Article

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The Location of High Knowledge Content Activities in the Canadian Urban System, 1971-1991

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Abstract

It is widely recognized that certain activities have a higher capacity than others to promote economic growth and development. Many of these more dynamic activities are often said to involve "high technology". In this paper we first question the conceptual and operational utility of the notion "high technology". We then propose a more straightforward and more easily measured concept — "high knowledge content" —, demonstrating that activities of this nature may be found in "low tech" sectors. By means of an empirical analysis, we then attempt to contribute to a better understanding of the locational dynamics of high knowledge content activities within the Canadian urban system over the period 1971-1991. Specifically, we seek to determine if this class of activities is becoming spatially more concentrated or more dispersed across the urban system. The answer to this question is particularly important for smaller communities in peripheral regions whose economic bases are highly dependent upon "low tech" activities.

Key Words: **high technology, high knowledge content, Canadian urban system, spatial concentration.**

Résumé

La localisation d'activités à contenu élevé en connaissances dans le système urbain canadien, 1971-1991

Parmi les activités les plus dynamiques au plan de la croissance économique et du développement, plusieurs sont associées à ce qui est communément appelé la «haute technologie». Dans cet article, nous remettons d'abord en question le concept de «haute technologie» pour lui préférer celui de «niveau élevé en connaissances», un concept moins ambigu, plus facile à opérationnaliser et, surtout, qui témoigne du fait que de telles activités peuvent avoir lieu dans des secteurs économiques reconnus comme traditionnels. Ensuite, grâce à une analyse empirique, nous examinons la localisation des activités à contenu élevé en connaissances dans le système urbain canadien au cours de la période 1971-1991. Plus particulièrement, nous voulons déterminer si ce type d'activité tend à se concentrer ou à se disperser dans le système urbain, question particulièrement importante dans le cas de petites communautés situées en régions périphériques et dont l'essentiel de l'activité économique s'appuie sur des secteurs traditionnels.

Mots-clés: **haute technologie, contenu élevé en connaissances, système urbain canadien, concentration spatiale.**

INTRODUCTION

More than ever before, high technology activities have come to be widely recognized as a major source of economic development. In hope of promoting the expansion of these activities and, concurrently, the development prospects of regions often in the grip of economic problems, various policies and strategies have been formulated, and considerable public and private resources have been made available. The footloose nature that is often attributed to high technology activities — since they generally are not associated with the market and natural resource based locational constraints that have historically characterized traditional (or so-called "low-tech") manufacturing activities — may indeed render them, at least in theory, a more likely development alternative for peripheral regions. In reality, however, many high technology activities remain highly attracted to large metropolitan centres with their agglomeration and urbanization economies (Coffey, 1990).

While numerous case studies of specific high technology activities have been undertaken, a comprehensive body of theoretical work on the location of these activities has yet to be developed. The case studies have yielded, at best, lists of locational factors, the validity of which are often criticized.[1] In general, however, a review of the literature suggests the existence of two contradictory locational trends: a tendency towards geographical concentration, particularly in those cases where new technologies are being developed and in the growth phase of the product life-cycle; and a tendency towards geographical decentralisation, largely among those activities that are characterized by a standardization of the production process. Within an industrial ensemble, the relative influence of these two contradictory trends remains to be completely elucidated (Scott and Storper, 1987).

In the present paper, we first question the operational utility of the notion "high technology", suggesting a more straightforward and more easily measured concept: "high knowledge content" activities. We then attempt to contribute to a better understanding of the locational dynamics of the latter class of activities; in particular, we seek to determine if they are becoming spatially more concentrated or more dispersed across the urban system. The following section examines the concept of high technology activities and identifies certain problems associated with its use. In section 3, we argue that the use of "high knowledge content" is in many ways more conceptually and operationaly satisfactory than the notion of "high technology". Next, we present the nature of our data and define our spatial frame of reference: the Canadian urban system. Section 5 then traces the evolution of the spatial distribution of high knowledge content activities in the Canadian urban system over the period 1971-1991.

THE HIGH TECHNOLOGY CONCEPT

In spite of the important role that high technology activities are considered to play in economic development, and in spite of the large volume of literature that has appeared on this issue in the latter half of the 1980s, there still exists no consensus as to the definition of either "high technology" or a "high technology activity". Castells (1985: 11-12) suggestion that high technology is not "a particular technique,

but a form of production and organization that can affect all spheres of activity by transforming their operation in order to achieve greater productivity or better performance, through increased knowledge of the process itself" appears quite accurate but is not operationalizable for empirical research.

Thus, in general, industrial sectors are considered to qualify as being "high technology" if they meet certain criteria, ranging from the very subjective (e.g., personal definition by an author, general reputation of an economic sector) to the more objective (rate of growth of employment, output or sales; level of R&D expenditures, perhaps as a percentage of sales; percentage of skilled personnel, and so forth). An alternative approach involves estimating the degree of research and conception functions associated with economic activities using information on occupational structure. This method has been used by Coffey and Polèse (1987) in order to identify, in the Canadian context, the office machine, telecommunications, pharmaceutical and medical equipment sectors as high technology *manufacturing* activities, as well as computer services, scientific and engineering services, and management consulting services as high technology *service* activities. In the United States, the list of high technology sectors is generally comparable (Malecki, 1984).

The range of criteria employed does little to contribute to the formulation of a clear definition of high technology activities. Further, in spite of certain advantages, the quality of many of these criteria leaves much to be desired. For example, certain traditional (i.e. "low tech") manufacturing sectors have displayed employment, output and sales growth rates that are superior to those experienced by those sectors that are generally classed as being "high technology" (Aydalot and Keeble, 1988). In addition, all of the activities within a sector classed as "high technology" are not necessarily equal in terms of their use or their production of high technology; for example, certain firms may be very involved in R&D activity, but do not bring high technology products to the marketplace (Malecki, 1984). A similar criticism may be leveled at indicators that involve the percentage of revenues devoted to R&D or those that involve the percentage of skilled workers. These criteria are especially inadequate in the case of industries which have attained the mature phase of their product life-cycles (Boisvert, 1992), or in the case of those industries having very high sales volumes (Aydalot and Keeble, 1988). Finally, even if it represents a useful method for comparing industrial sectors, the proportion of skilled workers in an industry is not a straightforward measure of the extent to which that industry may be characterized as "high technology" (Aydalot and Keeble, 1988).

The practical problems associated with the use of the concept "high technology" are thus numerous, and all emanate from the issue of definition: to classify an activity as high technology on the basis of an indicator, whatever its strengths may be, does not constitute a definition. Rather, from a theoretical/conceptual perspective, "high technology activities" should be defined according to the intrinsic characteristics of high technology itself (Delaplace, 1993). Indeed, it is most unlikely that one criterion could suffice to identify such a complex activity. Thus, the use of converging partial indicators (Martin and Irvine, 1983) may represent the most useful type of approach towards defining this type of activity.

As a result of the failure to arrive at a suitable definition of the concept, the notion of "high technology" has come to be employed in widely varying and often inappropriate contexts, while being overlooked in other, more relevant, ones. For example, due to the connotations of the word "technology", the concept tends to be more generously applied to industrial sectors than to service activities. In addition, the concept is also highly inadequate with respect to the distinction that should be made between the producer and the user of technology. For example, the fabrication of "high technology" products (e.g., computers) is often accomplished in the context of fairly "low tech" production processes; conversely, in certain traditional ("low tech") manufacturing sectors, such as clothing and textiles, the conception and the fabrication of products are in large measure assured by high technology equipment and processes. In sum, researchers have tended to make an excessive use of a global concept while, because of operational constraints, they are generally only examining one of its numerous aspects. Evidently, this situation limits the validity of studies on high technology, most of which oversimplify the complex phenomenon they refer to — innovation, whether concerning products or processes.

