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Changing Patterns of Residential Centrality: Population and Household Shift in Large Canadian CMAs, 1971-1996

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Abstract

The research focuses on Canadian CMAs with populations of 500 000 or greater over the period 1971-1996. It uses population density gradients and enumeration of population and household shift to assess changing patterns of residential centrality over the twenty-five year period. Results indicate that all of the CMAs examined have experienced continued outward dispersion, some more so than others. When population change in core and inner-city zones is examined in conjunction with reduced density gradients, only one Canadian metropolitan area, Vancouver, shows indisputable signs of strong recentralization. Three other CMAs, Toronto, Victoria and Calgary, also experience some re-population of their central parts, while Montreal and Quebec City are shown to maintain what we call "residual" centrality. However, when recentralization is gauged using household enumeration instead of population counts, all of the places studied show evidence of new housing production in the central city. The answer to the central question regarding residential centrality is thus a mixed one, yes and no. Overall, we conclude that there is a direct link between evolutionary patterns within the national urban system and changes observed in residential centrality. Whatever the measure used, highest rates of recentralization accompany strong metropolitan-wide growth over the 25-year period.

Key Words: **recentralization; decentralization; core tracts; inner-city tracts; population enumeration; Canadian metropolitan regions.**

Résumé

Évolution des tendances de la centralité résidentielle : densité et déplacements de population dans les grandes régions métropolitaines canadiennes, 1971-1996

Cet article se penche sur l'évolution, entre 1971 et 1996, des régions métropolitaines canadiennes dont la population atteint ou excède 500 000 personnes. Il se sert de gradients mesurant la densité résidentielle ainsi que des changements de population dans différentes zones d'urbanisation afin d'illustrer les tendances ayant trait à la centralité résidentielle au cours des vingt-cinq dernières années. Cette recherche indique que toutes les régions métropolitaines analysées ont connu, avec divers degrés d'intensité, une tendance à la décentralisation. Lorsque les changements de population dans le centre-ville et les quartiers centraux sont considérés de pair avec un nivellement des gradients de densité, seule Vancouver montre des signes incontestables de recentralisation. Trois autres régions, Toronto, Victoria et Calgary, jouissent aussi d'une hausse de population dans leurs quartiers centraux. Bien que souffrant d'une forte baisse de population, la densité de ces secteurs demeure élevée à Montréal et Québec. Leur centralité est cependant résiduelle, legs des fortes densités du passé. La prise en compte des ménages plutôt que des résidents montre que toutes les régions métropolitaines examinées dans cette recherche ont fait l'objet de nouvelles constructions dans leurs secteurs centraux. Selon les données employées, nous observons une décentralisation ou une certaine centralisation des régions métropolitaines. La principale conclusion de cet article est que la recentralisation des régions métropolitaines est fortement associée à leur prospérité et à leur taux de croissance.

Mots clés : recentralisation urbaine; décentralisation urbaine; quartiers centraux; régions métropolitaines canadiennes.

INTRODUCTION

This research utilizes urban population density gradients and population and household locational shifts to provide succinct comparative indices of urban spatial form. The empirical evidence is based on the nine Canadian metropolitan areas with a 1996 population of 500 000 or greater over the period 1971-1996. In particular, this paper is concerned with changing patterns of where people live in cities relative to the city centre. We define centrality as spatial concentration, manifest in heightened densities, within a metropolitan area's central parts. As indicative of centralized form, we look for the maintenance of strong distance-decay gradients over time. We also look for evidence of population growth, or at least stability, in tracts we define as core or inner-city to indicate continued attraction to the centre. When and where it occurs, a significant loss of residents in centrally-located tracts is interpreted to be indicative of decentralization – a rejection of the central part of the city as a place to live. Because housing is consumed by households, including single-person households, we examine statistics derived from both population and household counts. This adds an interesting theoretical and methodological variant, not found within the existing body of research on the topic.

Along with many others, we believe that the shift, over the course of the twentieth century, from centralized to decentralized city structure represents a fundamental re-alignment in the way cities work. This trend has not, however, raised much

interest among Canadian urbanists. There is, at present, very little evidence about change in density gradients and differential degrees of centrality across Canadian cities. This paper is designed to help fill the gap. It also contributes to the continuing debate about the extent to which Canadian cities can be considered to be centralized, especially in comparison to US counterparts (Bourne, 1987 and 1989; Ewing, 1992; Goldberg and Mercer, 1986; Mercer and England, 2000; Robinson, 1986; Yeates, 1998). On the policy side, this work comes as a response to calls for re-centralization and re-densification of the urban fabric; the rationale for the work presented here being that we need to identify and better understand the interrelated processes of both centralization and decentralization if we want to create effective change and make cities more economically and environmentally sustainable.

As it bears on large Canadian CMAs, the purpose of the empirical analysis reported on here is threefold: 1) to examine the widely-used population density gradient to gauge spatial shift over time; 2) to establish the relative rates of growth in central vs. suburban parts of the metropolitan envelope; and 3) to assess how we are differently informed when households enumeration is used in lieu of simple population counts as an index of centrality. The following section of this paper briefly reviews centralization and decentralization trends that account for population loss in even the most attractive of centralized metropolitan areas. This metropolitan-wide pattern, as evidenced in the literature on population density gradients, is also briefly reviewed. Empirical findings make up the main body of the paper. The penultimate discussion uses these findings to identify the different post-1971 evolutionary patterns that characterize the largest Canadian CMAs. By way of conclusion, we consider what these different trends imply about the changing nature of urban centrality in Canadian metropolitan areas.

CENTRAL-AREA DECLINE AND REVITALIZATION AMIDST OVERALL TRENDS TOWARDS DECENTRALIZATION

As would be expected, the most pervasive trend seen across Canadian metropolitan regions as a whole has been one of decentralization and relative decline in the central city. The most widely recognized reasons for decentralization relate to suburbanization and the attractiveness of open space and privacy, of lower densities and lower real estate costs and increased auto accessibility perceived to accompany relocation to the suburbs by businesses and residents alike. As they pertain to North American cities in general, these conditions have been clearly documented (see, for example, Berry and Kim, 1993; Borchert, 1991; Erickson, 1983; Ford, 1991; Garreau, 1991; Gottdiener, 1994; Gottdiener and Klephart, 1991; Henderson and Slade, 1993; Kling, Olin and Poster, 1991; Lewis, 1983; Rowe, 1991; Small and Song, 1994; Soja, 1989; Vance, 1990; 1991; Waddell and Shukla, 1993).

