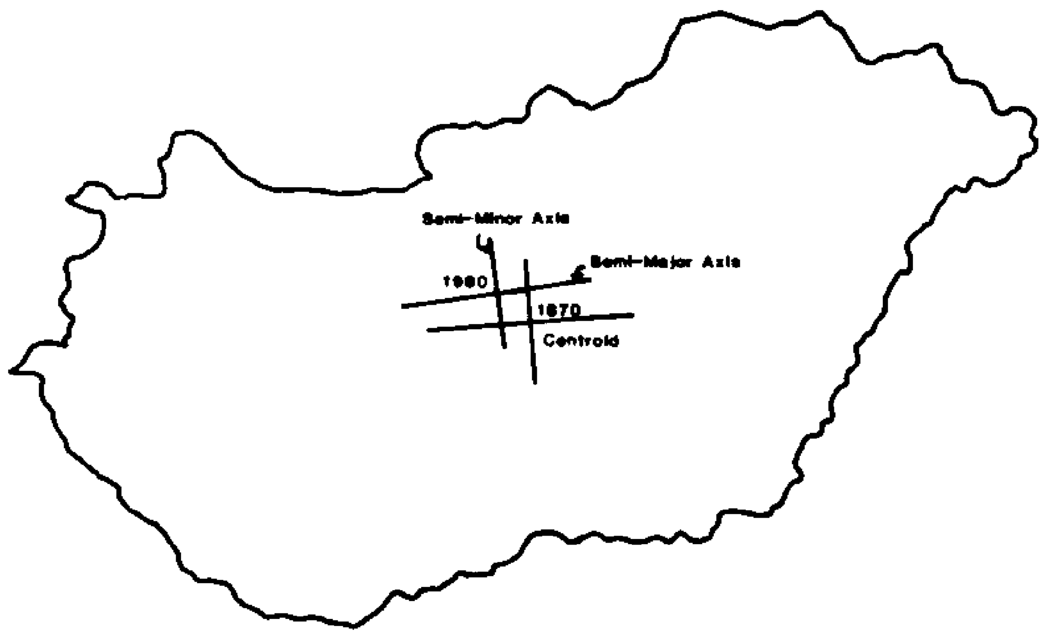

Figure 8: Patterns of Centrographic Measures

4.6 SUMMARY

The purpose of this chapter has been to start the data analysis and thereby gain an initial impression of the development dynamics occurring within the Hungarian urban system. The main points emerging from this chapter are as follows:

1). Data used for the analyses in this dissertation come from the 1980 Hungarian Census of Population which lists population totals for 96 towns for 10 time periods spanning 1870-1980. The cities are all contained within the contemporary (e.g. post 1949) boundaries of Hungary, and population totals for each city are enumerated to constant 1980 boundaries. A population threshold of 10,000 is imposed for entry into the various analyses performed in the study, which reduces the total combined sample of cities from 960 to 712. Overall, the data appear to be quite consistent and reliable, except for the switch in counting proceedure in 1949 from _de facto_ to _de jure_.

2). The analysis of both simple and standardized city growth rates taken individually and by rank categories revealed several interesting trends: (a) the steady decline of Budapest's growth rate over the 110 year period; (b) the unremarkable growth of the regional centers; (c) the spectacular growth of the "socialist" cities; (d) the generally below average growth of the middle rank centers; and (e) the growth spurt shown by the lowest order centers in the later periods. Overall, there has been a lessening of the hierarchial growth disparities present in 1870; but an increase in the level of spatial growth disparities, with the central and northern cities now growing faster than their southern and eastern counterparts.

3). The concentration/primacy indices show a fairly clear-cut pattern of increasing levels of hierarchial population concentration from 1870 to 1949, followed by decreasing levels. These measures thus provide the first indication of the agglomerative/deglomerative trends associated with urban turnaround.

4). The rank-size analysis, though, presents a less distinct pattern. The rank-size curves show the initial primacy of Budapest and a slight leveling of the system through time. The estimated coefficients for c and q show steady increase to 1941; sharp drops to 1949; followed by a return to increase. However, the rate of increase of q, and hence of agglomerative tendencies, slows considerably by 1980.

5). The centrographic analysis revealed a switch in the movement of the urban population centroid from a northwesterly direction toward Budapest up to 1941, followed by a southwesterly migration; and the spatial concentration of population also to 1941 followed by steady spread to 1980.

The general conclusions to be drawn from the initial analyses presented in this chapter are that rapid population agglomeration occurred in the Hungarian urban system up to the 1940s, and thereafter there has been a trend toward deglomeration, or at least a slowing of agglomeration. The initial level of urban primacy exhibited by Budapest along with the strong agglomerative tendencies appears to be a continuation of the regional development patterns associated with capitalist industrialization begun in the middle 1800s. Surprisingly, though, the heavy industrialization that occurred in the 1950s and 60s did not bring about the expected patterns of agglomeration. Perhaps the gini coefficients and rank-size measures are more accurate in this regard, though. In any event, there is reason to suspect that fundamental changes in the growth tendencies of the Hungarian urban system have occurred during the time horizon under investigation. In particular, the evidence thus far indicates that urban turnaround may have occurred sometime after World War II, and that patterns of agglomeration and deglomeration have not progressed evenly within the urban hierarchy.

Chapter V

DYNAMIC ANALYSIS

The analyses reported in chapter 4 served to reveal some of the growth tendencies of the Hungarian urban system over the period 1870-1980. The goal of this chapter is to more precisely identify the patterns of temporal, hierarchial, and spatial population agglomeration and deglomeration associated with the development of the Hungarian urban system. The analyses are performed with three goals in mind: (1) to determine which, if any, of the development models discussed in chapter 2 are relevant to the Hungarian situation; (2) to gain further understanding of the growth dynamics occurring within the Hungarian urban system and hence their relation to other processes of spatial-temporal change; and (3) to introduce a new set of analytical techniques designed to precisely identify trends of population agglomeration and deglomeration. The overall tone of this chapter, as in the last, is basic exploratory empirical analyses.

The basic analytical tool used in this chapter is the rank-size function. As discussed previously, the rank-size function relates the natural logarithm of the population size of a place (lnP) to the natural logarithm of its rank in the urban hierarchy (lnr):

$$\ln P = c + q \ln r \quad (7)$$

where c is the intercept value or logarithmic estimate of the rank 1 center; and q is the slope coefficient, which is used here as a measure of relative population concentration in an urban system. Changes in the magnitude of q are used to indicate growth dynamics: an increase in q denotes agglomeration; q decreasing indicates deglomeration. The parameter q of the rank-size model thus provides an excellent gauge for assessing the types of growth dynamics under investigation here; but as the analysis in section 4.4 showed, static applications of the rank-size model to time series data can paint only a very general picture of the growth trends.

The utility of the basic rank-size model as a tool in urban systems analysis can be greatly enhanced through use of the **expansion method** (Casetti, 1972; 1973). The expansion method is a proceedure used to generate new models by redefining some or all of the parameters of initial models as functions of other relevant variables. The expansion method is used to capture the quantitative change or "drift" of the initial parameters along whatever dimension is chosen for expansion. The importance of the expansion method to social science inquiry is that it not only provides a powerful tool for furthering empirical analyses, but it also can be a useful aid in suggesting new lines of research. Furthermore, the expansion method can be used in both exploratory and hypothesis testing environments.

Despite its fairly recent vintage, several studies have already used the expansion method to great advantage. For example, Malecki (1975, 1980) based his analysis of changes in urban systems on an expanded version of the rank-size function. Malecki's work is particularly significant here, since the present study uses it as a point of departure. Odland, Casetti, and King (1973; see also Casetti, King and Odland, 1971) used the expansion method to redefine the parameters of an initial function in terms of distance in order to identify the occurrence of polarized growth in a central place system. Finally, Krakover (1983) used the expansion method to derive polynomial power series that he used to identify the spatiotemporal paths of spread and backwash within the Philadelphia urban field.

In the analyses to follow, the expansion method is used to redefine the parameters c and q of equation (7) as functions of: (1) time, to assess the temporal trends of overall systems development; and (2) rank and time, to capture the patterns of polarization and trickle-down within the hierarchy itself. These analyses are designed to test for the occurrence of urban turnaround and cascading cycles within the Hungarian urban system; however, they are still capable of identifying other growth patterns.

5.1 IDENTIFYING TEMPORAL PATTERNS OF CHANGE

The goal of the analysis presented in this section is to precisely identify the temporal patterns of population agglomeration and deglomeration occurring within the Hungarian urban system taken as a whole. Identification of the patterns can be accomplished by assessing the temporal trend or drift of the parameter q in the basic rank-size function, which in turn can be undertaken through use of the expansion method.

Malecki (1975, 1980) has shown how the expansion method can be used to capture the temporal drift of the parameters of the rank-size model. He expanded the parameters c and q in equation (7) as linear functions of time:

$$c = c_0 + c_1 t \tag{8}$$

$$q = q_0 + q_1 t \tag{9}$$

where t is the number of years from the starting point in the time series of data being analyzed. By substituting the origininal parameters c and q in equation (7) by the right hand sides of equations (8) and (9), the following terminal model is obtained:

$$\ln P = c_0 + c_1 t + q_0 \ln r + q_1 t \ln r \tag{10}$$

If equation (10) is used in regression analysis on time series population and rank data, estimates for the expansion parameters representing the linear trends in c and q could be obtained. However, the analyses reported in chapter 4 strongly indicated that the development dynamics operating in the Hungarian system exhibit non-linear temporal trends. Specifically, the results suggested that a switch in the overall growth dynamics from agglomerative to deglomerative trends occurred sometime after World War II. Therefore, a linear expansion in time as in equation (10) is insufficient to capture the suspected trends; rather, a quadratic expansion is warranted.

In the analysis to follow, the parameters c and q are expanded as quadratic functions of time:

$$c = c_0 + c_1 t + c_2 t^2 \tag{11}$$

$$q = q_0 + q_1 t + q_2 t^2 \tag{12}$$

which, when replaced in equation (7), yield the terminal model:

$$\ln P = c_0 + c_1 t + c_2 t^2 + q_0 \ln r + q_1 t \ln r + q_2 t^2 \ln r \quad (13)$$

The reason for expanding q as a quadratic function of time is clear from the basic goal of the analysis, which is to assess the switch in the growth dynamics from agglomerative to deglomerative trends. The rationale for also expanding the parameter c into a quadratic of time is to allow for an increase of the rank 1 center (Budapest) at a decreasing rate, which is justified on the basis of the standardized growth rates reported earlier, and also to maintain symmetry in the terminal model. The fact that both parameters are expanded similarly, though, does not imply the necessity of doing so in all cases involving the expansion method.

