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URBAN SYSTEMS DYNAMICS: EVIDENCE FOR THE TORONTO URBAN SYSTEM: 1930-1991

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The Toronto urban system was studied for the period 1930-1991. Findings suggest that urban systems evolve differently under conditions of growth, stability and decline. New subsystems emerged until 1960 and resulted in a larger, more complex, and increasingly integrated urban system. Since that time, the system has been stable in terms of the rank order and patterns of dominance of its large cities. Moreover, since 1970, system formation has been increasingly influenced by Toronto's growing importance as the provincial and national business and financial center.

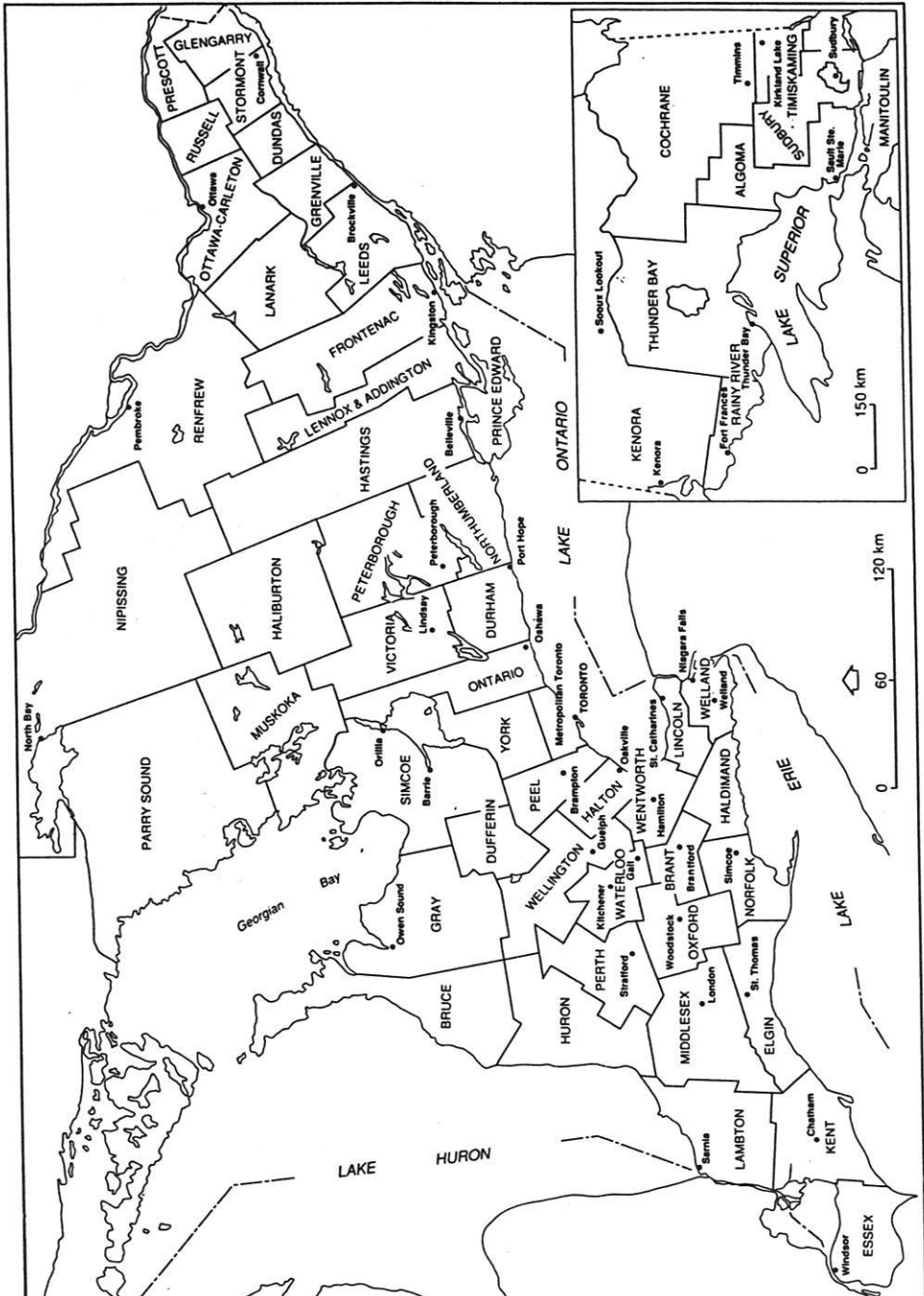
PROBLEM AND RESEARCH PROCEDURE

This study describes findings and a conceptual framework emerging from research on the Toronto urban system (Figure 1). The problem addressed was "How do urban systems change over time?" Findings were based on a decade-by-decade analysis of Toronto's system between 1930 and 1991. Because the nature of urban systems formation has changed since the late 1960s (PRESTON 1991a, 1991b), the 1971-1991 period was emphasized. The contrast between the pre-and post 1971 periods was highlighted by an examination and restatement of generalizations regarding urban systems formation based on the 1930-1971 experience (PRESTON, 1979).

The Toronto urban system was defined on the basis of daily commuting and newspaper flows, intermetropolitan migration, and air passenger flows (PRESTON, 1979, 1986). Toronto (Census Metropolitan Area, population 3,893,046 in 1991) dominates all of the urban subsystems in Ontario (population 10,084,885 in 1991). The places considered in this study were those that offered daily newspapers during one or more of the study years. Central place importance was emphasized and was defined initially by the number of daily newspapers exported from each town. The logical link between central place importance and the export component of economic base theory was therefore clear. Moreover, because of an emphasis on high-order central place (urban) functions, the terms central place and urban system were used interchangeably.

In the 1930-1971 study of the Toronto urban system, measures of central place and urban system dynamics were derived from daily newspaper circulation data for each decade. Included were all places offering a daily newspaper in one of the study years and all places receiving 25 or more copies on an average day. Measures were number of subsystems, number of papers offered and exported by each newspaper

Figure 1 Counties, Districts, and Urban Centers in Ontario



town, rank-size distribution, magnitude of primary and secondary linkages within both the system as a whole and each subsystem, and patterns of territorial competition.