It needs to be recognized that the suburbs themselves changed dramatically in the last part of the 20th century. The trend has been towards increased variability within suburbs. While low-density single-family development continues to predominate, suburbs have come to host new departures such as neo-traditional communities (Dowling, 1998), ethnic enclaves (Preston and Lo, 2000) high-rise apartment complexes, mixed-use nodes, some of them around "suburban downtown" developments (Tomalty, 1997) and social housing (Murdie, 1994). These

have impacted on central cities. The growth of suburban-based ethnic neighbourhoods (Kaplan, 1998; Li, 1998; Roseman *et al.*, 1995) has, for example, served to direct most foreign immigrants, once a bastion of central-city population growth, to suburban "ports of entry".

The CBD itself, as the fulcrum around which the central city as well as outer metropolitan parts were once organized, has changed. Due to the suburbanization of all types of land use, alongside the precipitous drop in the CBD's command over metropolitan-wide access, the demand for centrally located real estate has been greatly reduced (Gad and Matthew, 2000; Heikkila *et al.*, 1989; Robertson, 1995; Waddell, 1994). Trends in inner residential tracts outside downtown reflect the reduced *attractivity* of the CBD, so much so that the majority of central cities across North America registered population decline at some time in the post-1971 period. As well, since the 1970s, de-industrialization has released the central city's hold on working class households. (Broadway [1992; 1995], for example, shows that inner-city population loss is most characteristic of Canadian metropolitan areas with a heavy industrial economic base.) Another fundamental reason for reduced growth in the CBD and central neighbourhoods is simply one of cost. Even in the absence of environmental contamination, re-development costs much more than new development on "greenfield" sites[1]. The redevelopment cost equation goes a long way in explaining why most residential redevelopment in the central city has taken the form either of heavily subsidized social housing or luxury-end higher density housing.

On the other hand, in the face of all-pervasive trends towards decentralization, virtually all North American cities have witnessed some form of policy aimed at "revitalization" of their core parts. Trends towards revitalization in the CBD, core tracts immediately surrounding the CBD and those further out but still encompassed by the inner city, have received a great deal of attention in the research literature in both Canada and the US (see, for example, Beauregard, 1990; Caulfield, 1994; Ley, 1996). Since the 1970s, researchers, policy-makers, and the public at large have heralded these trends – reflected first as "gentrification" and later seen as new, higher density developments aimed primarily at higher income markets – and welcomed them as important counter-trends to decentralization. But, not all places experience these trends. Furthermore, close examination of evidence suggests that the extent of some kinds of revitalization, such as gentrification, has been greatly exaggerated. Where they do occur, factors that seem to explain residential revitalization in a city's central parts include: very rapid overall growth rates and tight suburban housing markets; white collar employment expansion in the CBD; attractive inner-city housing stocks and/or physical landscape amenities. While gentrification as such has the confounding effect of reducing population densities yet raising real estate values, redevelopment elevates land values alongside population densities. Conversion, often of aging industrial and warehouse premises, to residential use, the most recent trend in residential revitalization, also adds modest growth of population to the central city (Podmore, 1998; Sheppard, 1983; Zukin, 1989). Overall, however, in terms of population change, trends towards stability, rather than either growth or decline, have been believed to be the most pervasive feature of the majority of Canadian inner-city neighbourhoods (Bourne, 1993a; 1993b; Ley, 2000).

On the whole, we suspect that, in most Canadian cities, overall reductions in density far outweigh gains achieved through various types of intensification. Deconcentration has occurred everywhere because Canadians consume more housing space today than they did 50 years ago – there are more rooms per household and the rooms are bigger. Densities in the oldest neighbourhoods have dropped, in part because people take up more floorspace. A factor closely related to standards of floorspace consumption is household size. Floorspace ratios have increased, in large part, because household size has declined. In 1971 the size of the average Canadian household was 3.51; a quarter-century later, in 1996, it registered as 2.62 (Statistics Canada, 2000). In 1971, the average housing unit contained 5.4 rooms; in 1996 that figure stood at 6.1 (Statistics Canada, 2000). Nor has the decline in household size been felt equally across all of the metropolitan area. The central city has always been especially attractive to childless households or the public transit-dependent looking for smaller rental premises.

DENSITY GRADIENTS: CONVENTIONAL METHODS OF ASSESSING CHANGING PATTERNS OF POPULATION DISTRIBUTION

Numerous studies have examined the evolving pattern of North American urban form either in detailed documentation of specific metropolitan areas (e.g. Bussière and Dallaire, 1994; Charbonneau *et al.*, 1994; Goheen, 1970; Lemon, 1996; Léveillée and Paquette, 1996; Marois *et al.*, 1991; Millward, 1981; Nader, 1976; Sandalack and Nicolai, 1998; Sewell, 1993; Smith, 1978; Wynn and Oke, 1992) or more generally in terms of historiographic trends in urban growth (Borchert, 1991; Filion *et al.*, 1996; Ford, 1991; Garreau, 1991; Gottdiener, 1994; Ley, 1996; Soja, 1989; Vance, 1990 and 1991). There is, however, an absence of large-scale comparative studies designed to identify similarities and differences across national urban systems. As the most widely used numeric model of urban form, density gradients represent a reliable index of intra-urban centrality because density is responsive to accessibility advantages and resulting escalation of land values. Density gradients provide a consistent measure of the rate of decline in population density away from a central point (traditionally the CBD or, more precisely, the peak-value intersection) and so have been used in population density studies carried out on cities worldwide. The widespread availability of the demographic data from which the models are built also favours their use and helps to explain why a large body of research has grown around analysis of urban population density gradients and related econometric models (for review articles, see McDonald, 1989; Papageorgiou, 1989; Richardson, 1988).

Density gradients are especially useful research tools because they can be captured by a variety of curve-fitting models. The negative exponential form of the distance-decay population density gradient captures centralized patterns of urban form where highest densities are recorded just outside the CBD and drop off at rates that co-vary with factors such as city size, age of the housing stock, rates of automobile ownership and public transit availability. Since the 1970s, the single-most general finding from density-related research has been one of dramatically declining centrality. The goodness-of-fit of the negative exponential statistical form of the population density distance-decay gradient has given way to more complex,

polynomial formulations which place the main concentration of high density at or near the centre but recognize a secondary density peak, or several such peaks, in outlying parts. When polynomial models produce the best goodness-of-fit statistics, the implication is that centrality is being challenged by alternative decentralized locations (Filion *et al.*, 1999; McDonald, 1989; Richardson, 1988; Papageorgiou, 1989; Thrall, 1988). Throughout the nineteenth and first half of the twentieth century, greatly elevated density peaks were recorded adjacent the essentially non-residential CBD – a pattern best captured by the negative exponential form of the distance-decay gradient (Newling, 1969; on Toronto see Latham and Yeates, 1970). Over the course of the twentieth century, expansion of the CBD was curtailed by increasing suburban relocation and, since the 1970s, inner-city neighbourhoods have been protected from most kinds of high-rise redevelopment by planning policy. However, in the last two decades, decreased development pressures for commercial space in the core as well as the more recent release of vast tracts of centrally-located former rail and industrial lands have alleviated competition for central-area real estate. Today there is more potential for central-area residential growth than ever in the past century. Yet, the research record suggests that residential decentralization continues to feature predominantly across North America.