An application of equation (13) to time series data using stepwise multiple regression analysis would yield parameter estimates of the coefficients that are interpretable as follows. First, if all of the expansion parameters (c_1, c_2, and q_1, q_2) are not found to be significant (that is, not significantly different from zero at some significance level, usually set at 5%), then this means that the system either experienced no change over the time horizon being investigated; or else the change was so complex that the various trends cancelled-out one another. If c_1 is found to be significant and positive/negative, but c_2 is still not significant, then the largest city experienced steady growth/decline over the time horizon. If q_1 is found to be significant and negative/positive, but q_2 is not significant, then this indicates that the system experienced constant agglomeration/deglomeration over the time horizon. These two results of course correspond to Malecki's (1975) linear model; see pp. 44-46 in his paper for further discussion of the interpretation of these parameters.

If all of the expansion parameters in equation (13) are found to be significant for a particular data set, then four possibilities exist for both c and q:*

1). c_1 +, c_2 + = accelerating growth
2). c_1 +, c_2 − = decelerating growth
3). c_1 −, c_2 + = decelerating decline
4). c_1 −, c_2 − = accelerating decline

1). q_1 −, q_2 − = accelerating agglomeration
2). q_1 −, q_2 + = decelerating agglomeration
3). q_1 +, q_2 − = decelerating deglomeration
4). q_1 +, q_2 + = accelerating deglomeration

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* "+" = positive; "−" = negative. "Accelerating" is taken to mean "increasing at an increasing rate"; "decelerating" means "increasing at a decreasing rate."

These combinations of parameters can be equated with the development models described earlier. For example, a situation in which c_1 is positive, while neither c_2, q_1, nor q_2 are significant, indicates constant increase in the intercept with no change in the slope of the rank-size curve. This situation necessarily implies steady and equal increase of each city in the system, which is the hallmark of allometric growth. On the other hand, if c_1 and q_1 are found to be significant and positive/negative, with c_2 and q_2 still not significant, then the implication is that the larger centers grew at a relatively faster rate than the rest of the system, and hence agglomerative growth must be in operation. The second cases described for c and q in the lists above would indicate a slow-down in the rate of relative growth exhibited by the rank 1 center, and in the degree to which the system was undergoing further agglomeration. In this situation, if the parameter estimates were such that the value of q ceased to grow larger and actually began to decrease in magnitude within the time frame of the data set, then the urban turnaround phenomena would be documented. Results corresponding to the fourth cases listed above would indicate the growth tendencies of a system in an advanced state of development, supposedly long past the agglomerative phase. The third cases, however, do not correspond to any known or imagined urban systems development scenario.

Stepwise multiple regression analysis was used to obtain the parameter estimates for equation (13) from the Hungarian data set of places greater than 10,000 population simultaneously for each available time period 1870-1980. The criteria for a variable to enter the equation was set at .1, while the removal criteria was set at .05 to insure that only significant variables remained in the estimated equation. Results of the analysis are presented in Table 4.

Table 4

Results of Time Expansion Analysis

Parameter	Estimate	Significance
c_0	11.68684539	0.0001
c_1	0.02185144	0.0001
c_2	-0.00006056	0.0257
q_0	-0.60139862	0.0001
q_1	-0.00494327	0.0001
q_2	0.00002323	0.0047

$R^2 = 0.928$ DF = 5;707

Each of the parameters present in equation (13) proved to be significant at the 5% level or better. Furthermore, the parameter estimates for c and q correspond to the second cases as described above; namely, c_1 and q_2 positive, and c_2 and q_1 negative. The estimated values for c thus indicate that the population of Budapest grew at a decreasing rate over the time span. The actual numerical parameter estimates, though, are such that they correctly indicate no switch in the absolute growth of Budapest during the time domain nor within the foreseeable future.* The change in c predicted by the estimated parameters is thus as expected and will be pursued no further.

The estimated values for q indicate that the level of overall relative population concentration in the system also increased at a decreasing rate. This behavior is captured by the estimated expansion equation for q:

$$q = -0.60139862 - 0.00494327\, t + 0.00002323\, t^2 \qquad (14)$$

which indicates that the magnitude of q increased through time, but that the rate of increase itself decreased because of the squared term. The pattern becomes even more apparent when the expansion equation for q in (14) is differentiated with respect to time:

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* Although meaningless in itself, the equation predicts absolute loss of population by Budapest beginning in 2050.

$$dq/dt = -0.00494327 + 0.00004646\, t \qquad (15)$$

Equation (15) indicates that the rate of change of q, and hence overall population concentration in the urban system, is negative--corresponding to agglomerative trends--but that its increase slows through time.

The analysis of the time expansion results up to this point has indicated that the growth tendency of the Hungarian urban system over the period 1870-1980 has been non-constant. The final step is to determine if the switch in the drift of q from increasing to decreasing magnitude that is comensurate with urban turnaround has occurred within the domain of the time frame under investigation. Such a switch can be determined analytically by setting the derivative of q with respect to time--equation (15)--equal to zero and then solving for t. According to the calculations, the urban turnaround event occurred approximately 106 years after the starting point 1870, which places it at 1976. Since this date is within the time frame of the data, the urban turnaround phenomena is documented for the Hungarian case.

The actual trajectory of q through time is portrayed graphically in Figure 9. This graph clearly shows the steep rise in the magnitude[10] of q in the early phases of

[10] Note that the ordinate in Figure 9 is transformed to show increasing magnitude, and hence concentration, in

the study period, corresponding to rapid agglomeration; and then the actual switch to deglomeration after 1976.

The results obtained in this section thus document the validity of the urban turnaround model of urban systems development as defined in Section 2.2.3. It would seem that the possibility does indeed exist for urban systems to experience shifts in their growth dynamics through time. Further analyses using the same technique, plus more in-depth analyses of the processes underlying the turnaround phenomena, should prove useful.

The results are also important for furthering our understanding of Hungary's urban growth dynamics. That urban turnaround has occurred is a good sign, since it marks a trend toward a leveling-out of the urban system, which has been a goal of the government for some time. Also, the timing of the turnaround event--1976, approximately 4-8 years after the introduction of government policies aimed at bringing about just such a trend--suggests the possible effectiveness of the regional policy instruments. This finding thus illuminates a potentially friutful path of investigation.

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the normal upward orientation.

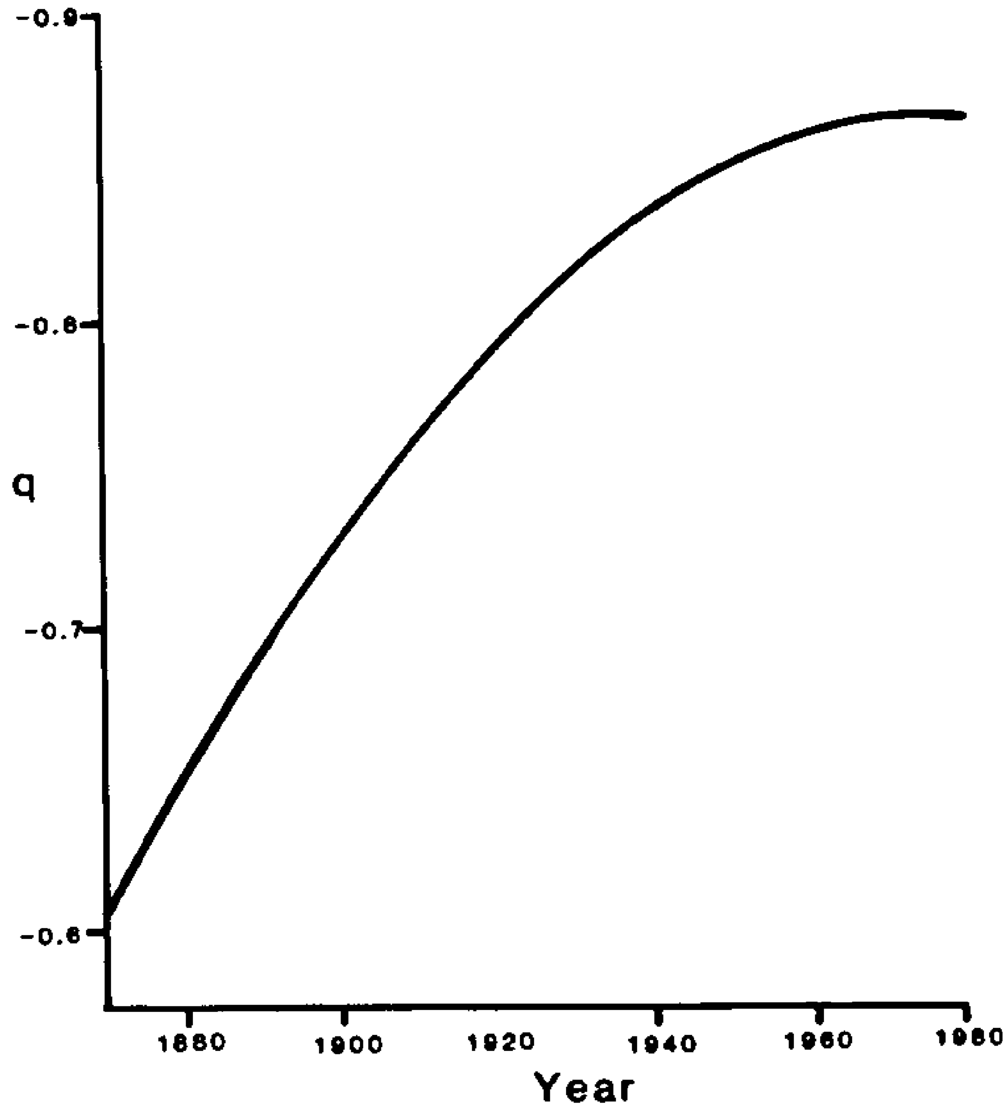

Figure 9: Drift of q with Respect to Time

5.2 IDENTIFYING HIERARCHIAL PATTERNS OF CHANGE

The previous analysis served to identify the overall growth tendencies exhibited by the Hungarian urban system over the 110 year study period. In particular, it documented the occurence of urban turnaround: the switch in system-wide growth dynamics from predominantly agglomerative to deglomerative trends. Having thus established this basic pattern, the analysis now turns to an examination of the manner in which agglomerative and deglomerative trends manifest themselves within the urban hierarchy itself during the development process.

The suggestion was made earlier that the process of urban systems development may be more complex than the simple agglomeration/deglomeration pattern associated with the urban turnaround model. That is, participation in the development process may occur unevenly with respect to the various segments of the urban system. Furthermore, these functional relationships may themselves change through time. Under the cascading cycles framework, particular segments of the urban system may be experiencing deglomeration, while others may be starting their agglomerative phase. These speculations, though, are largely unsubstantiated since the differential patterns of population agglomeration and deglomeration have yet to be precisely identified within a developing urban system. The goal of the analysis presented in this section is thus to identify the patterns of polarization and trickle-down in order to gain deeper understanding of the development of the Hungarian urban system and to test for the validity of the cascading cycles model of development.

The analysis again uses the expansion method to redefine the parameters of the basic rank-size function. In this instance, the parameter q is expanded as a quadratic function of rank to capture the non-linearities of the rank-size curve at both the top and bottom ends of the curve. The choice of a quadratic reflects the desire to identify patterns of polarization and trickle-down occurring within both the largest and smallest sized centers.