The evolving patterns of territorial dominance and hierarchical organization were analyzed decade-by-decade and from two perspectives. First, ray diagram maps showing patterns of dominance by newspaper town in each study year were considered. Then, choropleth maps showing patterns of dominance and competition by decade by county were considered. The first set of maps can be used to evaluate different nodal variables, while the second set identify patterns of dominance for a temporally stable and data rich set of spatial units.

Findings from the 1930-1971 study provided the basis for the following generalizations about the recent evolution of urban systems

1. Urban systems are not static over time, and, as they evolve, both territorial and hierarchical reorganization takes place.
2. The weight of the urban systems in existence at the outset of a study period has considerable influence on the pattern in subsequent years. Most important, here, is the persistence of the patterns of rank order and dominance of the largest centers.
3. Changes in rank order are concentrated below the level of the largest places and can be spectacular and significant.
4. As an area's urban system evolves, the number of linkages increases and a more complex hierarchical structure emerges.
5. As urban systems evolve, central places and market areas increase in number and produce a nested hierarchical structure in which boundaries between smaller places are well defined and larger places penetrate the market areas of smaller places.
6. Over time, the territorial extent of large center dominance is reduced by a sequence in which large center dominance is replaced by smaller but more accessible central places inserting themselves between receiving places in their local areas and the larger centers.
7. Central place replacement first occurs at the periphery of large center market areas, next in interstitial locations relative to larger centers, and later still within the commuting zones of larger centers.
8. When central place replacement occurs in an area, that area's main secondary link remains with the formerly dominant place.

Early in the consideration of data for 1971-1991, it was apparent that forces shaping the Ontario urban system during that period were different from those of the preceding forty years (SIMMONS, 1992, PRESTON, 1986, 1991b). Consequently, some of the generalizations regarding the evolution of urban systems based on the 1930-1971 experience appeared not to be holding up and were in need of revision. To deal with this situation, an attempt was made to (1) incorporate other variables, (2) consider space and time together, (3) include exogenous forces, and (4) to adopt a multiple-scale perspective (SIMMONS, 1992).

This study thus incorporated not only measures of daily newspaper flows, but daily, weekly, and monthly business press flows, population size, domestic intermetropolitan air passenger flows, and air passenger flows between Toronto and large U. S. cities. Emphasized also was a four-scale analytical framework, identifying different geographical patterns and suggesting different shaping forces; namely, (1) the urban regional system scale, (2) the agglomeration scale, (3) the national urban system scale, and (4) the international scale.