FROM HIGH TECHNOLOGY ACTIVITIES TO HIGH KNOWLEDGE CONTENT ACTIVITIES

Given the conceptual ambiguity and the operational difficulties inherent to the concept of "high technology", and given the fact that these difficulties appear to be intractable, we believe that it would be more useful to favour a concept that is both more easily defined, clearer to interpret and less ambiguous. In other words, we prefer using a concept that refers to a more restrained, more readily identifiable phenomenon, rather than one that is broader and is characterized by ambiguity. As indicated briefly in the previous sections, our candidate for a more precise concept is that of "high knowledge content" (Coffey and Polèse, 1987). Specifically relating to the level of knowledge associated with an economic activity,[2] this term succeeds in capturing certain attributes that, in a rather ambiguous manner, are at the root of the "high technology" concept — namely economic functions that are rich in information, characterized by innovation, and involve a high degree of R&D — while eliminating any bias relating to the characteristics of innovative products and services. In such a perspective, this concept emphasizes a particular way of producing rather than a product type (Planque, 1985), which is in accordance with recent work on innovation (Kline et Rosenberg, 1986).

Ideally, high knowledge content activities are defined by a greater input of technological, commercial or administrative capabilities than those that are generally involved in production processes (Trépanier and Bataïni, 1996; Bataïni, Martineau and Trépanier, 1997), rather than corresponding to certain occupational categories, regardless of the nature of their associated tasks.[3] Thus, operationally, the notion of "high knowledge content" is best suited to a micro-analytical scale or a case study approach. At other analytical scales, however, high knowledge content activities are most logically defined in terms of their occupational composition, which makes the concept much easier for a researcher to operationalize, since data on occupational structure are widely available at a variety of spatial scales. Unlike

numerous high technology indicators, our use of the high knowledge content concept is not meant to introduce a threshold that enables one to class certain economic sectors as being more "high-tech" than others. This reflects the fact that high knowledge content activities are sometimes present in even the most "low-tech" economic sectors (see section 4.3).

In the present paper, two major groups of occupations are involved:

1. Managerial & administrative occupations (directors, managers and administrators);[4]

2. Scientific & engineering occupations (personnel in the natural and social sciences, engineering and mathematics).[5]

While these two occupational groups may be viewed as dissimilar from a certain perspective (e.g., managers vs. "doers"), there are two major points of commonality. First, they are both characterized by relatively similar levels of educational qualifications — a university diploma is generally a prerequisite (Coffey *et al.*, 1987). Second, the major function of the personnel in each group is to obtain, to process, and to interpret information; knowledge is the "raw material" upon which "production" is based. In this respect, the two groups coincide with Reich's (1992) notion of "symbolic analytic" activities involving problem-solving, problem-identifying and strategic-brokering functions:

> Symbolic analysts solve, identify and broker problems by manipulating symbols. They simplify reality into abstract images that can be rearranged, juggled, experimented with, communicated to other specialists, and then, eventually, transformed back into reality. The manipulations are done with analytical tools, sharpened by experience. The tools may be mathematical algorithms, legal arguments, financial gimmicks, scientific principles, psychological insights about how to persuade or to amuse, systems of deduction or induction, or any other set of techniques for doing conceptual puzzles.
>
> Some of these manipulations reveal how to more efficiently deploy resources or shift financial assets, or otherwise save time and energy. Other manipulations yield new inventions — technological marvels, innovative legal arguments, new advertising ploys for convincing people that certain amusements have become life necessities...
>
> When not conversing with their teammates, symbolic analysts sit before computer terminals — examining words and numbers, moving them, altering them, trying out new words and numbers, formulating and testing hypotheses, designing or strategizing... Periodically, they issue reports, plans, designs, drafts, memoranda, layouts, renderings, scripts, or projections... Final production is often the easiest part. The bulk of time and cost (and, thus, real value) comes in conceptualizing the problem, devising a solution, and planning its execution (Reich, 1992: 178-9).

A useful comparison of the "high technology" and "high knowledge content" concepts can be made using table 1, which lists several economic sectors that are generally considered to be "high technology" in nature, along with a "classic" "high tech" indicator: intra-mural R&D expenditures as a percentage of company sales, a measure often referred to as "research intensity" (Britton, 1987); table 1 also presents measures of the degree to which these sectors qualify as "high

Table 1 "High technology" economic sectors, Canada, 1991

Economic sector	High tech		High knowledge content					
	Current intra-mural R-D expenditures		Managerial & Administrative		Science & Engineering		Man. & Admin. + Sci. & Eng.	
	as % of co. sales*	Rank (45 sectors)	% employ.	Rank (159 sectors)	% employ.	Rank (159 sectors)	% employ.	Rank (159 sectors)
Telecommunication equipment	22.1	2	14.7	25	27.1	11	41.8	13
Engineering & sci. services	18.7	3	11.6	50	62.7	2	74.3	2
Aircraft and parts	13.0	6	10.6	59	18.5	18	29.1	28
Pharmaceuticals and medicine	5.3	10	17.8	14	14.2	28	32.0	23
Business machines	3.1	13	17.1	15	29.6	8	46.7	8
Scientific & profess. equipment	2.7	17	10.8	56	12.1	37	22.9	48
Other electronic equipment	1.2	26**	12.8	35	10.8	41	23.6	45

* *Source*: Statistics Canada, *Industrical Research and Development*. Catalog n° 88-202, p. 63.

** Tied with construction, electrical power, and wholesale trade.

knowledge content" activities.[6] First of all, there is a significant difference in the position of the sectors according to whether research intensity or the percentage of high knowledge content occupations is employed. The second most R&D-intensive sector, telecommunication equipment, ranks only 13th out of 159 individual economic sectors in terms of the combined percentage of managerial & administrative and scientific & engineering workers. Indeed, barely over one-quarter (27.1) of the workers in this sector are characterized by occupations involving science & engineering functions. Other generally accepted "high tech" sectors, such as aircraft and aircraft parts, pharmaceuticals and medicine, scientific and professional equipment, and other electronic equipment are situated considerably further down the "high knowledge content" hierarchy. Interestingly, it is a service activity — engineering & scientific services — rather than a manufacturing activity that performs best in terms of both the high knowledge content (2nd out of 159 sectors, behind offices of architects) and research intensity (3rd, after telecommunication equipment) indicators. In sum, table 1 shows that the generally accepted "high technology" sectors are not necessarily as "high tech" (whatever that means) as conventional wisdom would suggest. It also illustrates the validity problem referred to earlier: the identified high technology sectors change depending on the way the concept is operationalized. In that sense, it appears to us that the decomposition of the phenomenon and the examination of its elements may be a better way to bring to light all the mechanisms involved in order to eventually develop a valuable analysis tool. Despite its shortcomings, our paper is a contribution in that direction.

DATA AND DEFINITIONS

This section provides some basic information concerning the concepts and the data employed in the present study. We begin by presenting a definition of the Canadian urban system, then examines the sources and nature of the data that form the basis of the empirical analyses undertaken in the remainder of the paper.

THE CANADIAN URBAN SYSTEM

In the present context, the term "Canadian urban system" refers to a set of 152 urban areas, each having a population of at least 10 thousand inhabitants in 1991 (figures 1 and 2).[7] This set of places includes three types of statistical units:

1. 25 census metropolitan areas (CMAs), ranging in size from Toronto (3.9 million) to Thunder Bay (124 thousand). A CMA consists of a "core" city having a population of at least 100 thousand, plus surrounding individual municipalities that are characterized by "a high degree of social and economic integration with the core city". For example, the Montréal CMA contains the City of Montréal (with approximately 1 million inhabitants), plus a contiguous region containing 101 other municipalities. Together, the 25 CMAs include 16.7 million people, representing 61 percent of the population of Canada (and 78.8 percent of the population of the Canadian urban system) in 1991.