METHODOLOGY: ASSESSING RESIDENTIAL CENTRALITY, CANADIAN CMAS, 1971-1996

The empirical focus of this paper is restricted to measures of population and household growth and decline and to gross density change over the period 1971-1996[2]. Admittedly this gives us only one measure of urban form, but the strength of this approach lies in the consistency of the data set and comparability of the findings. Within this framework, we use two different measures for assessing centrality. Centralization is assessed through the distance-decay density gradient on the assumption that any CMA whose distance-decay density profile exhibits a statistically significant relationship between distance from the CBD and population density is one wherein the CBD continues to exert influence over the rest of the urbanized territory (*e.g.* Brueckner, 1981; Thurston and Yezer 1994). Steepness of slope is a related indicator of centralization. In this research, distance-decay gradients are calibrated using the two most widely-used methods, the negative exponential and the cubic polynomial.

As a second indicator of centrality, we scrutinize population and household change in central zones – the inner city as a whole as well as the core area immediately adjacent to the CBD. The distinction between centralization, as indexed by distance-decay parameters, and re-centralization, as measured by tract level growth or decline, is important because, as we shall see, it is possible for a metropolitan area to register population decline in its inner-most parts and yet still retain centralized form. Conversely, it is also possible for a CMA to exhibit declining density gradients and also experience central area population growth. Re-centralization indicates that new development is ongoing (*i.e.* not a remnant from previous development) and that the CBD and/or surrounding areas remain attractive as places to set up residence. In contrast, the absence of growth expressed as population loss is indicative of decentralization, or of an absence of attraction of central-area living.

The measurement unit for statistics used in this research is the census tract[3]. We ensure a reliable basis for comparison of population and density shifts over time and between places by limiting our observations to fully developed or "urbanized" tracts within CMAs' built-up perimeters which, on average, contain about 80 % of the total CMA population. The number of places that we analyze has been limited to those cities that had a population of at least 500,000 in 1996 because it is difficult to accommodate statistical tests in smaller places. As regards internal division within the metropolitan envelope, we adopt a primarily historic-structural perspective, rather than a simply spatial one measured in terms of distance from the CBD. Our definition of inner city, based on age of housing, incorporates tracts wherein the majority of the housing stock was built before 1946[4]. These tend to be areas where structural relationships reflect an urban form in which pedestrian and public transit trips predominated (see Bunting and Filion, 1988; Ley, 2000). However, within this broad zone we look more closely at tracts within walking distance of the CBD, allowing that there may be different forces at work in areas within the immediate vicinity of downtown than in the inner city at large. Significant increase in either zone is taken to be indicative of recentralization and the reverse, decline, of decentralization.

We add another perspective to the interpretation of observed trends towards recentralization and decentralization by substituting household enumerations for ones based on population. This alternative perspective is important because households constitute the basic unit of demand for housing. As a result, population counts may underestimate demand for residence in a given area. In the case of the inner city, for example, a drop in base population may actually mask increased demand for housing units on the part of smaller-sized households.

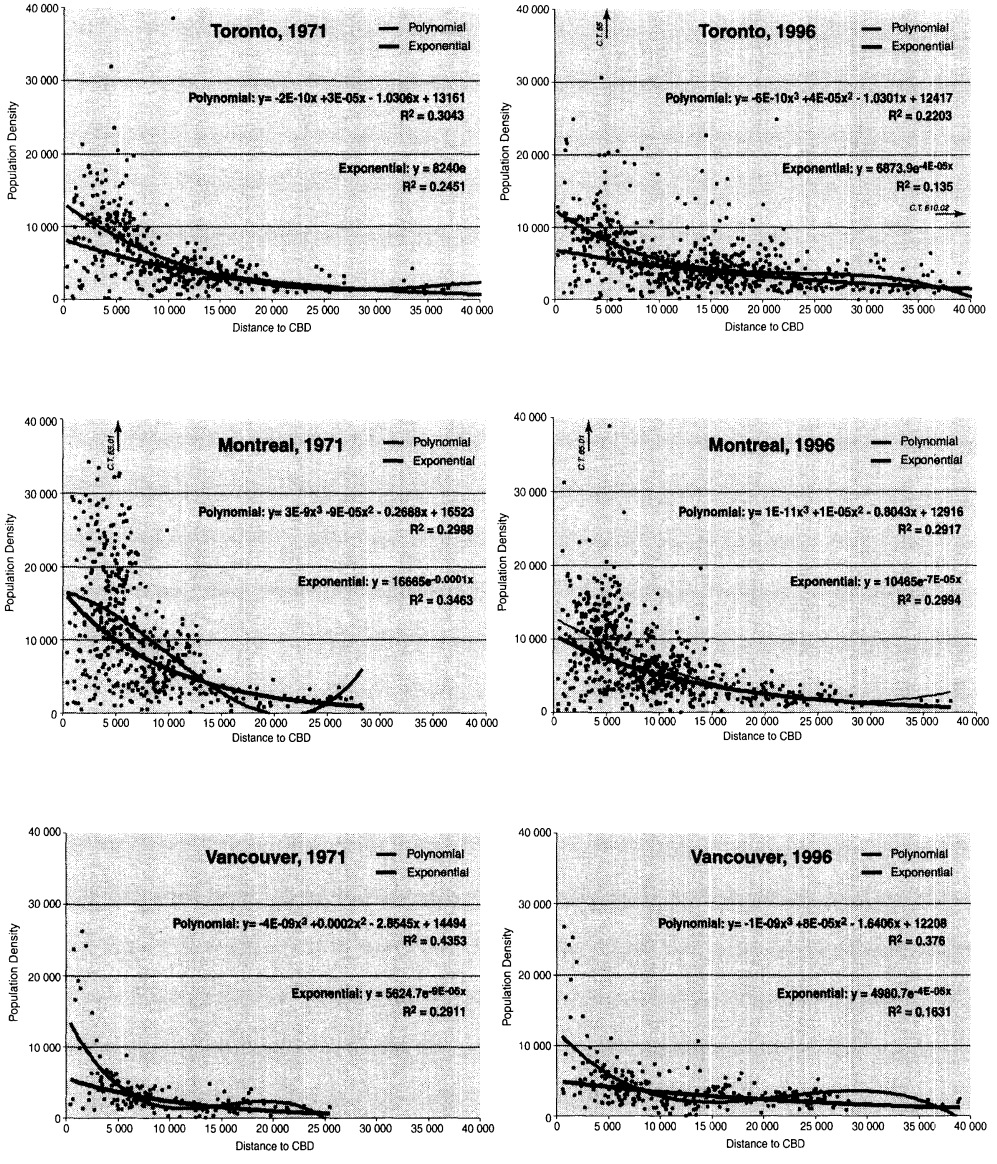
In the empirical observations that follow we expect to see widespread decentralization. This should register as diminished steepness of slope and reduced ability of distance-decay gradients to capture spatial patterns of metro-wide population density over the 1971-1996 period. We further expect population to drop almost everywhere in the central city, more so in the area we define as "inner-city" than in the "core". On the other hand, we also expect considerable variation in central area population shifts from one metropolitan area to another. We further expect figures relating to household enumeration, as opposed to population growth, to paint somewhat different pictures of core area and inner-city change than ones based on population alone.