FINDINGS

Findings for the Regional Urban System Scale were based on the two series of maps and were as follows. (1) Within Ontario, the number of newspaper towns, the number of places receiving newspapers, the total number of newspaper linkages, and the ratio of primary to secondary linkages, all increased between 1930 and 1950, but have been stable since. Moreover, the complexity of linkages between Toronto and places outside Ontario has increased since 1971. (2) Rates of growth in central place importance within both the Toronto and national systems changed from an overall pattern of growth prior to 1971 to one of concentration of growth in a few larger centers, widespread stability, and pockets of decline. When percentage change in central place importance by decade was examined for the Toronto system by three classes (gain, stable, and loss), 94 % of the places grew during the 1940-1950 decade, but only 38 % for 1981-1991. By contrast, places with stable central place indices increased from 3 % in 1950 to 36 % in 1981-1991, and places showing losses in centrality increased from 3 % in 1950 to 43 % in 1971-1981, and stood at 26 % in 1981-1991.

(3) The entire provincial system is increasingly dominated by Toronto, with Ottawa and London playing important, but secondary, roles. (4) The overall system has shown considerable structural (territorial and hierarchical) stability since 1961. Moreover, most shifts occurred among the smaller central places. It is thus clear that when a place rises to some significance in the system, its rank order tends to stabilize. (5) Between 1930 and 1960 new subsystems emerged consistently and the patterns of territorial and hierarchical change were repetitive. (6) After 1960 however, urban systems emerging within Toronto's daily urban system prior to 1971 disappeared, at least as daily newspaper towns, and components of subsystems near the outer edge of Toronto's daily urban system weakened substantially (for example, those dominated by Kitchener and St. Catharines). (7) Linkages between Toronto and the other system-forming central places in Ontario increased steadily after 1971. (8) Linkages between Toronto and regional centers outside of Ontario increased substantially after 1971.

Several additional findings stood out when the central place rank-size distributions for each study year were compared. (9) A notable break-of-slope existed between the dominant and continuous lower part of the distribution in every study year.

(10) Toronto dominated the urban rank size distributions. (11) The overall structure of the urban rank-size distribution changed between 1930 and 1971 in the sense of a filling-out of a fan-shaped zone between the largest places and those forming the continuous tail of the distribution. Cities within that zone became the third and fourth order system-forming central places in Ontario.

It was apparent that the situation of the Ontario urban system changed from one of overall growth between 1930 and approximately 1971, to one of limited growth focused in a few larger centers, overall stability, and pockets of decline. Moreover, it is suggested that the spatial structure of the Toronto urban system was established by 1960, and that since that time change has taken forms other than the generation of new urban subsystems.

In the context of both the provincial and national urban systems, the growth of Toronto has been the outstanding event. Overall, the city greatly increased its central place importance (from 292,000 exported newspapers in 1960 to 680,000 in 1991, an increase of 388,000). Thus, while the overall pattern of territorial dominance within the province changed very little after 1960, linkages between Toronto and key places within its commuting area, the province (Table 1), and throughout the country, increased substantially after that date. The increasing national importance of Toronto is underscored by the increase in the number of copies of the "Toronto Globe and Mail" delivered outside of Ontario from 4,726 in 1961 to 108,163 in 1991.

Table 1 Linkages between Toronto and System-Forming Central Places in Ontario: 1971-1991.

Central Place	1971	1991
Hamilton	12,829	24,563
Ottawa	12,860	19,051
Kitchener	5,963	14,425
St.Catharines	5,196	11,028
London	6,628	8,947
Kingston	5,995	6,311
Sudbury	3,774	5,111
Windsor	3,454	3,512
Thunder Bay	1,615	1,079

Source: Audit Bureau of Circulations

Analysis at the Toronto Agglomeration Scale showed three clear dimensions: (1) the increasing importance of Toronto as a focus of population concentration. (2) an outward spread effect, and (3) an influence beyond the daily urban system, or commuting zone, referred to here as an urban field or cottage effect.