Figure 1 The Canadian urban system: an overview

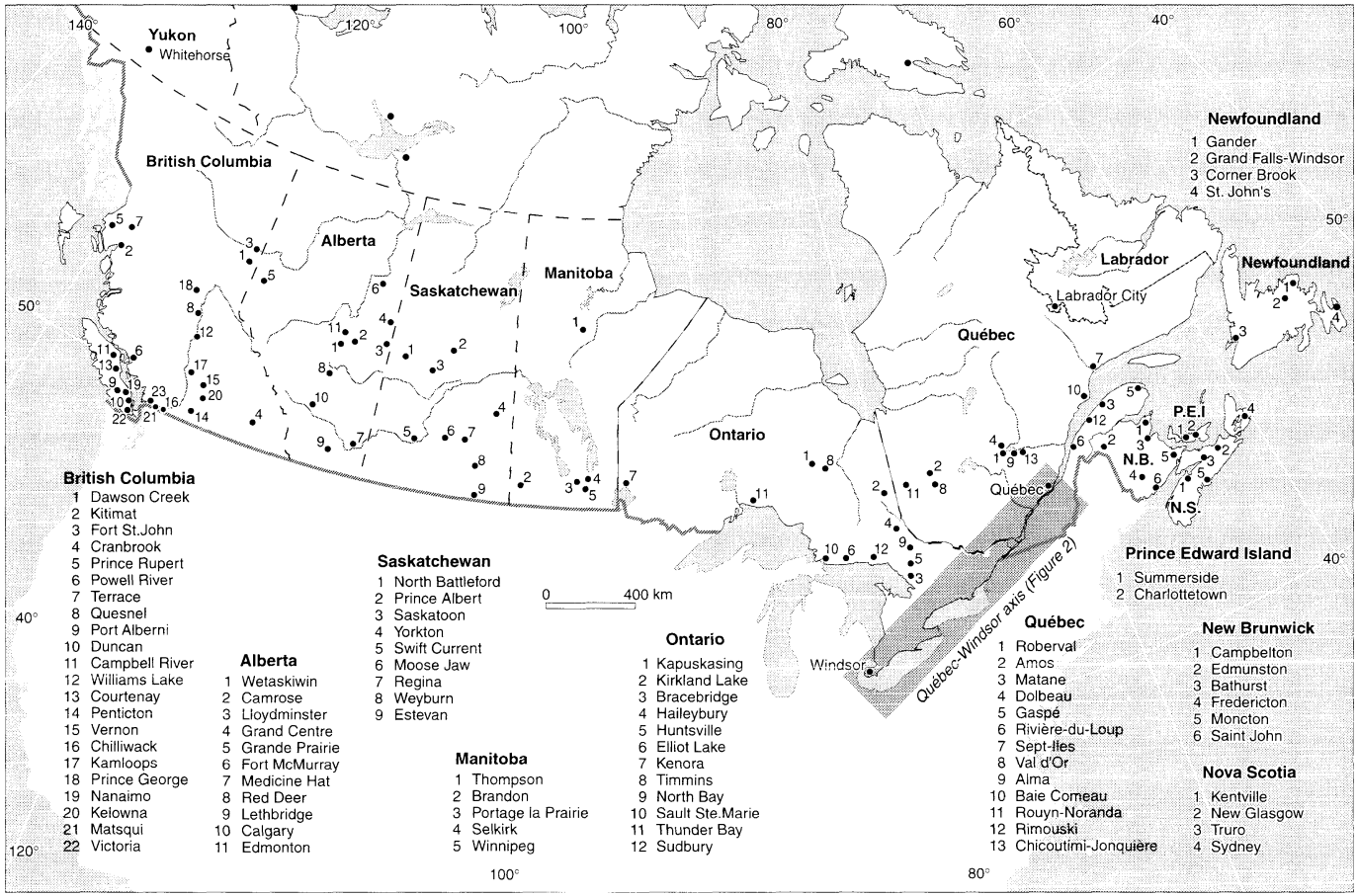
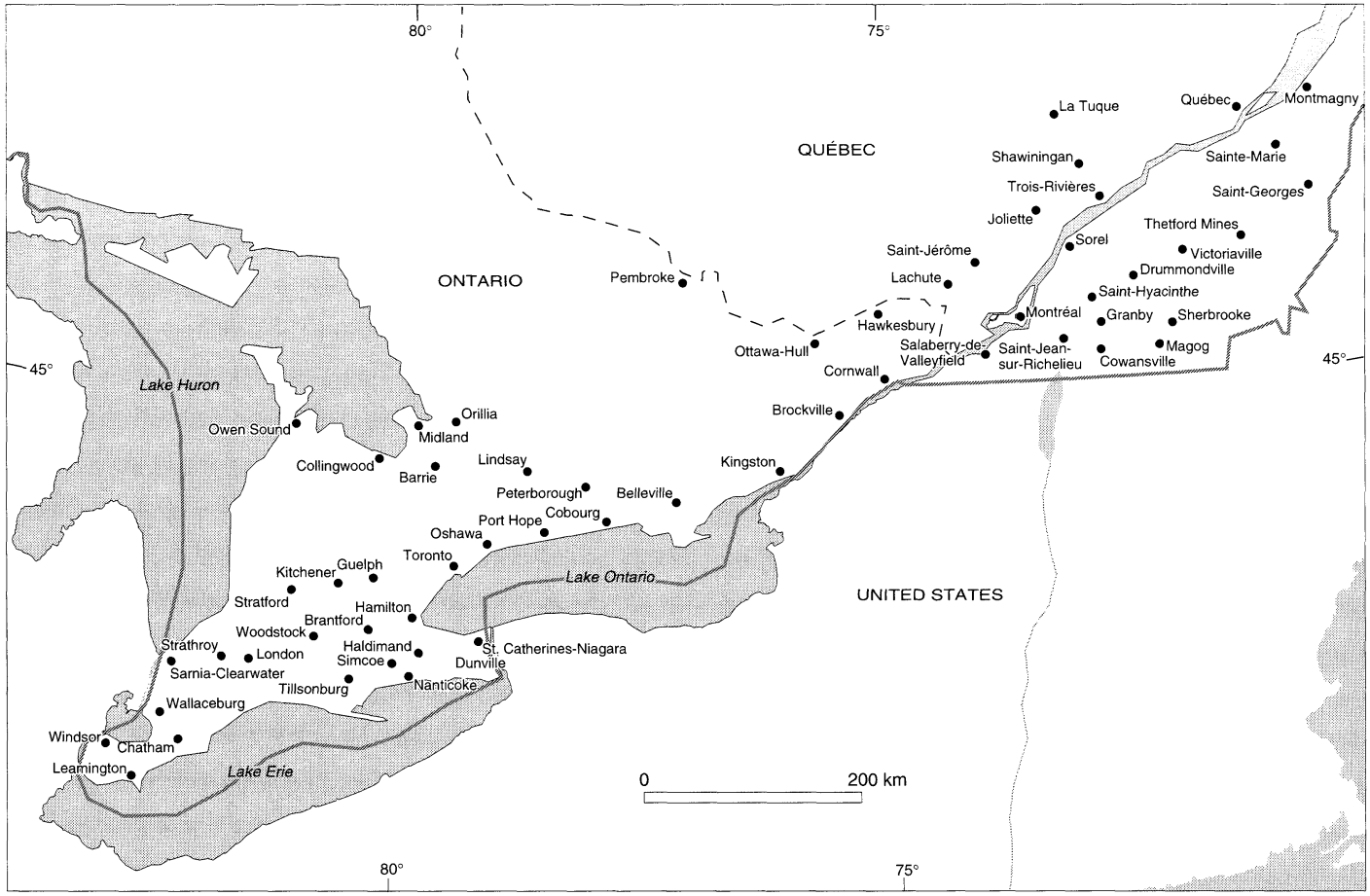


Figure 2 The Canadian urban system: the Windsor-Québec axis



2. 115 census agglomerations (CAs), ranging in size from Kingston, Ontario (136.4 thousand inhabitants) to Weyburn, Saskatchewan (9.7 thousand).[8] CAs are defined using principles similar to that of CMAs; they consist of a smaller "core" municipality (with a population of at least 10 thousand, but less than 100 thousand), plus surrounding individual municipalities that have "a high degree of social and economic integration with the core city". The Brantford (Ontario) CA, for example, includes the City of Brantford (76.1 thousand), plus Brantford Township (6.3 thousand) and the Town of Paris (8.1 thousand); thus, the Brantford CA has a total population of 90.5 thousand. The 115 CAs account for 4.4 million inhabitants, representing 15.8 percent of the national population and 20.3 percent of the urban system population.