The actual expansion of q is thus:

$$q = q_0 + q_1(\ln r) + q_2(\ln r)^2 \quad (16)$$

where lnr is the logarithm of rank; and $(\ln r)^2$ is the square of the logarithm of rank (not the logarithm of rank squared). The parameters in (16) represent the drift of q within an urban system. If both q_1 and q_2 are not found to be significant, then the urban system is best characterized by a straight line and hence levels of concentration are equal at each rank position. For q_1 positive/negative, levels of concentration decrease/increase for lower rank centers. For q_2 positive/negative, the change of q with respect to rank is more convex/concave than linear.

Equation (16) could be replaced into (7) to obtain a terminal model capable of assessing the drift of q across the urban hierarchy for a particular time period, or to determine the average condition from a time series of data. However, the expansion method can be applied again to construct an equation that simultaneously captures the drift of q across rank and through time. This model is specified by redefining the parameters q_0, q_1, and q_2 of equation (16) as functions of time. Again, since the aim of this analysis is to identify shifts in the temporal behavior of the drift of q, the parameters were expanded into quadratics of time:

$$q_0 = q_{00} + q_{01}t + q_{02}t^2 \quad (17)$$

$$q_1 = q_{10} + q_{11}t + q_{12}t^2 \quad (18)$$

$$q_2 = q_{20} + q_{21}t + q_{22}t^2 \quad (19)$$

In addition to the expansion of q, the parameter c was also expanded as a quadratic function of time as before:

$$c = c_0 + c_1t + c_2t^2 \quad (20)$$

Substituting the right hand sides of (17), (18), (19), and (20) into (7) yields the terminal model:

$$\ln P = c_0 + c_1 t + c_2 t^2 + q_{00}\ln r + q_{01} t\ln r + q_{02} t^2 \ln r + q_{10}(\ln r)^2 + q_{11} t(\ln r)^2 + q_{12} t^2(\ln r)^2 + q_{20}(\ln r)^3 + q_{21} t(\ln r)^3 + q_{22} t^2 (\ln r)^3 \quad (21)$$

The parameters of equation (21) can be interpretated as follows. First of all, the parameters q_{00}-q_{02} are the original q's expanded in time only; they are therefore interpreted exactly as before for q_1 -q_2 .

The parameters q_{10}-q_{12} represent the quadratic terms in equation (21), but in equation (18) q_1 is the linear expansion in rank. Therefore, if q_{10} is found to be not significant, then this implies that q is stable with respect to the urban hierarchy and hence levels of relative population concentration are uniform with respect to rank. If q_{10} is found to be positive/negative, then levels of relative population concentration become smaller/larger with increasing rank numbers. For q_{11} and q_{12} not significant, the situation identified by q_{10} remained constant through time. If q_{11} is significant and negative/positive, while q_{12} remained not significant, then the drift behavior identified by q_{10} grew less/more pronounced for q_{11} positive; more/less for q_{11} negative. For q_{12} also significant and positive/negative, the values of q_{10} grew larger or smaller at a decreasing/increasing rate for q_{11} negative; and the opposite for q_{11} positive.

The parameters q_{20}-q_{22} represent cubic terms in (21), but are the quadratic terms in (19). The parameter q_{20} thus indicates the non-linear component in the drift of q with respect to rank: q_{20} negative/positive produces convexity/concavity in whatever relationship is identified by q_{10}. For q_{21} and q_{22} not significant, the situation identified by q_{20} remained stable through time. If q_{21} is found to be significant, this indicates steady change through time in the convexity or concavity comensurate with all the signs concerned. Last, q_{22} significant would indicate non-linear temporal trends in the behavior of the q_{20} parameter.

As was the case for the time expansion analysis, some of these parameter combinations are more likely to be associated with actual situations than others. For exmple, the cascading cycles model of development would be associated with the following sequence of parameter signs:

q_{00} negative

q_{01} negative

q_{02} positive

q_{10} positive

q_{11} positive

q_{12} negative

q_{20} negative

q_{21} negative

q_{22} positive

This combination of signs would indicate agglomeration followed by deglomeration first in the largest city, then in turn by lower order centers down the hierarchy. Other combinations of parameter estimates are of course possible, but will not be pursued here.

Equation (21) was applied to the Hungarian data using stepwise multiple regression as before. The results are shown in Table 5.

The results show that all of the parameters in equation (21) are significant at very high levels of confidence, and that the signs of the estimates correspond to the cascading cycles model. Furthermore, the results are given added credibility by the fact that the parameters that overlap with the time expansion analysis--namely, c_0 $-c_2$, q_{00}-q_{02}--match signs and are of similar relative magnitude.

Table 5

Results of Rank and Time Expansion Analysis

Parameter	Estimate	Significance
c_0	12.56455872	0.0001
c_1	0.03335927	0.0001
c_2	-0.00017024	0.0001
q_{00}	-2.40835924	0.0001
q_{01}	-0.02917734	0.0001
q_{02}	0.00026774	0.0001
q_{10}	0.88136977	0.0001
q_{11}	0.01084973	0.0001
q_{12}	-0.00011725	0.0001
q_{20}	-0.12384007	0.0001
q_{21}	-0.00131912	0.0004
q_{22}	0.00001553	0.0001

$R^2 = 0.982$; Df = 11;701

The patterns of population agglomeration and deglomeration occurring within the Hungarian urban system over the study period are indicated by the estimated expansion equation for q, obtained by replacing the letter parameters of equations (17), (18), and (19) by their numerical estimates:

$$q = -2.40835924 - 0.02917734t + 0.00026774t^2 + 0.88136977(\ln r)^2 + 0.01084973t(\ln r)^2 - 0.00011725t^2(\ln r)^2 - 0.12384007(\ln r)^3 - 0.00131912t(\ln r)^3 + 0.00001553t^2(\ln r)^3 \quad (22)$$

The behavior of q, and hence the characteristics and growth dynamics of the Hungarian urban system, can be determined by solving equation (22) for values of time and rank. For example, Figure 10 plots estimates of the values of q by rank for the periods 1870, 1900, 1930, 1960, and 1980. In this graph, the higher up the ordinate, the greater the magnitude of q and hence the level of hierarchial concentration existing at the particular rank position indicated on the abscissa. Likewise, the steeper the slope of the curve, the greater the rate of change of q with respect to rank, and hence the degree of non-linearity present in the original rank-size distribution. Since a straight, horizontal line on the graph would indicate equal values or q at each rank position, a tendency for the curves in Figure 10 to steepen or flatten through time indicates increasing or decreasing polarization.

The curves in Figure 10 can thus be interpreted as follows. The steepness of the curve for 1870 indicates that the Hungarian urban system was markedly unbalanced even at

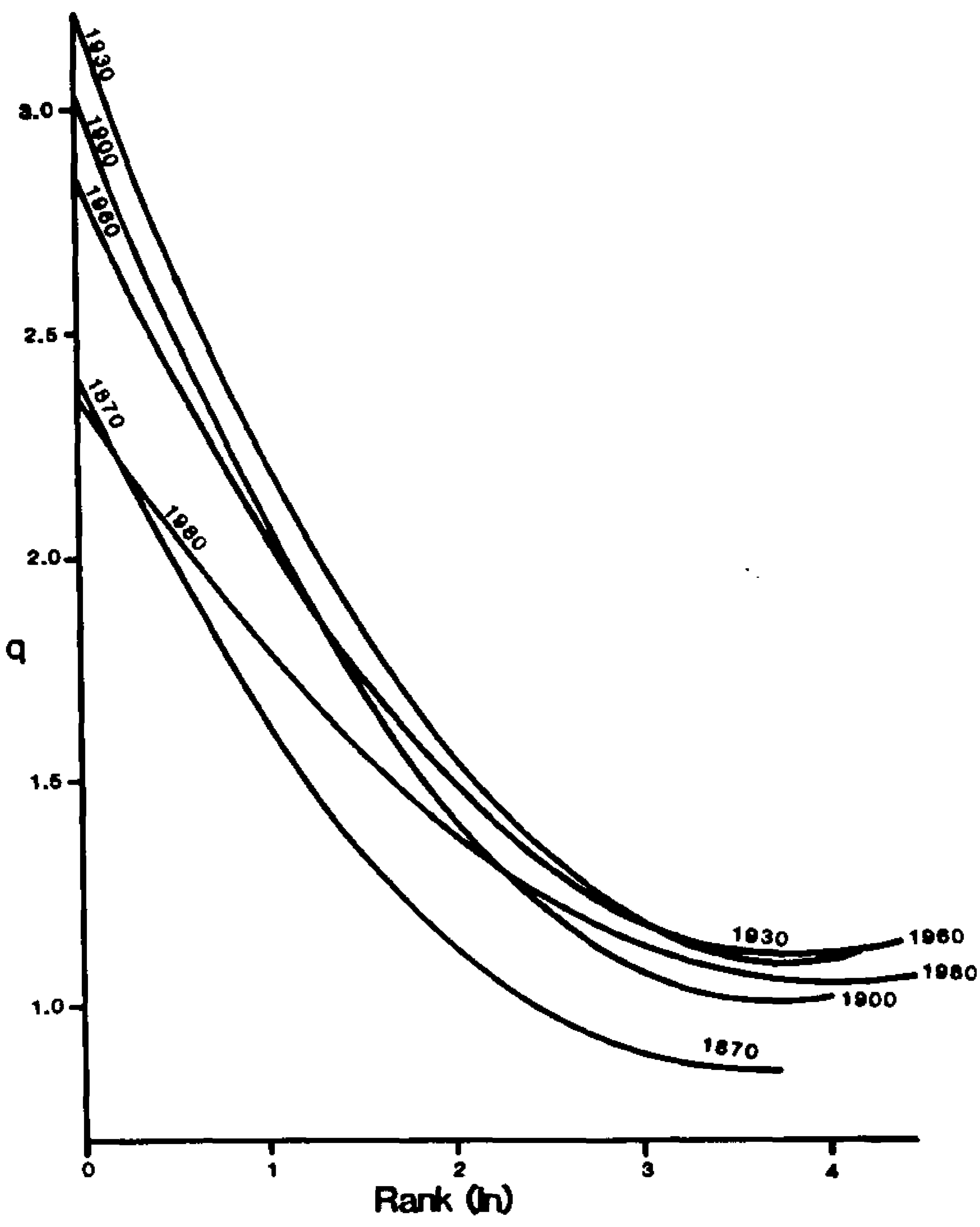

Figure 10: Drift of q with Respect to Rank and Time

the outset of the study period, prior to the first wave of industrialization. Between 1870 and 1900, the intercept--which is the estimate of q for Budapest--rises dramatically, while only modest gains are registered by the small centers. This pattern is indicative of rapid polarization within the Hungarian urban system during the last 30 years of the 19th century. From 1900 to 1930, however, the curve shifts outward almost equally at each rank position, denoting proportional growth. The minimum point, though, continues to shift outward indicating further polarization effects in the small cities. After 1930, the intercept value begins to drop, while the values of q continue to increase for a segment of the curve corresponding to the lower ranking centers. The intercept value then drops rapidly between 1960 and 1980 to below the 1870 level, while the smaller sized places remain near their 1960 levels of concentration. These results clearly demonstrate the phase of polarization up to 1930, followed by trickle-down effects and a general leveling of relative population concentration within the Hungarian urban system especially since 1960. These findings thus correspond to the cascading cycles model of urban systems development discussed earlier.