A key reason for Toronto's growing role as the "Metropolitan Center" of Canada is

the sheer mass and complexity of the agglomeration embraced by its daily urban system. In 1991, there were 5,684,513 people (20.8 % of Canada's 27,296,859) living in the Oshawa-Barrie-Kitchener-Niagara triangle, an area consisting of Metropolitan Toronto, the Regional Municipalities of Durham, Halton, Hamilton-Wentworth, Niagara, Peel, Waterloo, and York, and the Counties of, Simcoe and Wellington.

Moreover, in southwestern Ontario there are seven regional urban complexes (PRESTON, 1991a) that serve as nearby investment alternatives to the Oshawa-Toronto-Hamilton complex: Kitchener-Guelph, London-St.Thomas, Niagara, Brantford-Paris, Mariposa-Lake Simcoe, Peterborough-Lindsay, and Belleville-Trenton. All of these complexes are located in the most dynamic section of the Windsor-Quebec City Axis, and their growth has caused a shift of the national heartland's core toward southwestern Ontario.

Using the number of daily newspapers originating in Toronto and delivered in counties within its daily urban system as a measure of agglomeration effect, an increasing linkage with Toronto was revealed (Table 2). This situation is at least partially explained by the increase in employment in the outer reaches of Toronto's commuting area (BRYANT, 1991).

Table 2 Agglomeration Spread Effect (Daily Urban System).

County	Percent Toronto Newspapers	
	1961	1991
York	100	100
Peel	85	100
Dufferin	95	100
Ontario	56	69
Durham	54	65
Wentworth	19	21
Wellington	28	30

Source: Audit Bureau of Circulations.

The same measure also showed strong links between Toronto and counties located beyond its daily urban system in the traditional cottage country of Ontario. Counties included in the cottage or urban field effect included those where the proportion of total daily newspapers in each county originating in Toronto exceeded 29 % in 1991 (Table 3). This cut-off figure is arbitrary and these data must be refined to produce a more complete spatial pattern. Nevertheless, they identify, at least partially, the territory included in the weekend, or longer, recreational (cottage) dimension of Toronto's urban field.

Table 3 Urban Field Effect (Beyond the Daily Urban System): 1961 and 1991.

County	Percent Toronto Newspapers	
	1961	1991
Haliburton	100	100
Muskoka	90	96
Parry Sound	66	50
Victoria	50	41
Northumberland	64	37
Manitoulin	79	30
Prince Edward	47	30
Hastings	79	30
Peterborough	25	29

Source: Audit Bureau of Circulations

This section emphasizes the National Urban System Scale, and thus the increasing linkages between Toronto and the system-forming central places in the country outside Ontario (PRESTON, 1986, 1991a, 1991b). For example, SEMPLE and GREEN (1983) demonstrated Toronto's importance as the command and control center of the national economy by the number of corporate and financial head-offices it attracted. Following this theme, the nation's nine Census Metropolitan Areas with over 500,000 inhabitants were ranked by population size and viewed in terms of three measures of high order urban functional importance for 1991. Toronto's leadership in every category was striking (Table 4).

When Toronto's increasing national dominance in high order urban functions was combined with the fact that during the 1970s and 1980s the main regional system-forming central places throughout the country either increased or maintained their central place importance, it was clear that there has been a concentration of national- and region-serving central place functions both in Toronto and the regional capitals (PRESTON, 1991b). It is suggested, moreover, that this concentration has been at the expense of the smaller and more specialized urban centers.

The most significant change in the national pattern of daily newspaper dominance in Canada since 1970 has been the increase in both volume and area coverage of Toronto newspapers, especially of the Toronto Globe and Mail (PRESTON, 1986). This situation suggests that the increasing importance of Toronto, the decline of Montreal, and stability in the pattern of dominance of the main regional centers are all associated with Toronto's rapid development as the nation's key business center (SIMMONS, 1994).

Table 4 Corporate Control Points in the Canadian Urban System: 1991.

Metropolitan Area	Population	Top 100 Industries	Top 100 Financial Firms	Top 500 Industries
Toronto	3,893,046	44	53	191
Montreal	3,127,242	21	13	94
Vancouver	1,602,502	8	8	41
Ottawa	920,857	1	4	13
Edmonton	839,924	2	4	16
Calgary	745,033	9	2	43
Winnipeg	652,354	5	1	20
Quebec City	645,550	0	2	3
Hamilton	599,760	2	2	8

Sources: Statistics Canada (1991) and The Financial Post 500 (1992).