3. 12 census sub-divisions (CSDs) with populations of at least 10 thousand inhabitants. The CSDs are individual municipalities, and range in size from Nanticoke, Ontario (22.7 thousand inhabitants) to Kapuskasing, Ontario (10.3 thousand). Together, the 12 CSDs contain a population of 167.8 thousand, which is only 0.6 percent of Canada's population and 0.8 percent of that of the urban system.

Thus, in 1991, the urban system contained 21.2 million inhabitants, representing 77.4 percent of the Canadian population. The urban system therefore includes a major portion of the national population, and many observations concerning this set of places may be more generally applied to the nation as a whole. Appendix 1 lists the 152 elements of the Canadian urban system, while Maps 1A and 1B indicate the geographic locations of these urban units.

DATA SOURCES

The analyses presented here utilize *employment by place of residence* data, collected by the 1971, 1981 and 1991 Censuses of Canada. The basic concept underlying these data is that of the "employed labour force": those persons who held a remunerated job during the week immediately preceding Census Day (on or near June 1st) of the relevant year. These data have been standardized to control for both changes in sectorial definitions and modifications in the boundaries of spatial units that may have occurred between the 1971 and 1991 Censuses.

SECTORIAL AND OCCUPATIONAL CLASSIFICATION

The concept of "economic sector" (utilized in table 1, above, only) is conventionally utilized to sub-divide an economy into relatively homogeneous groups of activities. Individual *firms*, and thus their employees, are assigned to economic sectors on the basis of the "finished product" that results from each firm's activity. Thus, an individual *establishment* (and its employees) within a mining or a manufacturing firm — a head office or a research laboratory, for example — will be classified, along with the rest of the firm (and the rest of the firm's employees), in the primary or manufacturing sector, even though the establishment itself (and its employees) may, in reality, be more correctly regarded as fulfilling a high-order service function. For this reason, when describing the structure of an economy, the

use of sector alone may prove to be somewhat misleading; service-related functions or occupations (see below) within "goods-producing" firms, in particular, tend to be underestimated by sectorial classifications.

A complementary manner of categorizing the employed labour force is in terms of *occupation*, rather than economic sector. Occupation refers to "the kind of work performed" (i.e., the duties and tasks carried out) by a person, irrespective of the kind of business (and thus the economic sector) in which this work is accomplished and of the status of the individual performing it. The major portion of the analyses presented in this paper utilize a simple typology based upon six occupational categories that have been aggregated from 22 major occupational groups. table 2 indicates the six occupational categories employed here.

Our database consists of a cross-tabulation of 159 economic sectors by six occupational categories for each of the 152 elements of the Canadian urban system. Note that, in order to ensure comparability between the 1971, 1981 and 1991 Census data, all data have been classified using the 1970 Standard Industrial Classification (SIC) and the 1971 Occupational Classification, rather than the more recent versions of these typologies (1980 and 1981, respectively).

EMPIRICAL ANALYSIS

Our empirical analysis begins with a broad overview of changes in the occupational structure of the Canadian urban system over the period 1971-1991. We then examine the issue of the location of high knowledge content (hereafter referred to as HKC) activities in considerably more detail.

OVERVIEW

Table 2 presents an overview of the growth in HKC activities within the Canadian urban system over the period 1971-1991 and, more generally, an overview of changes in occupational structure over the period. This table indicates: 1) the percentage distribution of employment across occupations; 2) growth rates; and 3) the corresponding numbers of employed workers involved in 1) and 2). The most striking features of this table is the very rapid growth of the two HKC groups, both individually and collectively, from 1971 to 1991. With growth rates of 174.4 and 172.1 percent, respectively, the managerial & administrative (hereafter referred to as M&A) and science & engineering (hereafter referred to as S&E) groups increased much more rapidly than all other occupational categories. Note, however, that of the two groups, the M&A activities grew more rapidly during the 1970s (115.1 vs. 84.9 percent), while the S&E activities grew more rapidly during the 1980s (47.1 vs. 27.6 percent); indeed, the performance of the M&A group during this latter period is not significantly higher than the sales & service category (26.7 percent), and is actually lower than the education & health group (31.5 percent). Note also that, in terms of relative weight within the economy, HKC activities increased from 10.5 percent of all employment in 1971 to 16.8 percent in 1991. Over the period 1971-1991, 1.03 million HKC jobs were added within the urban system (of which 55 percent in the M&A category and 45 percent in the S&E group), representing 25.8 percent of total employment growth.

Table 2 Occupational structure, Canadian urban system, 1971-1991

Occupation	1971 (000)	1971 %	1981 (000)	1981 %	1991 (000)	1991 %	1971-1981 absolute growth (000)	1971-1981 growth rate %	1981-1991 absolute growth (000)	1981-1991 growth rate %	1971-1991 absolute growth (000)	1971-1991 growth rate %
Managerial & Administrative	323.3	5.7	695.3	8.3	887.0	9.2	372.0	115.1	191.7	27.6	563.7	174.4
Science & Engineering	268.3	4.8	496.1	5.9	729.8	7.6	227.8	84.9	233.7	47.1	461.6	172.1
SUB-TOTAL: HIGH KN. CONT.	591.6	10.5	1191.4	14.2	1616.8	16.8	599.8	101.4	425.5	35.7	1025.3	173.3
Education & Health	620.2	11.0	942.2	11.3	1239.4	12.9	322.1	51.9	297.2	31.5	619.2	99.8
Clerical & Related	1153.5	20.5	1774.0	21.2	1947.5	20.3	620.4	53.8	173.6	9.8	794.0	68.8
Sales & Service	1370.1	24.3	1926.0	23.0	2440.2	25.4	555.9	40.6	514.2	26.7	1070.1	78.1
SUB-TOTAL: GREY COLLARD	2523.6	44.8	3700.0	44.2	4387.7	45.7	1176.3	46.6	687.8	18.6	1864.1	73.9
Blue Collar	1892.0	33.6	2539.1	30.3	2357.5	24.6	647.1	34.2	-181.6	-7.2	465.6	24.6
TOTAL	5627.3	100.0	8372.7	100.0	9601.5	100.0	2745.3	48.8	1228.8	14.7	3974.2	70.6

More generally, table 2 indicates that the period was characterized by a *relative* (but not absolute) shift of employment out of blue collar occupations (a decline of 9 percentage points, from 33.6 percent of the employed labour force in 1971 to 24.6 percent in 1991) into white collar occupations (HKC activities plus education & health), which increased by 8.2 percentage points, from 21.5 to 29.7.[9] Note, too, that growth rates for all occupational categories were significantly lower in the 1980s than in the 1970s, reflecting worldwide economic conditions.

LOCATIONAL ISSUES

Employment Growth Rates and Absolute Change

An analysis (not shown), for each decade of the study period, of those urban areas characterized by the highest and the lowest growth rates of HKC activities, yields several identifiable trends. First, in the 1970s, the most striking feature of the analysis is the regional distribution of both high and low growth urban areas. With the exception of Ste-Marie, Québec, all of the high growth areas are located in Alberta and British Columbia, as well as in the Yukon (Whitehorse) and in the Northwest Territories (Yellowknife). On the other hand, with the exception of Kitimat (B.C.), Swift Current (Sask.), and Thompson (Man.), all of the slow growth areas are located in Ontario and Québec. This spatial division is an accurate reflection of the regional dynamics of the period, characterized by a resource "boom" in the West and a relative decline in the East. A second striking feature of the 1970s is the relative absence of metropolitan areas and other large agglomerations in the case of both high growth and low growth areas. Only three census metropolitan areas (CMA) appear: Calgary (Alta.) as a high growth unit, and Windsor (Ont.) and Sudbury (Ont.) as low growth units. The other high growth urban areas tend to be small, resource-based cities, while the other low growth areas tend to be small cities with an economic base of traditional manufacturing. Thus, even the highest growth rates generally involve relatively modest levels of absolute HKC employment growth. After Calgary (47.4 thousand), the next highest positive change involves Kelowna (B.C.) with a growth of only 2.6 thousand jobs.