A further test, though, is needed to confirm the model. As stated previously, if the cascading cycles framework is in operation, then the switch from agglomerative to deglomerative trends will occur first in the largest center and then in successively smaller ones through time; and that this pattern will be mirrored by the smallest centers. To determine if this pattern holds for the Hungarian system, the time of the occurrence of the switch from agglomeration to deglomeration was calculated for the various ranks from equation (22). The plot of the results is shown in Figure 11. This graph indicates the estimated time (year) when a particular rank level (as shown on the ordinate) experienced the switch. The graph clearly shows that the timing of the switch was not uniform across the urban hierarchy: the switching phenomena began in Budapest, and then proceeded to successively smaller centers through time. This finding lends support to the cascading cycles framework, and provides confirmation as well to Daroczi's (1984, p. 73) hypothesis. Furthermore, the graph indicates that the switch in growth dynamics also occured earliest in the smallest cities and then proceeded up the hierarchy through time to larger ones. This finding confirms the second component of the cascading cycles framework; namely, that growth dynamics of the large centers are mirrored by the small centers.

The results also add to a better understanding of the development of the Hungarian urban system. The finding of

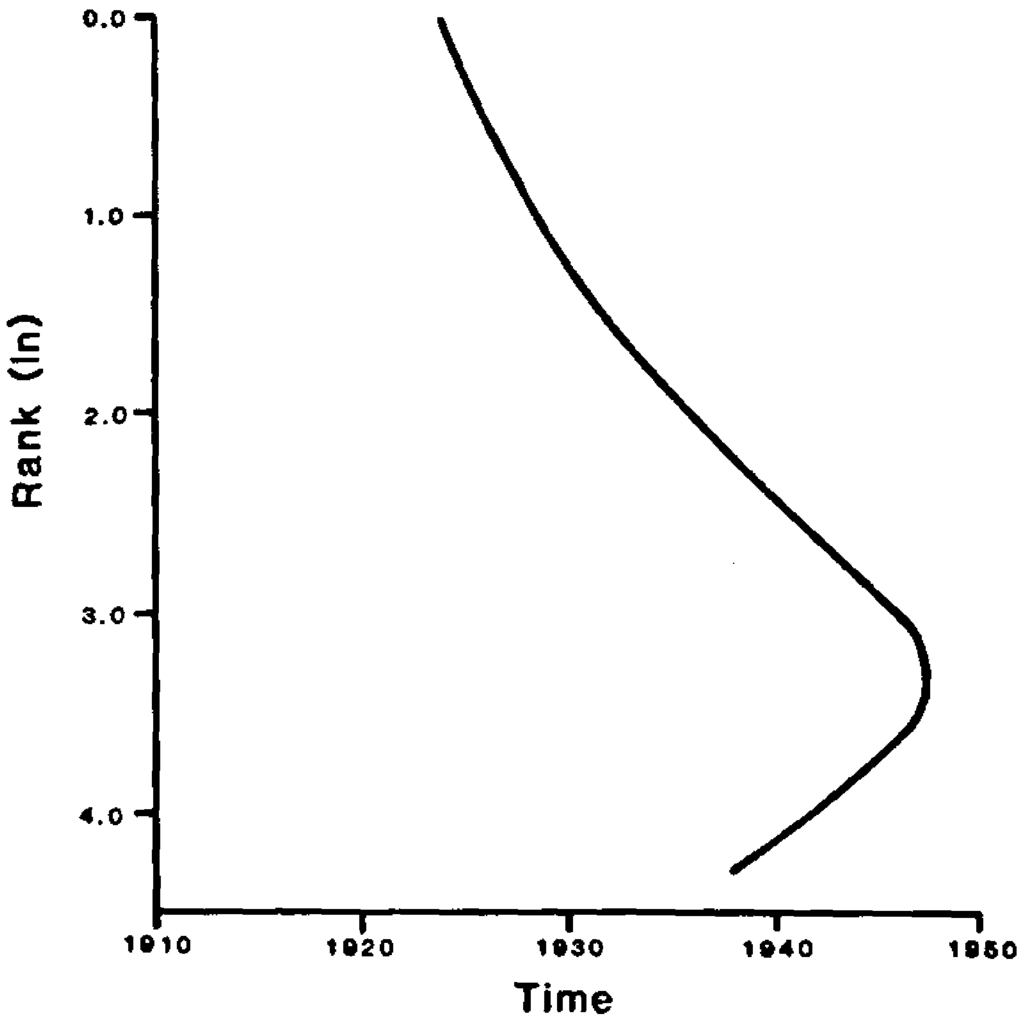

Figure 11: Timing the Switch from Agglomeration to Deglomeration

the temporal expansion analysis was that urban turnaround occurred shortly after various government policies were implemented to reduce urban primacy and achieve a more balanced state in the settlement system. However, the patterns emerging from the rank expansion analysis reveal a much more complex pattern of agglomeration and deglomeration occurring differentially across the system. Specifically, the results show that the relative levels of population concentration existing in the highest order centers, especially Budapest, have been declining since the 1930s; the government policies initiated in the 70s have thus followed rather than created the desired goals. Furthermore, it appears that the patterns of deglomeration and trickle-down usually attributed to post-industrial economies are, at least for Hungary, more a feature of post industrial revolution economies. It would thus seem that the population dynamics operating within Hungary have exhibited a much higher level of vitality than was previously suspected.

5.3 IDENTIFYING SPATIAL PATTERNS OF CHANGE

The accent of the analyses presented thus far in this chapter has been on identifiying the changing patterns of hierarchial population agglomeration and deglomeration within the Hungarian urban system. This emphasis reflects the fact that on the one hand the urban turnaround and cascading cycles models of urban systems development are best suited to describing hierarchial patterns of change; while on the other the method chosen for application in the analyses--expansion of the rank-size function--is also best suited to assessing hierarchial change. However, the spatial component of development is also of vital concern, especially in cases where regional imbalance has persisted as in Hungary.

The results obtained from the rank and time analysis presented in the previous section can also be used to assess the patterns of spatial change. For example, the curves shown in Figure 10 were derived by solving equation (22), the estimated expansion equation for q, for values of rank and time. This proceedure of course can be extended to determine estimates of q for any rank and time position within the domain of the data set. A map could thus be prepared that showed the estimates of q for each city in the system for different time periods to provide a spatial portrait of the levels of relative concentration existing at different locations across the country. Likewise, the change in the value of q associated with the various cities could also be calculated and mapped to provide information on the spatial growth dynamics exhibited by the urban system. This type of analysis would of course be similar to mapping standardized city population growth rates as in Figure 6.

Figure 12 shows the distribution of changing levels of q for the various Hungarian cities for the three time periods 1870-1910, 1910-1949, and 1949-1980. The maps were derived as follows. First, the estimated values of q for each city greater than 10,000 population were calculated for the years 1870, 1910, 1949, and 1980. These values were determined by solving equation (22) for the rank of each city for the different values of time. The change in the value of q for each city during the three periods was then calculated and standardized. Last, these standardized values were plotted and the country was divided into those territories containing cities that experienced above average change in their value of q from those experiencing below average change. The maps in Figure 12 are thus comparable to those in Figure 6.

Although the maps in Figure 12 are somewhat crude, they still portray some interesting patterns. The map for the first period (1870-1910) shows a distinct pattern of above average increase in levels of q--denoting polarization--occurring in the central area around Budapest, and also around the regional centers and the extreme eastern and western portions of the country. The unbroken area covering the rest of the country identifies the areas containing