It is suggested that the failure of regional centers to prevail as suppliers of the latest specialized information to expanding regions, or even to their traditional regions, also reflects Toronto's increasing ability to provide this type of information for the nation. The nationwide increase in Toronto's newspapers appears to be related directly to the city's expanding central place function as the national center for business and finance. This argument is developed next.

At outset of the 1970s Canada did not have a national daily business press (PRESTON, 1986). The task of spreading business information by newspaper fell to the region-serving daily papers in each province and to nationally-distributed weekly and monthly business publications. This situation changed between 1971 and 1981, and has persisted. That change was linked to a increase in national coverage by the Toronto Globe and Mail. Facilitated by satellite transmission and same day publication in four locations outside of Toronto (Vancouver, Calgary, Ottawa, and Moncton), by 1991 the Globe and Mail occupied a strong presence in every major central place system in the country. This situation suggests that 'the nation's business had become Toronto's business and vice versa' (Table 5).

The key element in the nationwide appeal of the Globe and Mail has been demand for its 'Report on Business'. This is a daily survey of national and international business and financial matters plus special reports on subjects of interest to business people. The performance level of the Report on Business has surpassed and replaced attempts by metropolitan and regional newspapers elsewhere in the country to develop or maintain a regionally dominant daily national business section. This dominance in the daily business press was reinforced 1989 by the addition of a daily edition by the Toronto based "Financial Times".

Table 5 Links between Toronto and System-Forming Central Places Outside Ontario: 1961 and 1991 (Based on the Number of Copies of the Toronto "Globe and Mail").

Central Place	1961	1991
Vancouver	124	25,085
Calgary	69	10,496
Edmonton	99	8,433
Regina	49	2,776
Saskatoon	35	2,253
Winnipeg	191	7,495
Montreal	934	15,590
Quebec City	149	1,392
Saint John	26	1,370
Halifax	51	7,602
St. John's	35	1,806

Source: Audit Bureau of Circulations

The Toronto Globe and Mail experience during the 1970s and 1980s was only part of the story of events highlighting the increasing importance of Toronto in the territorial reorganization of Canada's business press. The city has also become the national center for weekly and monthly business publications. Moreover, much of Toronto's growth has been at the expense of Montreal (PRESTON, 1986).

When the nation's urban system was organized on the basis of intermetropolitan air passenger flows for 1991, Toronto's dominance was apparent (Table 6). Toronto appeared in the three largest links, with Montreal, Ottawa and Vancouver. Toronto also appeared in seven of the top ten links. No other city appeared in more than three.

This section emphasizes the International Scale, and thus links between Toronto and large U.S. cities. Toronto appeared in eight of the top ten air passenger links in 1991 (Table 7). This suggests an increasing integration of Canada by way of Toronto into the North American network of large cities. Significantly, the link between Toronto and New York is second only in magnitude to that between Toronto and Montreal in the Canadian context. Moreover, the 2nd through 10th links between Canadian and U.S. cities are similar in magnitude to the 4th through 10th links within Canada.

Table 6 Ten Largest Domestic Air Passenger Links: 1991 (Pairs Ranked by Total Inbound and Outbound Passenger Volumes).

Rank and City-Pair	Number of Passengers (000)	Percent of Total
1. Toronto-Montreal	1,122.0	9.87
2. Toronto-Ottawa	659.5	5.80
3. Toronto-Vancouver	639.8	5.63
4. Calgary-Vancouver	399.8	3.52
5. Toronto-Calgary	375.2	3.30
6. Toronto-Winnipeg	317.2	2.79
7. Toronto-Halifax	298.9	2.63
8. Vancouver-Edmonton	293.6	2.58
9. Calgary-Edmonton	259.8	2.28
10. Toronto-Edmonton	245.5	2.16

Statistics Canada. Air Passenger Origin and Destination Flights. Domestic Journeys. 1991.

Table 7 Ten Largest Air Passenger Links between Canadian and U.S. Cities in 1991 (Pairs Ranked by Total Inbound and Outbound Passenger Volumes).