CENTRALITY: TRENDS IN DISTANCE DECAY GRADIENTS

Figure 1 consists of graphs of the negative exponential and cubic polynomial curvilinear relationships in 1971 and 1996 for the three largest CMAs, Toronto, Montreal and Vancouver, while Figure 2 reproduces the 1996 curvilinear patterns for the other six CMAs under observation. Table 1 outlines the coefficient of determination (R^2), "F" statistic and steepness of slope as captured by the negative exponential and cubic polynomial models for all nine CMAs in 1971 and 1996. In both 1971 and 1996 distance-decay relationships remain highly significant in all CMAs (except Calgary in the 1996 negative exponential model). However, greatly increased variability around the regression line, especially in the form of scattered

plots of exceptionally high-density suburban tracts is signified by the considerable drop in R^2 values and by the overall improved performance of the cubic polynomial over the negative model between 1971 and1996. Decreases in the slope registered for the negative exponential regression bear similar trends suggestive of declining centrality and overall increased inter-tract variability.

Figure 1 Population Density vs. Distance: Cubic Polynomial and Negative Exponential Regression Models, 1971 and1996



In Figure 1, the overall 25-year pattern of change in Toronto and Vancouver seems to be one of increased variability around the distance-decay regression line, especially as regards density increments in some suburban tracts. In Montreal, on

the other hand, the pattern is more one of traditional decentralization, that is, of central area decline and continued outward low-density expansion. In Figure 2, two places, Calgary and Edmonton, stand out because they have relatively low central densities, characteristic of CMAs not greatly developed before the twentieth century, alongside relatively high density concentrations in suburban areas that grew rapidly in the over-heated real estate markets that characterized western parts of the country in general and these two CMAs in particular in the late 1960s, 1970s and 1980s. The decentralized pattern is more muted in other places but the evidence in Table 1 supports an overall decentralizing pattern and increased variablity for the other CMAs illustrated in Figure 2. In Toronto and Vancouver, the scattering of

Figure 2 Population Density vs. Distance: Cubic Polynomial and Negative Exponential Regression Models, 1996

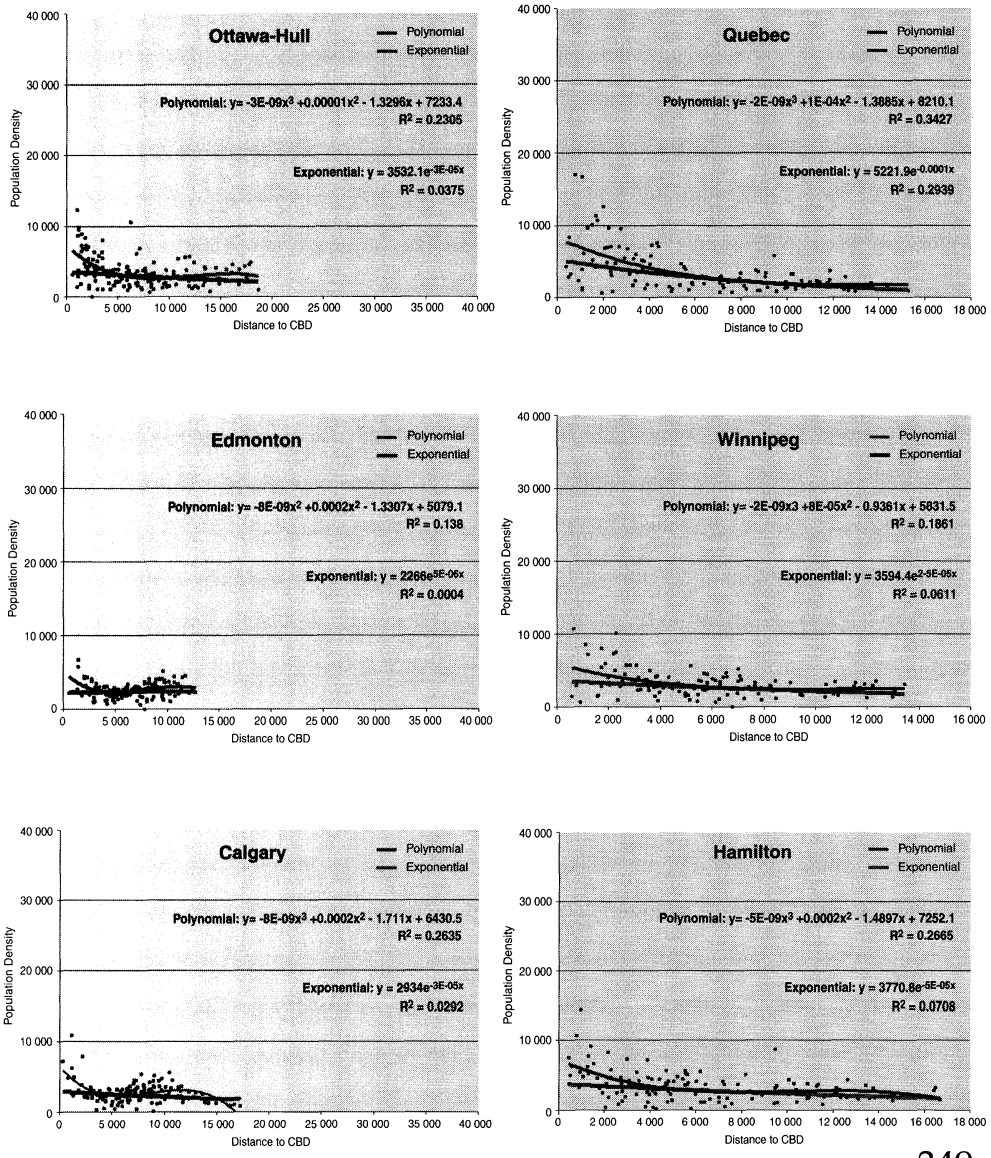


Table 1 Regression Statistics, "Population Density" *vs.* "Distance from CBD", Negative Exponential and Cubic Polynomial Models, 1971 and 1996