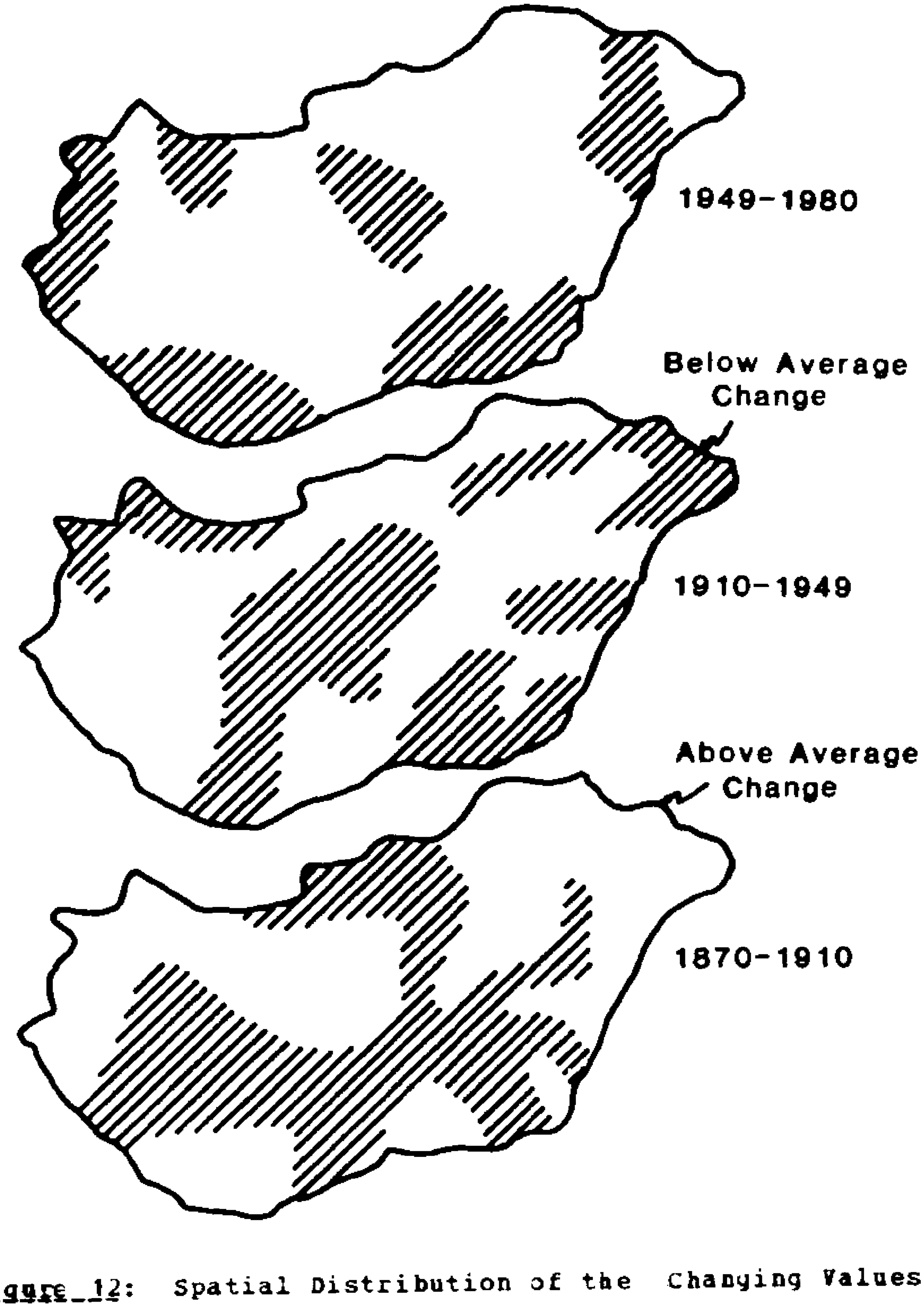

Figure 12: Spatial Distribution of the Changing Values of g

cities that experienced lower than average rates of increase in their values of q. Essentially, the shaded area in this map indicates the lowest ranking centers in the Hungarian urban system for that time period. The second map (1910-1949) shows a somewhat different pattern. For this time period, areas of below average increase emerge in a central axis and along the periphery of the country. These patterns most probably represent a transitional phase in the development of the Hungarian urban system. The last map (1949-1980) is somewhat misleading since it appears that most of the cities in the country are experiencing above average increase in their values of q. This is not the case, however; the reason for the apparant distortion is due to the extremely rapid drop in the values of q for Budapest and the regional centers over the time period which tended to skew the calculations of the mean and standard deviation used to standardize the changes. However, the pattern of rapid deglomeration in the highest ranking centers, with the continued increase in q for the rest of the system is evident. In fact, the map for the period 1949-1980 is opposite to the one for 1870-1910, denoting the spatial patterns first of polarization then trickle-down. The results from this analysis thus serve to illustrate the strong hierarchial nature of the urban systems development process occurring in Hungary; an aspect of growth dynamics that was not detected by the analysis of standardized growth rates. The analysis presented here thus helps to further confirm the operation of the cascading cycles model for the Hungarian urban system. The results also point to the trend of general evening of the growth dynamics of the Hungarian system during the socialist period.

5.4 SUMMARY

The goal of this chapter has been to precisely identify the changing patterns of population agglomeration and deglomeration in the Hungarian settlement network with respect to the entire system, within the hierarchy of the system, and across space. The analyses used the expansion method to redefine the parameters c and q of the basic rank-size model as functions of time, and rank and time. The findings are summarized as follows:

1). The quadratic time expansion analysis revealed the occurrence of a switch in system-wide growth dynamics from agglomerative to deglomerative trends in the mid-1970s. The occurrence of urban turnaround shortly after the implementation of govermental decentralization policies is quite interesting, and calls attention to the need for further study of policy effectiveness.

2). The rank and time expansion analysis identified several interesting patterns of hierarchial polarization and trickle-down. Specifically, the results revealed that: (a) initially, the Hungarian system was markedly convex, denoting higher levels of relative concentration existing in the largest urban centers than in the smaller ones; (b) the switch from agglomerative to deglomerative growth tendencies in Budapest occurred in the mid-1920s (as already shown by the analysis of standardized growth rates); (c) that the switch from agglomerative to deglomerative trends progressed through time down the urban hierarchy from the top, and up from the bottom; and finally (d) the overall trend toward a leveling of the urban system in the later periods. Overall, the results strongly support the cascading cycles model of urban systems development.

3). The spatial analysis also supported the cascading model. In particular, the maps of change of the estimated values of q for each city for the three time periods showed the spatial dimensions of polarization and trickle-down occurring within the Hungarian spatial hierarchy.

Chapter VI

CONCLUSIONS

This study has examined the patterns of population agglomeration and deglomeration within the developing Hungarian urban system over the period 1870-1980. The goals of the study have been to contribute to the theoretical understanding of the urban systems development process; to help identify specific growth dynamics occurring within Hungary; and to relate these dynamics to other processes of change and to public policy. Another goal has been to develop new methodologies for identifying urban systems development patterns. The major points arising from the discussion are summarized below.

A major conceptual and analytical building block in this study has been the rank-size function, which relates population and rank data for urban systems. In particular, interpretations are given to the parameters of the model and their change through time. The parameter q of the rank-size model evaluates the level of hierarchial concentration existing in an urban system at one point in time; its change through time denotes agglomeration or deglomeration. Change in the degree of non-linearity associated with the logarithmic rank-size curve at either the high or low end of its spectrum indicates polarization and trickle-down effects that are in turn associated in the first instance with rapid growth of the largest, especially primate, centers and relative de-population of the smallest centers; and then by reversal of this pattern. The urban systems development models predict the patterns of population redistribution within urban systems. The allometric growth model is the simplest, calling for proportional growth of all parts of the system and denoted by parallel shifts of the rank-size curve. The agglomerative growth model, on the other hand, points to increasing levels of population concentration in the urban system brought-on by spatial and hierarchial agglomeration. Agglomerative growth is signalled by the continued increase in both the c and q parameters of the rank-size function. The urban turnaround model is of fairly recent origin, and calls for a switch in the overall growth dynamics from agglomerative to deglomerative trends. Urban turnaround is thus indicated by a change in the trend of q through time from increasing to decreasing, and occurs when congestion costs in the core rise relative to peripheral locations. The cascading cycles model extends the turnaround framework to account for non-linearities in rank-size change, and hence polarization and trickle-down occurring in both the largest and smallest centers. The cascading cycles framework is indicated by increasing then decreasing skewing of the rank-size curve. It is also signalled by the differential switch in the change in q for different rank positions; specifically, the switch in q from increasing to decreasing occurs first in the largest and smallest centers and then proceeds through time down and up the urban hierarchy. Public policy in recent years has focused on growth center strategies aimed-at reducing the dominance of primate cities and stimulating growth in peripheral areas. However, efforts by governments, even in socialist countries, have been less than successful. A major impedement has been a lack of clear understanding of the urban systems development process.

Hungary presents a very interesting case for analysis because it is one of the best examples of an imbalanced urban structure brought-on by historical context and belated industrialization. Although Hungary has existed for over 1000 years, throughout its history development has been hampered by outside domination. The 150 year occupation by the Turks retarded the normal process of economic and social development during the 15 and 1600s. Likewise, Austrian domination kept Hungary's economy rooted in agriculture and thus sustained the feudal system longer than for other parts of Europe. The first phase of industrialization thus did not begin until the latter part of the 19th century. Once begun, though, development occurred rapidly and resulted in agglomeration in Budapest and some cities located in the central and northern areas. The Treaty of Trianon following World War I severed Hungary from her former trading partners and also disrupted the urban structure. War damage and economic stagnation limited development during the inter-war period. Beginning in 1949, though, industrialization was renewed under socialist planning strategies. A longtime goal of the government has been to reduce the dominance of Budapest over the rest of the urban system and to spread growth across the country.

The analysis of the Hungarian city population data began with a preliminary analysis using traditional techniques. Results of the analyses of city growth rates, concentration indicies, rank-size measures, and centrographic analysis revealed strong population agglomeration up to the socialist period, followed by deglomeration and a general leveling of the Hungarian urban system. The dynamic analysis was more specifically designed to test for the occurrence of urban turnaround and cascading cycles development frameworks. The analyses were based on the rank-size function, and used the expansion method to redefine the parameters of the initial model first in terms of time to assess temporal drift of the parameters; and in terms of rank and time to assess change occurring within different segments of the urban system. Results of the temporal expansion analysis identified the occurrence of urban turnaround in the mid-1970s. However, the results of the rank and time expansion analysis revealed a more complex pattern of change. Specifically, the results indicate that Budapest has been in its deglomerative phase since the 1930s, which has helped to produce leveling of the system since that time. The timing of the switch from agglomerative to deglomerative trends for the different rank positions reveals the pattern predicted by the cascading cycles model; namely, the switch occurring later for cities located down the urban hierarchy from the largest centers; and up the hierarchy from the smallest ones. The spatial patterns of change in the value of q for the different cities further reinforces the notion of differential hierarchial polarization and trickle-down.

The major conclusion to be drawn from the various analyses is that deglomerative tendencies apparently set-in much earlier than has been previously suspected. On the basis of the Hungarian example, polarization reversal appears to commence immediately after the initial phase of rapid industrialization. This finding of course has implications to developing countries that are faced with mounting problems in their primate cities, and who desire greater spatial equity in the patterns of industrial development. However, it is difficult to transfer the results from Hungary to other settings without first understanding the spatial processes.

This study has also served to illustrate the usefulness of the methodology developed here; namely, the interpretation of the expanded parameters of the rank-size function. Further applications of the same techniques in other situations should prove useful in either confirming or rejecting the general validity of the patterns found in Hungary. Once the patterns of urban systems development have been more firmly established, the task of identifying the underlying dynamics can begin in earnest. In particular, the demographic processes, especially migration flows, need to be better understood in relation to general economic development. Furthermore, such understanding would improve the potential for success of government planning strategies aimed-at population redistribution. This study has at least laid the groundwork for further investigations into the growth dynamics of other national urban systems.

Appendix A

THE HUNGARIAN CITY DATA

	City	1870	1900	1910	1920	1930
		1941	1949	1960	1970	1980
1	Budapest	302086	861434	1110453	1232026	1442869
		1712791	1590316	1783167	2001083	2059347
2	Debrecen	43048	70377	87221	97933	111778
		119608	110963	131613	162313	191494
3	Gyor	32456	45328	53356	60098	63028
		70715	69583	86101	102600	124147
4	Miskolc	30661	61160	76207	85151	93877
		114674	109124	140821	180581	207303
5	Pecs	29553	54350	60886	59428	75071
		89178	89025	121277	150249	168715
6	Szeged	59851	85926	99282	103305	112124
		115844	110278	119522	151714	170794
7	Ajka	3577	5445	6026	5812	6607
		7554	9822	15633	22699	29656
8	Baja	21248	23642	24558	22497	27669
		32055	27907	30738	35535	38503
9	Balassagyarmat	7033	9210	11724	12426	12685
		12873	12073	13426	14823	18543
10	Balatonfured	2257	2421	3015	3346	4037
		4788	5335	6026	9040	12697
11	Barcs	3339	8496	9658	9043	9459
		10088	8993	8921	8964	11464
12	Berettyoujfalu	6735	9250	10120	10670	12866
		13847	13725	13917	13886	16454
13	Bekes	18294	20680	20649	21544	22042
		22245	21961	22501	21174	22265
14	Bekescsaba	26897	33228	37883	41759	46707
		49626	43399	51783	58169	67225
15	Bonyhad	7893	7846	8741	8654	8685
		10008	9306	11132	12640	14716
16	Cegled	21278	28831	32401	35231	35507
		36165	35237	37953	37845	40644
17	Celldomolk	3734	6306	7798	9340	10391
		9970	10285	10542	10857	12558
18	Csongrad	15919	20814	23297	23778	23857
		23468	23026	22720	21726	22217