In the 1980s, the trends involving regional distribution, although now to a somewhat lesser extent, and small size, to a somewhat greater extent, again appear. With the exception of Yellowknife (N.W.T.), Matsqui (B.C.) and Grand Centre (Alta.), three hold-overs from the 1970s, the high growth urban areas are now all traditional manufacturing centres located in Ontario and Québec. On the other hand, the regional distribution of the low growth areas is somewhat less clear: 7 cities in Québec and Ontario, 5 in Saskatchewan, and 1 each in Newfoundland, Manitoba and British Columbia; almost without exception, these are resource-based communities. Note that in the 1980s, low growth rates are actually negative for all 15 urban areas. Turning to urban size, Oshawa (Ont.), with a population of 240 thousand is the only CMA to appear as either a high or low growth area. Among the low growth units, the largest city is Prince Albert (Sask.), with a population of only 41 thousand. Thus, once again, it is smaller places that tend to experience the most extreme *rates* of change.

An interesting counterpoint to the above analysis is one which indicates the urban areas experiencing the highest and lowest levels of *absolute change* in HKC employment. In terms of those urban areas experiencing the highest levels of absolute employment change, the list for each decade fairly well resembles a list of the largest CMAs, ordered by descending population size. Minor exceptions do occur, however. For example, Windsor (Ont.), the 15th largest CMA in 1991, appears in neither decade. Nor do St. Catharines (11th) or Oshawa (16th) in the 1970s. In addition, in neither decade is the population size ordering perfectly respected. For example, Winnipeg, the 7th largest CMA, appears in the 13th position in the 1980s. In general, however, there does appear to be a direct correspondence between population size and absolute level of employment change.

This is not the case, however, for those urban areas characterized by the lowest absolute levels of change, where the low growth places are much less concentrated near the bottom of the urban hierarchy. In the 1970s, the list of low growth places generally includes the lower quintile of the urban hierarchy; the largest place listed is Coburg (Ont.), ranking as the 36th smallest urban area on the basis of its population of 15 thousand. In the 1980s, however, the list of places is much more dispersed throughout the urban hierarchy, and includes the 111th smallest (i.e., the 42nd largest), 89th smallest (i.e., 64th largest) and 87th smallest (i.e., 66th largest) urban areas: Kamloops (B.C.), population 68 thousand; Prince Albert (Sask.), population 41 thousand; and Salaberry-de-Valleyfield (Que.), population 40 thousand, respectively. Thus, low absolute employment growth is not simply a function of a small population base.

Specialization and Spatial Concentration

A useful and frequently employed indicator of sectoral or occupational specialization is the *location quotient*. The location quotient compares the spatial concentration of employment *in a given category* (here the HKC category and its two components) and in a given spatial unit (here, each of the individual elements of the Canadian urban system) to that sector's level of concentration in a "benchmark" spatial unit — in this case the entire Canadian economy. Thus, a category having the same level of concentration in a given urban unit as in the national economy will have a value of 100. Values below 100 indicate a lower degree of specialization than in the national system, while those above 100 indicate a higher degree of specialization.[10]

Table 3 identifies the urban areas that are the most specialized and the least specialized in the HKC category and its two components. In 1991, ten urban areas have HKC employment that is more than 10 percent (e.g., location quotient ≥ 110) more specialized than the national system; seven of the group are CMAs. The three remaining urban areas — Whitehorse, Yellowknife, and Fredericton — are provincial/territorial administrative centres. On the other hand, ten smaller, resource or traditional manufacturing centres display location quotients that are less than 55 (i.e., their level of specialization is at least 45 percent less than the national average).

In the case of the M&A sub-set, 11 urban areas (the same set as above plus Halifax, also a CMA) are characterized by levels of specialization that exceed the

Table 3 Most specialized and least specialized urban areas: High knowledge content activities, Canadian urban system, 1991

Urban area	location quotient 1991	change 1991-1971	Urban area	location quotient 1991	change 1991-1971
High knowledge content activities (total of Man. & Admin. and Sci. & Eng.)					
Most specialized: LQ ≥ 110			**Least specialized: LQ < 55**		
Yellowknife	180	16	Port Alberni	53	6
Ottawa-Hull	168	-20	Powell River	53	2
Whitehorse	151	54	Leamington	52	6
Calgary	137	-9	Courtenay	51	8
Toronto	134	6	Dunnville	51	-5
Fredericton	133	-8	Montmagny	50	-19
Québec	131	1	Chilliwack	49	-5
Montréal	116	-12	Campbellton	48	-2
Regina	116	-8	Wallaceburg	46	-13
St. John's	114	5	Labrador City	44	-23
Managerial & Administrative					
Most specialized: LQ > 110			**Least specialized: LQ < 50**		
Yellowknife	205	50	La Tuque	49	-30
Whitehorse	172	84	Port Alberni	49	3
Ottawa-Hull	160	-18	Labrador City	48	6
Toronto	142	11	Chilliwack	47	-10
Québec	123	-11	Courtenay	47	4
Calgary	123	-6	Grand Centre	44	6
St. John's	122	7	Dunnville	42	-28
Montréal	122	-16	Powell River	41	5
Regina	121	-4	Kapuskasing	40	-23
Fredericton	115	-2	Campbellton	38	-5
Halifax	111	12			
Science & Engineering					
Most specialized: LQ ≥ 125			**Least specialized: LQ ≤ 68**		
Ottawa-Hull	177	-25	Medicine Hat	54	-10
Fredericton	154	-15	St. Georges	53	17
Calgary	154	-13	Drummondville	53	-17
Yellowknife	151	-25	Chilliwack	51	0
Québec	142	17	Thetford Mines	50	-26
Thompson	133	-27	Leamington	46	8
Ft. McMurray	131	17	Ste. Marie	40	14
Sarnia-Clearwater	129	-42	Labrador City	39	-60
Kirkland Lake	129	41	Wallaceburg	39	-10
Toronto	125	0	Montmagny	39	-25
Orillia	125	-55			
Whitehorse	125	17			

national average by at least 10 percent. In addition, approximately the same set of low specialization places identified above (with La Tuque and Kapuskasing replacing Wallaceburg and Leamington) display LQs with values inferior to 50. Finally, in the case of the S&E sub-set, the situation changes significantly. Twelve urban areas exceed the national benchmark by 25 percent or more; seven of these — four large CMAs (Ottawa, Calgary, Québec, and Toronto) plus the three provincial/territorial administrative centres — are holdovers from the HKC high specialization list, while five new urban areas appear. The five newcomers include mining centres (Thompson and Kirkland Lake), petroleum exploitation (Ft. McMurray) and refining (Sarnia-Clearwater) centres, and a centre with manufacturing and central place functions (Orillia). The ten urban areas that are least specialized (LQ ≤ 68) in S&E activities include five centres from the list of least specialized HKC places, plus five additions: Medicine Hat (Alta.) and St. Georges, Drummondville, Thetford Mines and Ste-Marie, all of which are in Québec.

For all categories, table 3 also indicates the changes in the location quotient over the period 1971-1991. Thus, we see that Whitehorse and Yellowknife became relatively more specialized in HKC activities, in general, and in M&A activities, in particular. With respect to S&E activities, Yellowknife became less specialized, while Whitehorse became more specialized. Among the large CMAs, Toronto increased its level of specialization in HKC and M&A activities, while it remained stable in terms of the S&E category. Montréal became less specialized in HKC and M&A activities; it does not appear as one of the most specialized S&E centres. Ottawa declined in all three categories. And Vancouver, Canada's 3rd largest CMA, does not appear as a specialized centre under any of the three categories. Among the smaller, least specialized places, location quotient change is fairly evenly divided between losses and gains over the period.