CMA	Exponential Regression R^2 1971	1996	Δ1971-1996	Intercept 1971	1996	Slope exponent 1971	1996	F statistic 1971	F sig 1971	F statistic 1996	F sig 1996
Toronto	0.2451	0.1350	-0.1101	8240.01	6873.92	-0.0607	-0.0377	123.39	0.00000	102.55	0.00000
Montreal	0.3463	0.2994	-0.0469	16705.00	10464.56	-0.1028	-0.0711	240.69	0.00000	262.35	0.00000
Vancouver	0.2911	0.1631	-0.1280	5624.67	4980.68	-0.0851	-0.0377	54.20	0.00000	44.43	0.00000
Ottawa-Hull	0.1893	0.0375	-0.1518	5738.26	3532.08	-0.1170	-0.0278	22.18	0.00001	6.12	0.01447
Edmonton	0.1440	0.0004	-0.1436	4214.44	2266.04	-0.0904	0.0048	11.44	0.00120	0.06	0.80700
Calgary	0.1191	0.0292	-0.0899	3956.38	2934.02	-0.0933	-0.0293	8.92	0.00395	3.91	0.05021
Quebec	0.3415	0.2939	-0.0476	9563.42	5221.91	-0.1964	-0.1061	34.75	0.00000	47.44	0.00000
Winnipeg	0.2056	0.0611	-0.1445	6075.16	3594.45	-0.1372	-0.0524	22.26	0.00001	8.20	0.00491
Hamilton	0.1694	0.0708	-0.0986	5206.70	3770.81	-0.0827	-0.0461	18.15	0.00005	10.14	0.00181
Mean	0.2279	0.1212	-0.1068	7258.23	4848.72	-0.1073	-0.0448				

CMA	Cubic Polynomial Regression R^2 1971	1996	Δ1971-1996	Intercept 1971	1996	x 1971	x^2 1971	x^3 1971	x 1996	x^2 1996	x^3 1996	F statistic 1971	F sig 1971	F statistic 1996	F sig 1996
Toronto	0.3043	0.2203	-0.0840	13160.61	12416.51	-1030.56	28.27	-0.23	-1063.09	44.00	-0.62	55.10	0.00000	61.70	0.00000
Montreal	0.2988	0.2917	-0.0071	16513.66	12916.32	-257.66	-88.73	2.99	-804.25	13.69	0.01	64.33	0.00000	84.01	0.00000
Vancouver	0.4353	0.3760	-0.0593	14493.89	12207.75	-2854.52	198.32	-4.30	-1640.61	82.64	-1.25	33.41	0.00000	45.39	0.00000
Ottawa-Hull	0.3492	0.2305	-0.1187	9449.44	7233.40	-1874.86	161.37	-4.64	-1329.57	119.96	-3.29	16.64	0.00000	15.48	0.00000
Edmonton	0.1638	0.1380	-0.0258	4455.87	5079.11	-556.80	86.66	-6.75	-1330.68	189.13	-7.74	4.31	0.00776	7.10	0.00018
Calgary	0.2736	0.2635	-0.0101	6852.35	6430.46	-2127.08	339.69	-17.55	-1711.01	220.16	-8.39	8.03	0.00013	15.26	0.00000
Quebec	0.3046	0.3427	0.0381	13432.41	8210.15	-1949.38	4.08	6.58	-1388.52	98.48	-2.31	9.49	0.00003	19.47	0.00000
Winnipeg	0.3032	0.1861	-0.1171	6503.98	5831.50	-358.31	-83.39	6.91	-936.07	83.42	-2.39	12.18	0.00000	9.45	0.00001
Hamilton	0.3182	0.2665	-0.0517	8179.26	7252.08	-1345.42	102.06	-2.50	-1489.73	154.45	-5.10	13.53	0.00000	15.87	0.00000
Mean	0.3057	0.2573	-0.0484	10337.94	8619.70	-1372.73	83.15	-2.17	-1299.28	111.77	-3.45				

Table 2 Central Area Demographic Shifts, 1971-1996

i) Core Area Tracts*

CMA	Population		Population Density			Households**			Household Density		
	1971	1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996
Toronto	87 000	121 255	6 270	8 738	39.37%	30 930 (2.59)	59 305 (1.90)	91.74%	2 229	4 274	91.73%
Montreal	74 780	64 125	6 049	5 248	-14.25%	31 375 (2.12)	35 960 (1.70)	14.61%	2 538	2 943	15.96%
Vancouver	39 450	53 615	5 697	8 342	35.91%	21 075 (1.64)	35 675 (1.48)	69.28%	3 043	5 551	82.41%
Ottawa-Hull	48 115	39 913	6 546	5 429	-17.05%	19 100 (2.38)	22 405 (1.65)	17.30%	2 598	3 047	17.27%
Edmonton	27 790	24 057	3 653	3 163	-13.43%	13 240 (1.95)	13 665 (1.62)	3.21%	1 740	1 797	3.22%
Calgary	31 925	32 607	4 541	4 638	2.14%	15 780 (1.92)	20 380 (1.54)	29.15%	2 245	2 899	29.14%
Quebec	30 895	19 519	6 731	4 253	-36.82%	10 435 (2.55)	11 845 (1.54)	13.51%	2 274	2 581	13.52%
Winnipeg	24 255	21 367	4 646	4 090	-11.91%	9 995 (2.18)	10 975 (1.78)	9.80%	1 915	2 101	9.72%
Hamilton	44 129	39 094	7 314	6 479	-11.41%	17 005 (2.48)	20 990 (1.77)	23.43%	2 818	3 479	23.43%
Mean	45 371	46 172	5 716	5 598	-2.07%	18 771 (2.20)	25 689 (1.66)	30.23%	2 378	3 186	33.97%
Weighted Mean	n/a	n/a	5 945	6 524	9.75%	n/a (2.21)	n/a (1.69)	36.86%	2 436	3 615	48.39%