19	Csorna	6652	9255	9597	10296	10411
		10839	10862	11329	11423	12115
20	Dombovar	3397	7184	10015	12045	13421
		12639	13576	15128	16761	19985
21	Dunakeszi	1204	2837	4811	6133	8415
		11232	11029	12453	19895	25137
22	Dunaujvaros	3563	3826	3958	4197	3905
		3981	3949	26918	45129	60736
23	Eger	20510	27658	30112	30902	32903
		34965	31844	38671	47960	60897
24	Esztergom	14478	17869	17831	17918	17095
		22041	19962	23545	28093	30473
25	Erd	3027	3480	3953	3990	5632
		14523	16444	19290	31205	41330
26	Fehergyarmat	3353	4220	4627	4375	5227
		5779	5779	6494	6729	8414
27	Godollo	3661	5893	7569	10262	11056
		11825	12216	16762	21929	28096
28	Gyongyos	16622	17301	19422	19647	21213
		24053	21969	25971	31733	36928
29	Gyula	21054	25451	27439	28097	28964
		29290	27764	39486	30578	34533
30	Hajduboszormeny	19625	25599	28684	29363	29801
		31408	31452	33704	30979	32177
31	Hajdunanas	13190	15874	16668	16965	17848
		18617	18041	19252	17638	18170
32	Hajduszoboszlo	12269	15451	16093	17722	17022
		17651	18541	18633	21549	23396
33	Hatvan	4491	10463	13162	15140	16144
		16681	17249	19962	21816	24772
34	Hodmezovasarhely	41428	51337	52509	51509	51176
		51865	49417	53636	53579	54486
35	Jaszbereny	19090	25227	27943	30738	28350
		28838	27528	30164	29764	31402
36	Kalocsa	9504	11380	11738	12332	11880
		12341	11537	13895	16102	18660
37	Kaposvar	10210	22845	28955	34314	37339
		37710	37940	48579	60929	72374
38	Kapuvar	5951	8165	8230	8662	9536
		10173	10335	10591	10283	11251
39	Karcag	14486	20896	22996	22569	24248
		25551	25100	25847	24066	25230
40	Kazincbarcika	2438	3137	3256	3481	3773
		4456	5059	11144	28320	37442
41	Kecskemet	30722	43177	49177	51717	54193
		59079	56828	66832	79978	92047
42	Keszthely	5784	8571	9781	10652	11070
		12429	12394	14684	17904	21736
43	Kiskoros	6513	9745	11280	11914	12730
		12523	12587	13798	14125	15616
44	Kiskunfelegyhaza	19677	27290	28594	30528	31754
		31812	31470	33177	33977	35414

45 Kiskunhalas	9850	13751	16547	17758	19789
	23714	22547	23217	26429	30604
46 Kisujszallas	10376	13224	13538	13766	14532
	14461	13925	14681	13384	13700
47 Kisvarda	4703	8257	10019	11435	14133
	14782	13055	14329	13677	17837
48 Komarom	3677	5836	6892	8985	11018
	12266	12681	14422	16638	19918
49 Komlo	2237	3246	3772	4285	4807
	6063	6914	26991	28580	30319
50 Kormend	5429	7977	8901	9349	8949
	8654	8501	8840	10044	11783
51 Koszeg	6915	7930	8423	8492	8537
	10320	8780	10621	11191	12704
52 Leninvaros	1327	1361	1367	1254	1291
	1363	1349	3377	11033	18677
53 Lenti	2498	3784	4149	4694	5408
	5658	5831	6146	6713	8132
54 Mako	26900	32707	33249	36265	35143
	34873	33068	31703	30274	29942
55 Marcali	6094	7359	7968	7927	8363
	8461	8225	9408	9762	12478
56 Mateszalka	3741	5405	5935	6519	9125
	10036	11055	11950	12455	17804
57 Mezokovesd	9324	15362	17348	18705	20984
	20988	18228	19143	17635	18426
58 Mezotur	18210	22352	22706	23951	24655
	24864	23343	23507	21930	22024
59 Mohacs	10684	13929	14870	13344	14695
	15442	16088	18624	19641	21383
60 Mosonmagyarovar	8382	9386	11440	13330	14859
	16938	16739	20144	24653	29728
61 Nagyatad	4025	5325	5740	5844	6567
	7009	6863	8494	10410	12938
62 Nagykanizsa	15905	24814	27358	30864	31917
	31933	29713	36096	40551	49247
63 Nagykoros	17298	22750	23500	23706	23447
	24121	24461	25621	26120	27808
64 Nyirbator	4598	5789	7433	8473	10036
	10941	10629	11800	11025	13371
65 Nyiregyhaza	21038	33204	39273	44850	53527
	61493	56334	68234	82046	108235
66 Oroshaza	17382	26812	28104	30112	31171
	31778	31429	31740	33438	36255
67 Oroszlany	1563	1663	1644	1527	1473
	1742	3740	12881	18482	20613
68 Ozd	5809	11935	15897	16010	21249
	26403	30307	38928	45765	48466
69 Paks	11720	13828	14587	14135	14090
	14087	13763	13913	13585	19509
70 Papa	15133	18604	21461	20614	22677
	25012	23114	28158	29845	32212

71 Salgotarjan	7035	23680	23542	24897	28489
	33035	32571	37426	43434	49603
72 Sarospatak	7770	9267	10459	11372	12253
	14143	13644	15378	14540	15320
73 Sarvar	5184	7886	10223	11232	10662
	12923	11337	11507	12626	15112
74 Satoraljaujhely	9946	16886	19940	21162	18431
	17848	15061	16227	17469	19262
75 Siklos	5000	5667	6521	6233	6566
	6768	6841	6786	7886	10625
76 Siofok	3897	4643	5216	5671	7158
	8556	10009	13006	16974	20125
77 Sopron	22376	35703	36721	38243	39436
	46120	35617	40178	47111	53945
78 Szarvas	20899	23997	21822	20785	21042
	20583	18569	19187	19418	20608
79 Szazhalombatta	993	1392	1751	1665	1717
	1782	1717	2353	9852	14292
80 Szekszard	12001	15412	16648	15388	15930
	16814	16354	18273	24896	34648
81 Szentendre	4683	4822	5673	5877	7210
	9651	9283	10276	13008	16901
82 Szentes	26866	30032	30344	30877	31516
	32768	32769	33552	33910	35317
83 Szekesfehervar	23279	32871	37444	39996	41582
	48861	42056	56251	78789	103310
84 Szigetvar	6229	7229	7831	7080	7691
	7962	8490	9316	10470	12136
85 Szolnok	16115	25827	29288	33060	39248
	42756	37520	46275	63601	75362
86 Szombathely	12934	29959	37289	42275	46379
	50935	47589	53797	65297	82851
87 Tapolca	5073	7069	7940	8294	8925
	8745	8335	10012	12049	17161
88 Tata	9855	12180	11489	11552	12050
	12380	13246	17787	20623	24088
89 Tatabanya	3214	9657	22927	28210	33146
	37955	40221	50373	66223	75971
90 Torokszentmiklos	11136	17579	20130	22403	23462
	22372	22387	24201	24314	25603
91 Turkeve	11207	14074	13492	13270	13961
	14384	13903	13286	11373	11398
92 Vac	12894	16720	18857	19287	20904
	22076	21287	24797	30737	34866
93 Varpalota	6559	6432	6581	6160	6696
	10189	11065	21455	26393	28392
94 Vasarosnameny	3577	4901	5398	5511	6797
	7197	6892	7788	7879	8654
95 Veszprem	12729	14723	15449	16211	18485
	22267	18922	26687	38273	54995
96 Zalaegerszeg	9211	14503	15884	18771	18992
	19588	20767	29088	39671	55348

Appendix B

SIMPLE GROWTH RATES OF THE HUNGARIAN CITIES

	City	1870-00 1941-49	1900-10 1949-60	1910-20 1960-70	1920-30 1970-80	1930-1941 1870-1980
1	Budapest	3.493	2.539	1.039	1.580	1.559
		-0.927	1.041	1.153	0.287	1.745
2	Debrecen	1.639	2.146	1.158	1.322	0.616
		-0.938	1.552	2.097	1.653	1.357
3	Gyor	1.113	1.631	1.190	0.476	1.046
		-0.202	1.936	1.753	1.906	1.220
4	Miskolc	2.302	2.200	1.110	0.976	1.819
		-0.620	2.318	2.487	1.380	1.737
5	Pecs	2.031	1.136	-0.242	2.337	1.565
		-0.021	2.811	2.142	1.159	1.584
6	Szeged	1.205	1.445	0.397	0.819	0.297
		-0.616	0.732	2.385	1.185	0.953
7	Ajka	1.401	1.014	-0.362	1.282	1.218
		3.282	4.225	3.729	2.673	1.923
8	Baja	0.356	0.380	-0.877	2.069	1.338
		-1.732	0.878	1.450	0.802	0.540
9	Balassagyarmat	0.899	2.413	0.582	0.206	0.134
		-0.802	0.966	0.990	2.239	0.881
10	Balatonfured	0.234	2.194	1.042	1.877	1.551
		1.352	1.107	4.056	3.397	1.570
11	Barcs	3.113	1.282	-0.658	0.450	0.585
		-1.436	-0.073	0.048	2.460	1.121
12	Berettyoujfalu	1.058	0.899	0.529	1.872	0.668
		-0.111	0.126	-0.022	1.697	0.812
13	Bekes	0.409	-0.015	0.424	0.229	0.083
		-0.161	0.221	-0.608	0.502	0.179
14	Bekescsaba	0.705	1.311	0.974	1.120	0.551
		-1.676	1.606	1.163	1.447	0.833
15	Bonyhad	-0.020	1.080	-0.100	0.036	1.289
		-0.909	1.629	1.270	1.521	0.566
16	Cegled	1.013	1.167	0.837	0.078	0.167
		-0.325	0.675	-0.028	0.714	0.588
17	Celldomolk	1.747	2.124	1.804	1.066	-0.376
		0.389	0.224	0.294	1.455	1.103
18	Csongrad	0.894	1.127	0.204	0.033	-0.149
		-0.238	-0.122	-0.447	0.223	0.303