Rank and City Pair	Number of Passengers (000)	Percent of Total
1. Toronto-New York	838.6	9.23
2. Montreal-New York	381.9	4.20
3. Toronto- Chicago	320.6	3.53
4. Toronto-Los Angeles	260.1	2.86
5. Toronto-Boston	264.3	2.91
6. Toronto-Miami	213.7	2.85
7. Vancouver-Los Angeles	251.7	2.77
8. Toronto-Tampa	214.8	2.36
9. Toronto-San Francisco	184.0	2.02
10. Montreal-Miami	182.3	2.01

Source: Statistics Canada. Air Passenger Origin and Destination, Transborder Journeys. 1991.

CONCLUSIONS

This study described the evolving urban system in Ontario between 1930 and 1991 and the emerging conceptual framework being developed to guide that research. Strong themes were the stability in the rank order and territorial extent of the areas of dominance of Ontario's main system-forming central places, increasing links between Toronto and key centers within Ontario, increasing links between Toronto and the main regional centers outside of Ontario, and strong links between Toronto and large cities in the United States. It is apparent that Toronto has become Canada's chief central place and the core of its main population concentration. It is suggested that the population figure for Toronto's Census Metropolitan Area understates the importance of the city in the province, in the nation, and as a link with key centers in the international system of cities.

Special attention was given to a list of generalizations describing the evolution of Toronto's urban system between 1930 and 1971 (PRESTON, 1979). This examination was in the light of comparable data for the period 1971-1991, and prompted by the shift in Ontario from one of general growth in the post-war period until 1970 to one of a complex pattern of concentrated growth, widespread stability, and pockets of decline between 1971 and 1991. It was concluded that urban systems evolve differently under conditions of growth, on the one hand, and of stability and decline, on the other. Accordingly, a partially revised list of generalizations was produced.

1. Urban systems are not static over time. As they evolve, territorial and hierarchical reorganization takes place. Under conditions of growth, decentralization is the rule at all scales. By contrast, under conditions of stability and decline, centralization is the rule.

2. The weight of the urban system in existence at the outset of the study period has considerable influence on the pattern in subsequent years. Most important, here, is the persistence of the rank order and patterns of dominance of the largest centers.

3. The dominant city in the system increases its central place importance over its chief competitors under conditions of both growth and decline. Under conditions of growth, urban systems expand and become more complex by increasing the number and magnitude of links both inside and outside of their primary systems. Under conditions of stability and decline, functional importance is concentrated, first, in the largest city in the system, and second, in key regional centers. Moreover, the links between the dominant center and both the most important centers within and beyond its immediate system increase in magnitude.

4. Changes in rank order are concentrated below the level of the largest central places and can be spectacular and significant.

5. As an urban system evolves, the number of linkages increases and a more complex hierarchical structure emerges.

6. As urban systems evolve under conditions of growth, central places and market areas increase in number and produce a nested hierarchical structure in which

boundaries between smaller places are well defined and larger places penetrate the market areas of smaller places.

7. Under conditions of growth, the territorial extent of large center dominance is reduced by a sequence in which larger central place dominance is replaced by smaller but more accessible places inserting themselves between receiving places in their local areas and the larger centers.

8. Under conditions of stability or decline, the territorial structure of the urban system stabilizes; however, the larger centers exert pressure on both emerging subsystems located within its daily urban system and on established urban systems located at its outer edge. This pressure appears to result in the centralization of functional importance within pressurized urban subsystems.

9. Under conditions of growth, central place replacement first occurs at the periphery of large center market areas, next in interstitial locations relative to larger centers, and later still within the commuting zones of larger centers. Under conditions of stability and decline, overall spatial structure stabilizes, and reorganization is concentrated within the area of continuous dominance of the largest center.

10. When central place replacement occurs in an area, that area's main secondary link remains with the formerly dominant place.

11. Under conditions of stability and decline, peripherally located urban systems stagnate, with what growth there is concentrating in the largest places.

Finally, it was concluded that explanation of evolving urban systems requires both consideration of exogenous forces and a multiple-scale perspective. The influence of exogenous forces on urban systems was not studied; however, a multiple-scale framework emerged that emphasized the (1) urban regional system scale, (2) agglomeration scale, (3) national urban system scale, and (4) international large city network scale.

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