* Core Area defined by CMA Size as: 1.5 km or 2 km from CBD.
** Parentheses = Household Size
Derived from Statistics Canada Census, 1971 and 1996

ii) Inner City Tracts*

CMA	Population		Population Density			Households**			Household Density		
	1971	1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996
Toronto	855 290	767 650	7 247	6 499	-10.32%	266 170 (3.04)	328 670 (2.28)	23.48%	2 255	2 783	23.39%
Montreal	610 450	419 339	10 471	7 533	-28.06%	200 520 (2.92)	210 235 (1.93)	4.84%	3 439	3 776	9.80%
Vancouver	208 910	246 617	3 697	4 364	18.06%	73 765 (2.65)	115 060 (2.10)	55.98%	1 305	2 036	55.99%
Ottawa-Hull	100 645	77 990	6 609	5 140	-22.23%	35 755 (2.69)	40 765 (1.80)	14.01%	2 348	2 687	14.42%
Edmonton	50 675	42 587	3 840	3 227	-15.96%	21 020 (2.32)	23 505 (1.73)	11.82%	1 593	1 781	11.82%
Calgary	43 595	42 757	2 002	1 963	-1.92%	19 695 (2.13)	25 380 (1.64)	28.87%	904	1 166	28.86%
Quebec	96 600	62 354	6 352	4 100	-35.45%	29 540 (3.00)	34 310 (1.72)	16.15%	1 943	2 256	16.15%
Winnipeg	209 550	160 839	4 870	3 738	-23.24%	70 450 (2.88)	71 355 (2.19)	1.28%	1 637	1 658	1.29%
Hamilton	117 807	88 016	3 624	2 707	-25.30%	36 595 (3.24)	36 545 (2.35)	-0.14%	1 126	1 124	-0.15%
Mean	271 964	227 517	5 412	4 364	-19.38%	89 614 (2.77)	106 160 (1.97)	18.46%	1 839	2 141	16.41%
Weighted Mean	n/a	n/a	7 138	5 734	-19.66%	n/a (2.91)	n/a (2.09)	17.56%	2 303	2 665	15.71%

* Inner City Defined as Census tracts dominated by pre-1946 housing.
** Parentheses = Household Size
Derived from Statistics Canada Census, 1971 and 1996

plots in parts of the core and the rest of the inner city, as reflected in Figure 1, indicates that some tracts have experienced density increase, but the overall statistics recorded in Table 1 do attest to significantly increased centrality.

RECENTRALIZATION AND DECENTRALIZATION: POPULATION CHANGE IN THE CENTRAL CITY

We can achieve a more detailed picture of change in central parts of a metropolitan area when we look specifically at population shifts over time. Table 2 separates population change patterns in the central city into "core", defined earlier as tracts within 1.5 or 2 km of the centre of the CBD (2 km for CMAs over one million residents and 1.5 km for the remainder), and "inner city" at large (which includes the core), thereby distinguishing tracts within a reasonable walk from the CBD from those built up under pre-World War II conditions but further removed from the centre. The range of population densities manifest in core area tracts in 1996 ran from a low of 3163 persons per km^2 in Edmonton to a high of 8738 in Toronto and 8342 in Vancouver as outlined in Table 2 (i). There is some relation between core area density and CMA size, albeit with important variations. Core densities in Vancouver tally higher than those recorded for Montreal where there

has been less in the way of postwar high-rise residential redevelopment (Germain and Rose, 2000). Those in Calgary, a CMA we have described as mainly suburbanized, but with centralized employment concentrations and high overall 25-year growth rates, come close to the figure of just over 5000 persons per km^2 registered in Montreal. Meanwhile, Hamilton with 6479 persons per km^2 comes third in ranking, after Toronto and Vancouver, a feature presumably explained by the exceptionally large-scale high-rise redevelopment undertaken in this particular city in the late 1960s (Dear, Drake and Reeds, 1987; Freeman, 1976). For the CMAs examined here, across-the-board 1971-1996 rates of population growth within the urbanized perimeter, register at 38.37 % (unweighted). By contrast, the average rate of core area population growth is minus 2.07 %. The places that enjoy core population growth, Toronto and Vancouver (and Calgary with a modest core population increment of 2 %), have also enjoyed employment growth in the CBD. The incidence in central real estate markets of high density residential "infill" housing, primarily in the form of luxury condominiums, has been disproportionately important in Toronto and Vancouver (Ley, 1996; 2000).

When we turn to the inner city as a whole, absolute levels of density reflect a pattern of variance not unlike that described for the core tracts (see Table 2[ii]). It is notable, however, that Montreal's inner-city density registers 7533 persons per km^2 coming in higher than second place Toronto (6499); likewise Ottawa-Hull's inner-city density level (5140) registers higher than Vancouver's (4365). These differences, which are largely reflective of standards of space consumption prevailing at the time of a city's original growth, confound direct relationships between metropolitan size and inner-city density. As regards absolute levels of growth, one feature – decline – stands out as characteristic of inner cities in all CMAs save one. Vancouver is the only place in Canada that recorded inner-city population growth between 1971 and 1996. In all other CMAs, rates of decline in the inner city escalate well above those seen in core tracts. Quebec City and Montreal register declines at or near 30 %; Ottawa-Hull, Winnipeg and Hamilton are in the minus 25 % range. Thus, notwithstanding exceptions, Vancouver, and as regards "core" tracts, Toronto and even Calgary, the dominant picture here, as in the case of the density gradients, is primarily one of population loss which could be interpreted as evidence of decentralization.

RECENTRALIZATION AND DECENTRALIZATION: HOUSEHOLD CHANGE IN THE CENTRAL CITY

Two features are notable when we shift our focus from population to household enumeration. First, trends reverse; household numbers increase rather than decrease over time. Second, though indicative of recentralization rather than decentralization, the ranking of the nine CMAs as regards intensity of core and inner-city household change corresponds closely to that of their central-area population change.

All nine of the largest Canadian CMAs have witnessed some form of central-area household growth between 1971 and 1996, whereas only Toronto and Vancouver enjoyed population growth. Increase in the number of households in core tracts varies from highs of 91.74 % in Toronto and 69.28 % in Vancouver to lows of 9.80 % in Winnipeg and 3.01 % in Edmonton. As in the case of population,

there is less evidence of growth in the inner city at large than in the core. Rates of inner-city household growth run at a high of 55.98 % in Vancouver through 28.87 % in Calgary and 23.48 % in Toronto to lows of 1.28 % in Winnipeg and slightly below 0 % in Hamilton. In terms of ranking from growth through stability to decline, the relative order of CMAs stays much the same. Vancouver, Toronto and Calgary have witnessed greatest inner-city households and population gains, while Montreal, Quebec City and Winnipeg experience the steepest inner-city population loss and minimal levels of household gain.

We need to think about new household formation in the central city as equating with housing unit availability (with the exception of unoccupied dwellings). Seen in this light, our figures indicate that almost all CMAs examined here have witnessed production of new housing units in the core, through the erection of new buildings and conversion or "doubling-up" within existing structures. Seen from another perspective, the figures indicate an absence of active de-centralization in terms of absolute loss of housing units through demolition or abandonment in central parts of the largest Canadian CMAs. In other words, while population change projects decline, central city household shift implies growth in the number of housing units and of households inhabiting the core and inner city.