19 Csorna	1.101	0.363	0.703	0.111	0.366
	0.026	0.383	0.083	0.588	0.545
20 Dombovar	2.497	3.322	1.846	1.082	-0.546
	0.894	0.984	1.025	1.759	1.611
21 Dunakeszi	2.857	5.282	2.428	3.163	2.625
	-0.228	1.104	4.685	2.339	2.762
22 Dunaujvaros	0.237	0.339	0.586	-0.721	0.175
	-0.101	17.448	5.167	2.970	2.578
23 Eger	0.997	0.850	0.259	0.627	0.553
	-1.169	1.766	2.153	2.388	0.989
24 Esztergom	0.701	-0.021	0.049	-0.470	2.310
	-1.238	1.501	1.766	0.813	0.677
25 Erd	0.465	1.274	0.093	3.447	8.612
	1.553	1.451	4.810	2.810	2.376
26 Fehergyarmat	0.767	0.921	-0.560	1.779	0.913
	0.000	1.060	0.355	2.235	0.836
27 Godollo	1.587	2.503	3.044	0.745	0.611
	0.407	2.876	2.687	2.478	1.853
28 Gyongyos	0.133	1.156	0.115	0.767	1.142
	-1.133	1.521	2.004	1.516	0.726
29 Gyula	0.632	0.752	0.237	0.304	0.102
	-0.669	3.202	-2.557	1.216	0.450
30 Hajduboszormeny	0.886	1.138	0.234	0.148	0.477
	0.017	0.629	-0.843	0.379	0.449
31 Hajdunanas	0.617	0.488	0.177	0.507	0.383
	-0.393	0.591	-0.876	0.297	0.291
32 Hajduszoboszlo	0.769	0.407	0.964	-0.403	0.330
	0.615	0.045	1.454	0.822	0.587
33 Hatvan	2.819	2.295	1.400	0.642	0.297
	0.419	1.328	0.888	1.271	1.552
34 Hodmezovasarhely	0.715	0.226	-0.192	-0.065	0.122
	-0.604	0.745	-0.011	0.168	0.249
35 Jaszbereny	0.929	1.023	0.953	-0.809	0.155
	-0.581	0.831	-0.133	0.536	0.452
36 Kalocsa	0.600	0.310	0.494	-0.373	0.346
	-0.842	1.691	1.474	1.474	0.613
37 Kaposvar	2.685	2.370	1.698	0.845	0.090
	0.076	2.247	2.265	1.721	1.780
38 Kapuvar	1.054	0.079	0.512	0.961	0.588
	0.197	0.222	-0.295	0.900	0.579
39 Karcag	1.221	0.958	-0.187	0.718	0.476
	-0.223	0.267	-0.714	0.472	0.504
40 Kazincbarcika	0.840	0.372	0.668	0.806	1.513
	1.586	7.179	9.327	2.792	2.483
41 Kecskemet	1.134	1.301	0.504	0.468	0.785
	-0.486	1.474	1.796	1.405	0.998
42 Keszthely	1.311	1.321	0.853	0.385	1.053
	-0.035	1.541	1.983	1.939	1.204
43 Kiskoros	1.343	1.463	0.547	0.662	-0.149
	0.064	0.835	0.234	1.003	0.795
44 Kiskunfelegyhaza	1.090	0.467	0.654	0.394	0.017
	-0.135	0.480	0.238	0.414	0.534

45	Kiskunhalas	1.112	1.851	0.706	1.083	1.645
		-0.631	0.266	1.296	1.467	1.031
46	Kisujszallas	0.808	0.235	0.167	0.542	-0.045
		-0.472	0.481	-0.925	0.233	0.253
47	Kisvarda	1.876	1.934	1.322	2.118	0.408
		-1.553	0.846	-0.466	2.656	1.212
48	Komarom	1.540	1.663	2.652	2.040	0.975
		0.416	1.170	1.429	1.799	1.536
49	Komlo	1.241	1.502	1.275	1.150	2.110
		1.642	12.381	0.572	0.591	2.370
50	Kormend	1.283	1.096	0.491	-0.437	-0.305
		-0.223	0.355	1.277	1.597	0.704
51	Koszeg	0.457	0.603	0.082	0.053	1.724
		-2.020	1.731	0.523	1.268	0.553
52	Leninvaros	0.084	0.044	-0.863	0.291	0.493
		-0.129	8.342	11.839	5.264	2.404
53	Lenti	1.384	0.921	1.234	1.416	0.411
		0.376	0.478	0.882	1.918	1.073
54	Mako	0.652	0.164	0.868	-0.314	-0.070
		-0.664	-0.383	-0.461	-0.110	0.097
55	Marcali	0.629	0.795	-0.052	0.535	0.106
		-0.354	1.222	0.369	2.455	0.652
56	Mateszalka	1.227	0.935	0.939	3.363	0.865
		1.209	0.708	0.414	3.573	1.418
57	Mezokovesd	1.664	1.216	0.753	1.150	0.002
		-1.762	0.445	-0.821	0.439	0.619
58	Mezotur	0.683	0.157	0.534	0.290	0.077
		-0.789	0.064	-0.694	0.043	0.173
59	Mohacs	0.884	0.654	-1.083	0.964	0.451
		0.512	1.331	0.532	0.850	0.631
60	Mosonmagyarovar	0.377	1.979	1.529	1.086	1.190
		-0.148	1.683	2.020	1.872	1.151
61	Nagyatad	0.933	0.750	0.180	1.166	0.592
		-0.263	1.938	2.034	2.174	1.061
62	Nagykanizsa	1.483	0.976	1.206	0.335	0.005
		-0.901	1.769	1.164	1.943	1.027
63	Nagykoros	0.913	0.324	0.087	-0.110	0.258
		0.175	0.421	0.193	0.626	0.432
64	Nyirbator	0.768	2.500	1.310	1.693	0.785
		-0.362	0.950	-0.679	1.929	0.970
65	Nyiregyhaza	1.521	1.679	1.328	1.769	1.261
		-1.095	1.742	1.843	2.770	1.489
66	Oroshaza	1.445	0.471	0.690	0.346	0.175
		-0.138	0.090	0.521	0.809	0.668
67	Oroszlany	0.207	-0.115	-0.738	-0.360	1.525
		9.551	11.242	3.610	1.091	2.345
68	Ozd	2.400	2.867	0.071	2.831	1.974
		1.724	2.276	1.618	0.573	1.929
69	Paks	0.551	0.534	-0.315	-0.032	-0.002
		-0.291	0.099	-0.239	3.619	0.463
70	Papa	0.688	1.429	-0.403	0.954	0.891
		-0.986	1.794	0.582	0.763	0.687

71	Salgotarjan	4.046	-0.058	0.560	1.348	1.346
		-0.177	1.263	1.489	1.328	1.776
72	Sarospatak	0.587	1.210	0.837	0.746	1.304
		-0.449	1.088	-0.560	0.523	0.617
73	Sarvar	1.398	2.596	0.941	-0.521	1.748
		-1.637	0.135	0.928	1.797	0.973
74	Satoraljaujhely	1.764	1.662	0.595	-1.382	-0.292
		-2.122	0.678	0.738	0.977	0.601
75	Siklos	0.417	1.404	-0.452	0.520	0.275
		0.134	-0.073	1.502	2.981	0.685
76	Siofok	0.584	1.164	0.836	2.329	1.622
		1.961	2.381	2.663	1.703	1.493
77	Sopron	1.557	0.281	0.406	0.307	1.423
		-3.230	1.095	1.592	1.355	0.800
78	Szarvas	0.461	-0.950	-0.487	0.123	-0.200
		-1.287	0.298	0.120	0.595	-0.013
79	Szazhalombatta	1.126	2.294	-0.504	0.308	0.338
		-0.464	2.865	14.320	3.720	2.424
80	Szekszard	0.834	0.771	-0.787	0.346	0.491
		-0.347	1.009	3.093	3.305	0.964
81	Szentendre	0.098	1.625	0.353	2.044	2.651
		-0.486	0.924	2.358	2.618	1.167
82	Szentes	0.371	0.103	0.174	0.205	0.354
		0.000	0.215	0.106	0.407	0.249
83	Szekesfehervar	1.150	1.303	0.659	0.389	1.466
		-1.875	2.644	3.370	2.710	1.355
84	Szigetvar	0.496	0.800	-1.008	0.828	0.315
		0.803	0.844	1.168	1.477	0.606
85	Szolnok	1.572	1.258	1.211	1.716	0.778
		-1.633	1.907	3.180	1.697	1.402
86	Szombathely	2.800	2.189	1.255	0.927	0.852
		-0.849	1.115	1.937	2.381	1.688
87	Tapolca	1.106	1.162	0.436	0.733	-0.185
		-0.600	1.667	1.852	3.537	1.108
88	Tata	0.706	-0.584	0.055	0.422	0.246
		0.845	2.680	1.479	1.553	0.812
89	Tatabanya	3.667	8.646	2.074	1.612	1.232
		0.725	2.046	2.736	1.373	2.875
90	Torokszentmiklos	1.522	1.355	1.070	0.462	-0.432
		0.008	0.708	0.047	0.517	0.757
91	Turkeve	0.759	-0.422	-0.166	0.508	0.271
		-0.425	-0.413	-1.555	0.022	0.015
92	Vac	0.866	1.203	0.225	0.805	0.496
		-0.455	1.388	2.147	1.260	0.904
93	Varpalota	-0.065	0.229	-0.661	0.834	3.816
		1.031	6.020	2.071	0.730	1.332
94	Vasarosnameny	1.050	0.966	0.207	2.097	0.520
		-0.541	1.111	0.116	0.938	0.803
95	Veszprem	0.485	0.481	0.481	1.313	1.692
		-2.035	3.126	3.606	3.625	1.330
96	Zalaegerszeg	1.513	0.910	1.670	0.117	0.281
		0.731	3.063	3.103	3.330	1.630

Appendix C

STANDARDIZED GROWTH RATES OF THE HUNGARIAN CITIES

	City	1870-00 1941-49	1900-10 1949-60	1910-20 1960-70	1920-30 1970-80	1930-1941 1870-1980
1	Budapest	2.890	1.121	0.643	0.876	0.682
		-0.534	-0.276	-0.151	-1.249	1.028
2	Debrecen	0.594	0.790	0.795	0.588	-0.171
		-0.542	-0.078	0.248	0.067	0.436
3	Gyor	-0.056	0.357	0.835	-0.361	0.219
		-0.016	0.070	0.103	0.310	0.227
4	Miskolc	1.415	0.836	0.733	0.199	0.917
		-0.315	0.217	0.413	-0.197	1.017
5	Pecs	1.080	-0.059	-0.983	1.725	0.688
		0.113	0.407	0.267	-0.409	0.782
6	Szeged	0.058	0.201	-0.171	0.024	-0.459
		-0.312	-0.395	0.370	-0.385	-0.179
7	Ajka	0.299	-0.162	-1.134	0.543	0.374
		2.473	0.953	0.938	1.049	1.300
8	Baja	-0.994	-0.695	-1.787	1.425	0.482
		-1.109	-0.338	-0.025	-0.753	-0.809
9	Balassagyarmat	-0.322	1.016	0.063	-0.663	-0.606
		-0.445	-0.305	-0.220	0.631	-0.289
10	Balatonfured	-1.145	0.831	0.646	1.210	0.675
		1.094	-0.250	1.076	1.746	0.762
11	Barcs	2.419	0.064	-1.510	-0.390	-0.198
		-0.898	-0.705	-0.617	0.843	0.077
12	Berettyoujfalu	-0.125	-0.258	-0.004	1.204	-0.123
		0.049	-0.628	-0.647	0.109	-0.395
13	Bekes	-0.929	-1.027	-0.137	-0.638	-0.652
		0.013	-0.592	-0.894	-1.042	-1.361
14	Bekescsaba	-0.563	0.088	0.561	0.361	-0.229
		-1.069	-0.058	-0.146	-0.132	-0.363
15	Bonyhad	-1.460	-0.106	-0.802	-0.855	0.438
		-0.521	-0.049	-0.101	-0.061	-0.769
16	Cegled	-0.181	-0.033	0.387	-0.807	-0.576
		-0.104	-0.417	-0.650	-0.838	-0.736
17	Celldomolk	0.728	0.772	1.614	0.301	-1.067
		0.406	-0.591	-0.513	-0.124	0.049
18	Csongrad	-0.328	-0.067	-0.416	-0.857	-0.862
		-0.042	-0.724	-0.827	-1.310	-1.171