Table 4 uses the location quotient in a more general context, measuring the relative level of concentration of each occupational category within the Canadian urban system in 1971, 1981 and 1991. In the case of the HKC category and its two sub-sets, approximately one-half of the 152 urban areas are characterized by a relative degree of under-specialization (LQ ≤ 80); the largest group of urban areas (54.6, 59.9 and 46.7 percent, respectively, in 1991) falls into the low-specialization class. On the other hand, very few highly specialized places (LQ ≥ 120) exist (4.6, 5.9 and 9.2 percent, respectively, in 1991). Thus, a high level of specialization in HKC activities tends to be restricted to very few centres. This pattern stands in marked contrast to that of the four remaining occupational categories (education & health, clerical & related, sales & service, and blue collar), where the vast majority (between 61.2 and 86.2 percent in 1991) of urban place do not differ significantly from the national benchmark (LQ from 119 to 81).

Using the *index of occupational concentration*, table 5 complements, in a more rigorous manner, the preceding analysis of the relative level of spatial concentration of each occupational type within the Canadian urban system.[11] Examining the 1991 values, we see that the HKC group (9.1) and its two sub-sets, the managerial & administrative (10.1) and science & engineering (8.3) categories, are the most concentrated in space. Note, however, that their low values (out of a possible maximum of 100) indicate that even the most "concentrated" categories are

Table 4 Occupational specialization in the Canadian urban system, 1971-1991

	1971			1981			1991		
	location quotients			location quotients			location quotients		
	LQ			LQ			LQ		
	LQ≥120	119 - 81	LQ≤80	LQ≥120	119 - 81	LQ≤80	LQ≥120	119 - 81	LQ≤80
	%	%	%	%	%	%	%	%	%
Managerial & administrative	5.3	36.8	57.9	6.6	42.1	51.3	5.9	34.2	59.9
Science & engineering	12.5	34.2	53.3	10.5	40.8	48.7	9.2	44.1	46.7
HIGH KNOWLEDGE CONTENT	6.6	38.8	54.6	7.9	38.8	53.3	4.6	40.8	54.6
Education & health	27.6	62.5	9.9	25.0	64.5	10.5	22.4	67.7	9.9
Clerical & related	4.6	50.7	44.7	3.3	69.1	27.6	0.0	86.2	13.8
Sales & service	19.1	75.7	5.3	16.4	78.3	5.3	17.8	80.2	2.0
Blue collar	25.7	58.6	15.8	23.7	64.5	11.8	26.3	61.2	12.5

relatively evenly distributed across the urban system. Nevertheless, in 1991, the HKC activities are generally characterized by levels of spatial concentration across the urban system that are at least twice those of the four remaining individual occupational groups. At the other extreme, the sales & service (3.4) and clerical & related (4.0) categories are the least concentrated. Overall, the results obtained here are consistent with those presented in the previous table. Finally, note that five of the six individual occupational categories (i.e., with the exception of the blue collar category, which has become slightly more concentrated), plus the HKC and grey collar groups, have become somewhat less concentrated over the 1971-1991 period. The behaviour of the S&E category differs somewhat from that of the HKC group, as a whole, and the M&A group, in particular, over the period; while the index of occupational concentration of the former experienced a monotonic decline, that of the latter two groups declined more rapidly from 1971 to 1981, and then actually increased from 1981 to 1991, although the net result is a decline over the 20-year period.

Table 5 Occupation concentration index, Canadian urban system, 1971-1991
(Values Range Between 0 [least concentrated] and 100 [most concentrated])

				change		
Occupational Category	1971	1981	1991	1971-81	1981-91	1971-91
Managerial Administrative	11.3	9.0	10.1	-2.3	1.2	-1.1
Science & Engineering	9.3	9.1	8.3	-0.1	-0.9	-1.0
SUB-TOTAL: HIGH KN. CONT.	9.7	8.5	9.1	-1.2	0.6	-0.6
Education & Health	5.7	6.3	4.5	0.6	-1.8	-1.2
Clerical & Related	7.6	6.1	4.0	-1.5	-2.1	-3.7
Sales & Service	4.9	3.9	3.4	-1.1	-0.4	-1.5
SUB-TOTAL: GREY COLLAR	3.6	2.7	1.7	-0.9	-1.1	-2.0
Blue Collar	7.2	7.3	7.4	0.1	0.1	0.2

Metropolitan Concentration

Table 6 presents supplementary evidence concerning the high degree of spatial concentration of HKC activities. In 1991, the ten largest Canadian CMAs contained 49 percent of the national population, up from 45 percent in 1971. Thus, the population of Canada is becoming increasingly concentrated in the ten largest CMAs. Note, however, that all CMAs have not experienced the same level of performance. Montréal's share of the national population has declined from 12.7 percent in 1971 to 11.5 percent in 1991, while the shares of Winnipeg, Québec, Hamilton and London have been relatively stable. On the other hand, Toronto,

Table 6 Metropolitan concentration of high knowledge content activities, Canada, 1971-1991

	Population		All Occupations		High Know. Cont.		Mgmt. & Admin.		Sci. & Engineer.		Edu. & Health		Grey Collar		Blue Collar	
	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %	% Canada	cumul. %
							1971									
Toronto	12.2	12.2	15.4	15.4	19.8	19.8	20.2	20.2	19.3	19.3	13.7	13.7	17.0	17.0	13.1	13.1
Montréal	12.7	24.9	12.6	28.1	16.2	36.0	17.4	37.6	14.7	34.0	13.0	26.7	13.5	30.5	10.6	23.7
Vancouver	5.0	29.9	5.7	33.7	5.8	41.8	5.6	43.2	6.1	40.1	5.3	32.0	6.3	36.9	5.0	28.7
Ottawa-Hull	2.8	32.7	3.3	37.1	6.3	48.1	5.9	49.2	6.7	46.8	3.4	35.4	4.0	40.8	1.9	30.5
Edmonton	2.3	35.0	2.8	39.8	3.0	51.1	2.8	51.9	3.4	50.2	3.0	38.5	3.0	43.9	23	32.9
Calgary	1.9	36.9	2.1	41.9	3.0	54.1	2.7	54.6	3.5	53.7	2.0	40.5	2.4	46.2	1.5	34.4
Winnipeg	2.5	39.4	3.0	44.9	3.3	57.4	3.4	58.0	3.2	56.9	3.0	43.6	3.4	49.7	2.5	36.9
Québec	2.2	41.6	2.2	47.1	2.8	60.2	2.9	60.9	2.7	59.7	2.9	46.4	2.5	52.2	1.5	38.4
Hamilton	2.3	43.9	2.6	49.7	2.4	62.6	2.3	63.2	2.6	62.3	2.5	48.9	2.4	54.6	2.8	41.2
London	1.3	45.3	1.6	51.3	1.6	64.2	1.6	64.8	1.6	63.9	2.0	50.8	1.7	56.3	1.4	42.5
							1981									
Toronto	12.9	12.9	15.1	15.1	19.2	19.2	20.0	20.0	18.1	18.1	13.6	13.6	16.6	16.6	12.3	12.3
Montréal	11.8	24.6	11.8	26.9	13.3	32.5	14.0	34.0	12.4	30.4	13.1	26.7	12.5	29.0	10.0	22.3
Vancouver	5.2	29.8	5.8	32.7	6.5	39.0	6.5	40.5	6.5	36.9	5.8	32.5	6.5	35.6	4.6	26.9
Ottawa-Hull	3.1	32.9	3.3	36.0	5.6	44.6	5.0	45.6	6.3	43.2	3.8	36.3	4.0	39.5	1.7	38.5
Edmonton	3.0	35.9	3.5	39.6	4.3	48.9	4.3	49.8	4.4	47.7	3.3	39.6	3.7	43.3	3.1	31.7
Calgary	2.6	38.5	3.2	42.8	5.0	53.9	4.4	54.2	5.8	53.4	2.5	42.1	3.4	46.7	2.5	34.2
Winnipeg	2.4	40.9	2.7	45.4	2.9	56.8	2.9	57.1	2.8	56.3	2.8	44.9	3.0	49.7	2.2	36.3
Québec	2.4	43.3	2.3	47.7	3.0	59.8	2.9	60.0	3.1	59.4	3.1	48.0	2.6	52.2	1.4	37.7
Hamilton	2.2	45.6	2.4	50.1	2.3	62.1	2.3	62.3	2.3	61.8	2.3	50.3	2.3	54.5	2.5	40.2
London	1.3	46.9	1.5	51.5	1.4	63.5	1.4	63.7	1.4	63.1	1.8	52.1	1.6	56.1	1.3	41.4
							1991									
Toronto	14.3	14.3	15.4	15.4	20.7	20.7	21.9	21.9	19.3	19.3	14.4	14.4	16.2	16.2	11.8	11.8
Montréal	11.5	25.7	11.5	26.9	13.4	34.1	14.0	35.9	12.6	31.9	12.2	26.6	12.0	28.2	9.5	21.3
Vancouver	5.9	31.6	6.4	33.3	6.5	40.6	6.4	42.3	6.6	38.6	6.2	32.8	7.1	35.3	5.3	26.6
Ottawa-Hull	3.4	34.9	3.8	37.1	6.3	46.9	6.0	48.4	6.7	45.3	4.0	36.8	4.0	39.3	2.0	28.6
Edmonton	3.1	38.0	3.4	40.5	3.6	50.5	3.5	51.9	3.8	49.0	3.4	40.2	3.6	42.9	2.9	31.5
Calgary	2.8	40.8	3.2	43.6	4.3	54.8	3.9	55.8	4.9	53.9	2.8	43.0	3.4	46.3	2.3	33.8
Winnipeg	2.4	43.2	2.5	46.2	2.5	57.3	2.4	58.2	2.5	56.4	2.8	45.7	2.7	49.1	2.1	36.0
Québec	2.4	45.5	2.5	48.6	3.2	60.5	3.0	61.2	3.5	59.9	3.0	48.7	2.6	51.7	1.6	37.6
Hamilton	2.2	47.7	2.2	50.9	2.2	62.7	2.3	63.5	2.2	62.1	2.4	51.0	2.2	54.0	2.1	39.7
London	1.4	49.1	1.5	52.3	1.4	64.1	1.4	65.0	1.4	63.5	1.8	52.9	1.5	55.5	1.2	41.0