DISCUSSION: DIVERSE TRENDS TOWARDS CENTRALIZATION AND DECENTRALIZATION

As assessed in the traditional manner by population density gradients, decentralization is the order of the day. The pattern in all nine CMAs is one of much diminished distance-decay gradients in 1996 as compared to 1971 but, nonetheless, significant interrelationships between population density and distance from the CBD remain throughout. Leading the trend towards decentralization, Edmonton, and to a lesser extent Calgary, show little difference between central area and suburban densities. But, more than anything, increased variability in density between tracts at similar distances from the centre of the CBD, seen primarily as a scattering of elevated densities in suburban zones, is the order of the day. This appears to be what contributes most to the greatly reduced R^2 values. This added complexity is to a large extent reflective of new styles of development in suburban parts of our CMAs – social housing, high-rise apartment complexes, townhouses, single-family houses on small lots, multi-use nodes and "suburban downtowns" – mentioned at the outset of this paper. At this time, there is insufficient evidence (Figures 1 and 2 and Table 1) to reject the notion of uni-centrality in favour of poly or multi-centrality. There is, however, some evidence of increasing suburban density. Five CMAs, mainly the smaller ones, continue to register lower suburban densities whereas the other four CMAs post substantial gains which tally to an overall (unweighted) 1971-1996 gain across all CMAs of 1.23 %. We present Table 3 to illustrate the trend and to provide a comparative perspective on central area trends.

All CMAs, except for Vancouver, further register decentralization in terms of inner-city population and density decline. Rates of decline in Montreal and Quebec City are of sufficient magnitude to suggest that their centralized form, as captured in the distance-decay profiles, is, to a large extent residual, more the product of earlier development phases than of recent central area redevelopment. Along with

Table 3 Suburban* Area Demographic Shifts, 1971-1996

CMA	Population			Population Density			Households**			Household Density		
	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996	1971	1996	Δ1971-1996
Toronto	1 433 181	2 634 466	83.82%	2 658	2 907	9.38%	416 435 (3.41)	891 710 (2.99)	114.13%	772	984	27.42%
Montreal	1 630 875	2 061 663	26.41%	3 525	2 955	-16.18%	478 290 (3.34)	832 230 (2.44)	74.00%	1 034	1 193	15.37%
Vancouver	609 295	1 157 824	90.03%	1 698	2 229	31.28%	195 250 (3.05)	422 460 (2.71)	116.37%	544	813	49.48%
Ottawa-Hull	390 955	637 099	62.96%	1 948	2 330	19.62%	108 555 (3.55)	245 345 (2.56)	126.01%	541	897	65.90%
Edmonton	366 255	530 287	44.79%	2 386	2 163	-9.35%	105 140 (3.42)	202 875 (2.58)	92.96%	685	827	20.80%
Calgary	312 740	604 739	93.37%	2 001	1 912	-4.42%	90 095 (3.38)	224 715 (2.67)	149.42%	576	711	23.29%
Quebec	284 150	405 411	42.67%	1 871	1 816	-2.94%	74 435 (3.68)	169 890 (2.33)	128.24%	490	761	55.27%
Winnipeg	260 345	367 775	41.26%	2 140	2 064	-3.54%	75 605 (3.42)	144 920 (2.50)	91.68%	621	813	30.89%
Hamilton	278 099	408 861	47.02%	2 191	2 291	4.59%	83 565 (3.27)	156 750 (2.58)	87.58%	658	878	33.44%
Mean	618 433	978 681	59.15%	2 269	2 296	1.23%	180 819 (3.39)	365 655 (2.60)	108.93%	658	875	33.03%
Weighted Mean	n/a	n/a	58.25%	2 615	2 560	-2.07%	n/a (3.36)	n/a (2.66)	102.22%	764	956	25.13%

* Mature Suburbs and New Suburbs, Urbanized Tracts.
** Parentheses = Household Size
Derived from Statistics Canada Census, 1971 and 1996

Quebec City and Montreal, Winnipeg, Ottawa-Hull and Hamilton have also suffered a large inner-city population loss. All but Winnipeg had high historic inner-city density levels, and all but Ottawa-Hull register below average CMA growth rates. Slow growth seems to favour less costly suburban styles of development over more expensive central alternatives.

With a substantial increase of 18 %, Vancouver is the sole exception to the across-the-board trend towards inner-city population decline. Vancouver is a metropolitan area whose profile is very different from that of older, slow growth places (Lee, 1998). Vancouver has a relatively modern, low-density fabric, even in its oldest neighbourhoods (see Skaburskis, 1989) and, over the last 25 years, has enjoyed very high rates of economic and population growth, the latter fueled by huge upswings in both internal and foreign migration. This growth has greatly escalated the price of residential real estate. Partially because of this, Vancouver is renowned across Canada for its high-density residential redevelopment schemes, especially the large ones that were undertaken on former industrial and port lands. As well, since the 1970s, the Greater Vancouver Regional Authority, put in place by the Province of British Columbia, makes recommendations regarding the metropolitan area's growth (Artibise *et al.*, 1990; Ito, 1997). Though this management body has no legal jurisdictional power, it is recognized as an influential player directing suburban development towards higher density, multi-use nodes and encouraging governments to enforce strict growth limits across the metropolitan realm. We also need to recognize that, more than any other Canadian CMA, Vancouver's growth is constrained by physical limits – a restricted supply of developable land due to the nature of its site which is bordered on three sides by mountains and ocean (Hutton, 1998; Wynn and Oke, 1992).

When we narrow our focus on population change to core tracts closest to the CBD, Toronto joins Vancouver as a recentralizing CMA. Alongside the overall trends to decentralization witnessed in density-decay profiles and inner-city population losses, Toronto enjoyed a near 40 % increase in the number of people residing in core tracts over the 1971-1996 period. As in Vancouver, high density residential "infill" housing, primarily in the form of luxury condominiums, has featured prominently in Toronto's central real estate market (Ley, 1996). Again, like Vancouver, Toronto enjoys high rates of centralized white-collar employment

growth, escalating residential property values and one of Canada's most publicized programs aimed at urban intensification (Nowlan and Stewart, 1991; Tomalty, 1997). Finally, we need to recognize that Calgary, with a 2 % increase in core area population, can be considered "stable", a feature we explain in terms of its original low-density fabric and continued CBD employment growth.

If growth and stability are the exception rather than the rule in regard to central-city population change, stability, as well as significant growth, proves to be the rule as regards household change. Where core tracts are concerned, we see Winnipeg, Edmonton, Quebec City and Montreal exhibiting modest growth in the range of fifteen percent or less, with more substantial gains recorded elsewhere, culminating in an explosive 92 % increase in the number of households residing in Toronto's core tracts. In the case of the inner city as a whole, more modest rates of household increase prevail, but again, three CMAs, Vancouver, Calgary and Toronto, record elevated gain in the number of households taking up residence. Thus, new inner-city housing is being produced everywhere and, on a very significant scale, in these three metropolitan regions.