19	Csorna	-0.072	-0.709	0.217	-0.770	-0.396
		0.147	-0.530	-0.603	-0.959	-0.802
20	Dombovar	1.656	1.780	1.666	0.318	-1.220
		0.767	-0.297	-0.205	0.169	0.824
21	Dunakeszi	2.102	3.428	2.405	2.652	1.645
		-0.035	-0.251	1.341	0.727	2.581
22	Dunaujvaros	-1.141	-0.729	0.069	-1.703	-0.569
		0.056	6.056	1.545	1.335	2.299
23	Eger	-0.201	-0.299	-0.347	-0.191	-0.228
		-0.707	0.004	0.272	0.774	-0.124
24	Esztergom	-0.566	-1.032	-0.613	-1.422	1.361
		-0.757	-0.098	0.108	-0.742	-0.601
25	Erd	-0.859	0.057	-0.557	2.970	7.056
		1.238	-0.117	1.394	1.180	1.992
26	Fehergyarmat	-0.486	-0.240	-1.386	1.100	0.098
		0.128	-0.268	-0.487	0.626	-0.357
27	Godollo	0.530	1.091	3.187	-0.059	-0.174
		0.419	0.433	0.497	0.861	1.193
28	Gyongyos	-1.270	-0.042	-0.529	-0.035	0.305
		-0.681	-0.090	0.209	-0.066	-0.526
29	Gyula	-0.652	-0.382	-0.374	-0.554	-0.635
		-0.350	0.558	-1.718	-0.354	-0.947
30	Hajduboszormeny	-0.338	-0.057	-0.378	-0.729	-0.295
		0.141	-0.435	-0.994	-1.160	-0.948
31	Hajdunanas	-0.670	-0.604	-0.451	-0.326	-0.380
		-0.153	-0.449	-1.008	-1.239	-1.189
32	Hajduszoboszlo	-0.483	-0.672	0.548	-1.346	-0.429
		0.568	-0.660	-0.023	-0.734	-0.738
33	Hatvan	2.056	0.916	1.101	-0.175	-0.458
		0.427	-0.165	-0.262	-0.302	0.735
34	Hodmezovasarhely	-0.550	-0.825	-0.919	-0.967	-0.617
		-0.304	-0.390	-0.642	-1.364	-1.253
35	Jaszbereny	-0.284	-0.154	0.534	-1.801	-0.587
		-0.287	-0.356	-0.694	-1.010	-0.943
36	Kalocsa	-0.691	-0.754	-0.049	-1.313	-0.414
		-0.473	-0.025	-0.015	-0.106	-0.698
37	Kaposvar	1.889	0.979	1.479	0.053	-0.646
		0.183	0.190	0.319	0.132	1.083
38	Kapuvar	-0.130	-0.948	-0.026	0.183	-0.196
		0.269	-0.591	-0.762	-0.659	-0.750
39	Karcag	0.077	-0.209	-0.913	-0.090	-0.297
		-0.031	-0.574	-0.939	-1.071	-0.864
40	Kazincbarcika	-0.395	-0.701	0.173	0.008	0.640
		1.262	2.093	3.302	1.163	2.155
41	Kecskemet	-0.030	0.080	-0.036	-0.370	-0.018
		-0.219	-0.108	0.121	-0.172	-0.112
42	Keszthely	0.188	0.096	0.407	-0.463	0.224
		0.103	-0.082	0.200	0.342	0.203
43	Kiskoros	0.228	0.216	0.019	-0.152	-0.862
		0.174	-0.355	-0.539	-0.559	-0.421
44	Kiskunfelegyhaza	-0.085	-0.622	0.155	-0.453	-0.712
		0.032	-0.492	-0.537	-1.127	-0.818

45	Kiskunhalas	-0.058	0.542	0.221	0.319	0.760
		-0.323	-0.574	-0.090	-0.113	-0.061
46	Kisujszallas	-0.434	-0.817	-0.463	-0.287	-0.767
		-0.209	-0.492	-1.028	-1.301	-1.248
47	Kisvarda	0.888	0.612	1.002	1.480	-0.358
		-0.981	-0.351	-0.834	1.032	0.215
48	Komarom	0.472	0.384	2.689	1.392	0.155
		0.425	-0.226	-0.034	0.207	0.710
49	Komlo	0.102	0.249	0.943	0.394	1.180
		1.301	4.101	-0.396	-0.957	1.981
50	Kormend	0.153	-0.093	-0.052	-1.385	-1.002
		-0.031	-0.540	-0.098	0.012	-0.559
51	Koszeg	-0.870	-0.507	-0.572	-0.835	0.831
		-1.315	-0.009	-0.417	-0.304	-0.790
52	Leninvaros	-1.330	-0.978	-1.770	-0.569	-0.281
		0.036	2.542	4.363	3.543	2.034
53	Lenti	0.279	-0.240	0.891	0.693	-0.356
		0.397	-0.493	-0.265	0.321	0.003
54	Mako	-0.628	-0.876	0.426	-1.247	-0.790
		-0.346	-0.825	-0.832	-1.632	-1.485
55	Marcali	-0.656	-0.346	-0.741	-0.294	-0.631
		-0.124	-0.206	-0.482	0.838	-0.640
56	Mateszalka	0.084	-0.228	0.516	2.876	0.055
		0.992	-0.404	-0.463	1.915	0.530
57	Mezokovesd	0.626	0.008	0.280	0.394	-0.725
		-1.131	-0.505	-0.984	-1.103	-0.689
58	Mezotur	-0.589	-0.882	0.002	-0.570	-0.658
		-0.436	-0.653	-0.931	-1.484	-1.370
59	Mohacs	-0.340	-0.465	-2.049	0.187	-0.320
		0.494	-0.164	-0.413	-0.707	-0.671
60	Mosonmagyarovar	-0.968	0.650	1.265	0.323	0.349
		0.023	-0.028	0.216	0.277	0.122
61	Nagyatad	-0.280	-0.383	-0.447	0.413	-0.192
		-0.060	0.071	0.222	0.568	-0.014
62	Nagykanizsa	0.401	-0.194	0.855	-0.518	-0.723
		-0.515	0.005	-0.146	0.345	-0.066
63	Nagykoros	-0.304	-0.742	-0.564	-1.018	-0.494
		0.253	-0.515	-0.556	-0.922	-0.975
64	Nyirbator	-0.484	1.088	0.986	1.003	-0.018
		-0.130	-0.311	-0.925	0.332	-0.153
65	Nyiregyhaza	0.448	0.397	1.010	1.088	0.413
		-0.654	-0.005	0.141	1.142	0.638
66	Oroshaza	0.354	-0.619	0.200	-0.507	-0.568
		0.030	-0.643	-0.418	-0.747	-0.614
67	Oroszlany	-1.179	-1.111	-1.612	-1.298	0.651
		6.952	3.661	0.887	-0.475	1.943
68	Ozd	1.537	1.397	-0.585	2.279	1.057
		1.360	0.201	0.046	-0.973	1.309
69	Paks	-0.752	-0.565	-1.074	-0.930	-0.729
		-0.080	-0.639	-0.738	1.959	-0.927
70	Papa	-0.583	0.187	-1.186	0.175	0.078
		-0.577	0.015	-0.392	-0.790	-0.586

71 Salgotarjan	3.574	-1.064	0.035	0.616	0.489
	0.002	-0.190	-0.009	-0.247	1.075
72 Sarospatak	-0.708	0.003	0.387	-0.058	0.452
	-0.193	-0.258	-0.874	-1.022	-0.692
73 Sarvar	0.296	1.169	0.519	-1.479	0.853
	-1.041	-0.625	-0.246	0.205	-0.150
74 Satoraljaujhely	0.750	0.384	0.080	-2.444	-0.991
	-1.388	-0.416	-0.326	-0.585	-0.717
75 Siklos	-0.918	0.166	-1.248	-0.311	-0.478
	0.224	-0.706	-0.003	1.345	-0.588
76 Siofok	-0.712	-0.036	0.386	1.716	0.739
	1.529	0.242	0.487	0.114	0.643
77 Sopron	0.493	-0.778	-0.160	-0.550	0.559
	-2.180	-0.255	0.035	-0.221	-0.413
78 Szarvas	-0.864	-1.814	-1.293	-0.757	-0.908
	-0.791	-0.562	-0.587	-0.953	-1.653
79 Szazhalombatta	-0.041	0.915	-1.314	-0.550	-0.422
	-0.204	0.428	5.411	2.057	2.065
80 Szekszard	-0.403	-0.366	-1.673	-0.507	-0.283
	-0.120	-0.288	0.669	1.657	-0.163
81 Szentendre	-1.314	0.353	-0.227	1.397	1.669
	-0.219	-0.321	0.358	0.996	0.146
82 Szentes	-0.975	-0.928	-0.454	-0.665	-0.407
	0.128	-0.594	-0.593	-1.134	-1.254
83 Szekesfehervar	-0.011	0.081	0.161	-0.459	0.598
	-1.211	0.343	0.786	1.084	0.433
84 Szigetvar	-0.820	-0.342	-1.954	0.033	-0.442
	0.702	-0.352	-0.144	-0.104	-0.708
85 Szolnok	0.512	0.043	0.862	1.029	-0.024
	-1.039	0.059	0.706	0.108	0.506
86 Szombathely	2.032	0.826	0.917	0.144	0.043
	-0.479	-0.247	0.181	0.767	0.942
87 Tapolca	-0.066	-0.037	-0.122	-0.073	-0.894
	-0.301	-0.034	0.145	1.880	0.057
88 Tata	-0.561	-1.506	-0.606	-0.421	-0.505
	0.732	0.357	-0.013	-0.030	-0.394
89 Tatabanya	3.106	6.258	1.956	0.913	0.386
	0.646	0.112	0.518	-0.203	2.753
90 Torokszentmiklos	0.449	0.125	0.682	-0.377	-1.118
	0.134	-0.404	-0.618	-1.028	-0.479
91 Turkeve	-0.495	-1.370	-0.886	-0.325	-0.482
	-0.176	-0.836	-1.294	-1.504	-1.610
92 Vac	-0.363	-0.003	-0.389	0.008	-0.279
	-0.197	-0.142	0.269	-0.312	-0.254
93 Varpalota	-1.516	-0.822	-1.514	0.041	2.722
	0.865	1.646	0.237	-0.822	0.399
94 Vasarosnameny	-0.135	-0.202	-0.412	1.457	-0.257
	-0.259	-0.248	-0.589	-0.622	-0.408
95 Veszprem	-0.834	-0.610	-0.064	0.577	0.802
	-1.326	0.529	0.885	1.965	0.396
96 Zalaegerszeg	0.439	-0.249	1.444	-0.763	-0.473
	0.650	0.505	0.673	1.681	0.853

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