Vancouver, Ottawa-Hull, Edmonton and Calgary have seen their relative shares improve considerably. Employment across all occupations is slightly more concentrated than the population, with the cumulative percentage of total employment being several points in advance of that of the population. Using 50 percent as a benchmark figure, we see that total employment (all occupations) is becoming slightly more concentrated over time; while 49.7 percent of all employment was concentrated in the nine largest CMAs in 1971, this figure rose to 50.9 percent in 1991. Once again, there are variations in the performance of individual CMAs during the period, with Montréal, Winnipeg, Hamilton and London losing ground while 5 other CMAs increased their shares; Toronto remained stable over the period.

The concentration of HKC employment remained relatively stable from 1971 to 1991, with the cumulative share of the five largest CMAs declining slightly from 51.1 to 50.5 percent, and that of the 10 largest CMAs going from from 64.2 to 64.1 percent. In terms of individual CMAs, Toronto, Vancouver, Edmonton, Calgary and Québec experienced increases in their percentages of HKC employment; Ottawa-Hull remained stable, and the four remaining CMAs experienced declining percentages. Employment in the M&A occupations, as well as that in the S&E occupations, is similarly concentrated in space, with 65 percent of the former and 63.5 percent of the latter being located in the ten largest CMAs in 1991. The distribution of employment in the education & health occupations is very similar to that of all occupations taken together, while grey collar employment (clerical & related, sales & service) is slightly more concentrated (55.5 percent in the ten largest CMAs in 1991). Finally, the cumulative percentage of employment in the blue collar occupations (resource exploitation, processing & machining, fabrication & assembly, construction, materials handling) that appears in the ten largest CMAs is significantly lower than for all occupational categories; it is even significantly lower than that for population (41 percent versus 49.1 percent in 1991). In sum, in the largest CMAs, the opportunities for employment in a HKC occupational category are significantly greater than the population shares of these areas would lead us to expect. HKC activities are highly concentrated at the upper end of the urban hierarchy, and the level of concentration has remained relatively stable over the past two decades.

Typology of Urban Areas

The location quotients presented above may also be utilized to develop a functional typology of urban areas based upon their relative degree of high knowledge content activities. In order to identify sets of urban areas that are most similar in terms of their occupational profiles, location quotients can be subjected to *cluster analysis*, a hierarchical grouping algorithm. The statistical information processed consists of the Z scores of the location quotients for six occupational categories (see table 2) in each of the 152 urban areas. The standardized values, or Z scores, of location quotients are employed rather than the actual values of the location quotients because, in the latter case, the extreme values found in certain sectors give an undue emphasis to these sectors in the grouping procedure. The clustering algorithm proceeds by measuring the Euclidean distance between pairs of urban areas in an iterative process that results in breaking out groups of most similar urban areas. (In statistical terminology, the overall variance between groups

has been minimized). This technique has been previously employed by Noyelle and Stanback (1984) and Beyers (1989) in their detailed analyses of the U.S. metropolitan system.

The cluster analysis yields seven groups of urban areas. The three largest groups, each having more than 28 members, were then individually subjected to the grouping procedure in order to identify logical sub-groups. Table 7 presents the results of the occupational cluster analysis using 1991 data. *Group 1* consists of 43 urban areas that are generally specialized in the sales & service and education & health professions. Many of these urban areas are also relatively specialized in blue collar occupations. Three individual sub-groups may be identified: a) a group of 21 areas, more than one-half of which are located in Ontario, that are moderately specialized (i.e., location quotients generally do not exceed the national average by more than 10 percent) in both sales & service and blue collar occupations; b) a group of ten areas (seven of which are located West of Ontario) with high levels of specialization in both sales & service and education & health occupations; and c) 12 urban areas in Québec and Ontario that add a certain degree of specialization in science & engineering to their generally moderate levels of specialization in sales & service and education & health professions. Note that there are seven metropolitan areas in Group 1: four in group 1A, one in Group 1B and two in Group 1C.

Group 2 includes 33 urban areas that are highly specialized (i.e., generally 25 percent more specialized than the national average) in the blue collar occupations; as a general rule, the members of Group 2 also tend to have low levels of specialization in the five other occupational categories. None of Canada's 25 metropolitan areas fall into this category. Once again, three separate sub-sets may be identified: a) a group of ten urban areas, four of which are in Ontario and four of which are in British Columbia, that have the highest levels of specialization in blue collar occupations, and the lowest levels of specialization in all other occupations; as a general rule (in fact, with the sole exception of Wallaceburg), these occupations are related to the exploitation of natural resources; b) a group of 20 areas, mostly located in Québec and Ontario, that also have a moderate degree of specialization in either the sales & service category or the education & health category; and 3) a group of three Western resource towns that are also characterized by high levels of specialization in science & engineering occupations.

Group 3 is composed of 14 smaller urban areas, 12 of which are located West of Ontario, specializing in sales & services occupations, but also having a high degree of specialization in blue collar occupations. Almost without exception, levels of specialization in all other occupations are relatively low. In general, these urban areas are "central places" that serve the surrounding rural region, while at the same time engaging in the exploitation of natural resources.