Near the outset of this paper we presented a listing of factors that contributed to change in central cities based on trends witnessed across the country. Based on findings presented here, the single-most characteristic of recentralizing cities is rapid CMA growth. Rates of population growth within the urbanized envelope come in at 48.7 % for Toronto, 71.6 % for Vancouver and 81.7 % for Calgary as compared to 35.8 % for the total population of our nine CMAs. The strong link between recentralization and CMA-wide demographic growth suggests the presence of a causal relationship between the economic performance of a metropolitan region and the status of its central area. There is therefore a connection between the evolution of the Canadian urban system and that of the central area of large Canadian cities. Contingent with rapid growth are "hot" real estate markets, characterized by higher density development patterns even in suburban parts (borne out in Table 3) and well-publicized escalation in the price of residential properties. Centralized employment growth, especially in the white-collar and advanced service sector is also characteristic of our re-centralizing places (Coffey and Drolet, 1993 and 1994). As well, both Vancouver and Toronto pursue residential intensification strategies in their central area (Tomalty, 1997). A reverse set of circumstances is characteristic of the places where decentralization figures more predominantly than recentralization. Winnipeg is, for example, the only Canadian city with significant housing abandonment in some of its central neighbourhoods. Likewise, Hamilton has been disproportionately affected by central-city employment loss as a result of de-industrialization. Space does not permit elaboration here. Further confirmation of these trends exists in the rather fragmented picture of central-city change that can be pieced together from previous research findings dealing with some or all of the nine CMAs under observation in the research reported on here (Bourne, 1987 and 1989; 1993a and 1993b; Broadway, 1992 and 1995; Ley, 1988, 1996 and 2000).

An important implication of this work pertains to the uneven attraction of urban centralization among different household types. The discrepancy between population and household trends and the known concentration of small households within central districts suggest that there is a specialized attraction to central areas

in the contemporary Canadian city. As amply demonstrated by the literature on gentrification, central-area housing is a niche market. The majority of Canadian households, especially larger and younger ones with strong orientation to a family lifestyle, are satisfied with, indeed attached to, living and carrying out most of their activities within suburban areas. For them, central-city living has either little appeal or is not worth the additional cost. But, what is important here is that central residential location remains attractive to some members of the population – those generally characterized by their small household size – a group, it also bears mention, that constitutes one of the fastest growing sectors in contemporary Canadian society.

There are two methodological issues raised by the research presented here. One concerns the merit of the distance-decay model in the face of overall metropolitan decentralization trends. The other relates to the unit of measurement itself – households or individuals. The question as to which measure is best suited to index centrality, household or population counts, is a moot one since both are useful and tell us different things. If we are interested in transportation demand, or demand for retail, personal and other services, population numbers are undoubtedly most critical, whereas housing units and residential real estate demand and costs are directly tied to household units rather than population per se. Residential tax returns are also levied against households as consumers of housing units. The important point that this paper makes, one which has been lacking in previous research, is that we get a different picture of centrality when we examine household rather than population enumerations. This picture is one of continued trends towards centralization and of continued demand for central residential property. Centrality cannot therefore be dismissed as a waning force in Canadian metropolitan development.

The final issue that needs to be addressed briefly by way of conclusion relates to the continued utility of distance-decay models in the face of overriding trends to decentralization. We come in strongly in favour of their continued use on two counts. First, they constitute perhaps the only consistent measuring stick that can be applied comparatively over time and across space. In and of itself, the extent to which their applicability weakens over time is an important piece of information for researchers who are interested in patterns of change and transition in urban form. Second, permutations of this model represent important vehicles that better inform us about the nature of ongoing change. We see this on the statistical side of things when more complex formulations such as the cubic polynomial are substituted for simpler models. A largely serendipitous finding of this investigation is that, as compared to population counts, household enumeration produces a different and highly informative perspective on urban change. The next step then clearly calls for a revamped distance-decay modeling exercise that includes households alongside populations as the unit to which statistical curve-fitting is applied.

CONCLUSIONS

The answer to the question raised by this paper – whether large Canadian cities are centralizing or decentralizing – is an ambiguous yes and no, or both, as regards the two trends because in most cities both processes are operating at the same time.

The findings relating to household location lead us to conclude that the central zones of most large Canadian cities continue to attract newly-formed or re-locating households. This picture is very different from the one presented by our other two measures, density gradients and population enumeration, where decentralization predominates and where we conclude that the suburbs must be deemed to be the most attractive place to live by the majority of Canadian urbanities. The main trend which presently characterizes the Canadian CMAs that we have examined is the growing importance of the suburban realm at the expense of the inner-city and core areas and the waning influence of the CBD on metropolitan-wide built form. This said, there are important counter trends in some places, notably Vancouver and Toronto. Moreover, the evidence as regards household shift, as opposed to population shift is different, indicating that even though absolute numbers of individuals residing in central parts of Canadian metropolitan areas are down, the number of housing units has grown as has the number of households who seek to locate there. This is perhaps the most remarkable of findings presented in this paper and deserves further study.

NOTES

1 This is discounting, of course, the many costs of greenfield development that are either hidden or directly absorbed by the state (see, for example, Blais, 1996; Greater Toronto Area Task Force, 1996). In the central city, land itself usually costs more because there is less of it and because land acquisition is more cumbersome and time-consuming due to highly fragmented land ownership configuration. There is also more "red tape" and the very real possibility of costly legal battles if close-by property-owners object to change (the all-pervasive NIMBY syndrome). Demolition adds to the cost of redevelopment and even construction activity is more expensive when it occurs amidst functioning neighbourhoods or business districts and on irregular lots common in older sectors.

2 Gross densities have traditionally been used in this type of analysis for simple reasons of data availability. If net density statistics were readily available they would show reduced census tract variability along distance decay curves. We would expect, however, differences in the average density of historical zones of urbanization to remain relatively constant whether gross or net density is used. This expectation also pertains to differences in trends over time.

3 The census tract is advantageous as the choice of spatial unit because of the availability of data aggregated at this level. It does, however, offer some problems for temporal comparisons of regression models because boundaries are occasionally shifted from census to census. However, because we are trying to compare cities' development on the basis of their built up areas, which have grown substantially in all cities over this 25 year time period, assertions as to the change in regression models over time already must be interpreted more as speculation than rigorous statistical fact. Given this, it would seem that the issues of sensitivity to shifting tract boundaries and splitting census tracts, while certainly consequential, do little to compound the already low level of statistical reliability.

4 In older areas that have experienced more recent redevelopment, such as a downtown location in which a new apartment has been constructed, the spatial form that remains is most always one oriented toward pedestrian and public transit. For this reason, tracts with newer housing that are located within the pre-1946 perimeter are also included in our definition of "inner city".

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