Group 4 includes 28 urban areas, only two of which are located to the West of Ontario, that have high levels of specialization in the education & health occupations, and that are also characterized by secondary specializations in either the sales & service or the blue collar categories. Only one CMA, Sherbrooke, is found in this group. Three separate sub-groups may be identified, although the differences between them are fairly subtle: a) a group of 13 urban areas (eight of

Table 7 Occupational typology of Canadian urban areas, 1991

GROUP 1: Sales/Education (N=43)

Group 1A: Sales/Blue Collar (N=21)

Grand Falls-Windsor	NF	CA
New Glasgow	NS	CA
Saint-Jerome	QC	CA
Shawinigan	QC	CA
Val d'Or	QC	CA
Bracebridge	ONT	CSD
Brantford	ONT	CA
Cornwall	ONT	CA
Kenora	ONT	CA
Kitchener	ONT	CMA
Port Hope	ONT	CA
Sault Ste. Marie	ONT	CA
Simcoe	ONT	CA
St. Catharines-Niagara	ONT	CMA
Sudbury	ONT	CMA
Windsor	ONT	CMA
Woodstock	ONT	CA
Grand Prairie	ALB	CA
Lloydminster	ALB	CA
Dawson Creek	BC	CA
Prince George	BC	CA

Group 1B: Strong Sales/Education (N=10)

Belleville	ONT	CA
Owen Sound	ONT	CA
Pembroke	ONT	CA
Saskatoon	SK	CMA
Prince Albert	SK	CA
Camrose	ALB	CA
Lethbridge	ALB	CA
Red Deer	ALB	CA
Wetaskiwin	ALB	CA
Kamloops	BC	CA

Group 1C: Sales/Education/Science (N-12)

Amos	QC	CSD
Chicoutimi-Jonquière	QC	CMA
Trois-Rivières	QC	CMA
Rouyn-Noranda	QC	CA
Brockville	ONT	CA
Chatham	ONT	CA
Cobourg	ONT	CA
Guelph	ONT	CA
Kirkland Lake	ONT	CA
Orillia	ONT	CA
Peterborough	ONT	CA
Sarnia-Clearwater	ONT	CA

GROUP 2: Blue Collar (N=33)

Group 2A: Hyper Blue Collar (N=10)

Labrador City	NF	CA
Dunnville	ONT	CSD
Leamington	ONT	CA
Nanticoke	ONT	CSD
Wallaceburg	ONT	CA
Estevan	SK	CA
Campbell River	BC	CA
Port Alberni	BC	CA
Powell River	BC	CA
Quesnel	BC	CA

Group 2B: Blue Plus Sales or Educ. (N=20)

Kentville	NS	CA
Baie Comeau	QC	CA
Cowansville	QC	CA
Granby	QC	CA
Lachute	QC	CA
La Tuque	QC	CA
Magog	QC	CA
Sainte-Marie	QC	CSD
Salaberry-de-Valleyfield	QC	CA
Elliot Lake	ONT	CA
Haldimand	ONT	CSD
Hawkesbury	ONT	CA
Kapuskasing	Ont	CSD
Midland	ONT	CA
Timmins	ONT	CA
Prince Rupert	BC	CA
Williams Lake	BC	CA
Fort St. John	BC	CA
Matsqui	BC	CA
Terrace	BC	CA

Group 2C: Blue Collar Plus Science (N=3)

Thompson	MA	CA
Fort McMurray	ALB	CA
Kitimat	BC	CA

GROUP 3: Sales/Blue Collar (N=14)

Summerside	PEI	CA
Huntsville	ONT	CSD
Moose Jaw	SK	CA
Swift Current	SK	CA
Yorkton	SK	CA
Medicine Hat	ALB	CA
Grand Centre	ALB	CA
Chilliwack	BC	CA
Courtenay	BC	CA
Cranbrook	BC	CA
Duncan	BC	CA
Kelowna	BC	CA
Nanaimo	BC	CA
Penticton	BC	CA

GROUP 4: Education/Sales or Blue (N=28)

Group 4A: Low manag./sci./cleric. (N=13)

Gander	NF	CA
Bathurst	NB	CA
Edmundston	NB	CA
Alma	QC	CA
Gaspé	QC	CSD
Joliette	QC	CA
Matane	QC	CA
Saint-Hyacinthe	QC	CA
Saint-Jean-sur-Richelieu	QC	CA
Sept-Îles	QC	CA
Sherbrooke	QC	CMA
Collingwood	ONT	CA
Stratford	ONT	CA

Group 4B: Lower manag./sci./cleric. (N=12)

Sydney	NS	CA
Truro	NS	CA
Dolbeau	QC	CA
Drummondville	QC	CA
Sorel	QC	CA
Thetford Mines	QC	CA
Victoriaville	QC	CA
Haileybury	ONT	CA
Lindsay	ONT	CA
Strathroy	ONT	CSD
Weyburn	SK	CA
Vernon	BC	CA

Group 4C: Lowest sci./cleric. (N=3)

Montmagny	QC	CSD
Saint-Georges	QC	CA
Tillsonburg	ONT	CA

GROUP 5: Diversified (N=18)

St. John's	NF	CMA
Moncton	NB	CA
Saint John	NB	CMA
Halifax	NS	CMA
Charlottetown	PEI	CA
Montréal	QC	CMA
Rimouski	QC	CA
Barrie	ONT	CA
Hamilton	ONT	CMA
London	ONT	CMA
Oshawa	ONT	CMA
North Bay	ONT	CMA
Thunder Bay	ONT	CMA
Winnipeg	MA	CMA
Regina	SK	CMA
Edmonton	ALB	CMA
Vancouver	BC	CMA
Victoria	BC	CMA

GROUP 6: Education/Sales (N=9)

Corner Brook	NF	CA
Campbelton	NB	CA
Rivière-du-Loup	QC	CA
Roberval QC	CSD	
Kingston ONT	CA	
Brandon MA	CA	
Portage la Prairie	MA	CA
Selkirk MA	CA	
North Battleford	SK	CA

GROUP 7: Managerial/Science (N=7)

Fredericton	NB	CA
Québec	QC	CMA
Ottawa-Hull	ONT	CMA
Toronto	ONT	CMA
Calgary	ALB	CMA
Whitehorse	YUK	CA
Yellowknife	NWT	CA

which are in Québec) whose high degree of specialization in education & health is complemented by a moderate degree of specialization in either sales & service or blue collar occupations (or both); in addition, this sub-set is characterized by levels of specialization in the managerial & administrative, science & engineering and clerical & related occupations that are somewhat lower than, but generally close to, the national average; b) a set of 12 urban areas having a very similar profile to the preceding group, but differing from the former in that their levels of specialization in the three remaining non-specialized occupations depart further from the national average; c) three smaller urban areas having profiles similar to the preceding two groups, except for even lower levels of specialization in the science & engineering and clerical & related occupations. Thus, the major distinctions between these three sub-sets are defined primarily in terms of the LQ values in those occupations in which the urban areas are relatively unspecialized.

Group 5 consists of 18 larger urban areas that are characterized by relatively diverse occupational structures. These places generally have moderately high degrees of specialization in two or more of the white collar and grey collar occupations; they are also generally under-specialized in the blue collar occupations. Thirteen of Canada's 25 CMAs fall into this group, which covers all ten of the provinces.

Group 6 includes nine medium-smaller places, all located to the East of Alberta, that are specialized in the education & health and the sales & services occupations. Group 6 differs from Group 1, also specializing in the same two occupations, in that the former displays very low levels of specialization in all other occupations. There is, however, a certain degree of affinity between Group 6 and Group 1B, the least diversified of the Group 1 sub-groups.

Finally, *Group 7* consists of seven urban areas that are highly specialized in both elements of the high knowledge content group: managerial & administrative and science & engineering occupations. These places also have moderately high levels of specialization in clerical & related occupations, and low levels of specialization in blue collar occupations. Four CMAs — Québec, Ottawa-Hull, Toronto, and Calgary — and three provincial/territorial administrative centres — Fredericton, Whitehorse, and Yellowknife — comprise this group.

In terms of inter-group similarity, Groups 1 and 4, both of which involve education & health services, have the highest degree of affinity; that is to say, if it were necessary to reduce the seven groups to six, Groups 1 and 4 would be the first to merge. Reducing from six groups to five groups, Groups 6 (education & health and sales & service) and 3 (sales & service and blue collar), would be the next to merge. If one would continue to reduce the number of groups, at four groups, Group 5 (diversified urban areas that are primarily metropolitan areas) and Group 7 (high knowledge content) would merge. At three groups, Group 6-3 would join Group 1-4, and at two groups, Group 5-7 would add itself to the 6-3-1-4 mega-group. This would leave two highly dissimilar groups: the Group 6-3-1-4-5-7 white collar and grey collar mega-group, on the one hand, and Group 2 (blue collar occupations), on the other hand. Thus, a clear division may be seen to exist between "knowledge-based" and "muscle-powered" occupations within the Canadian urban system.

The clustering presented in table 7 appears to reflect at least two types of influences. First, the distinction between metropolitan and non-metropolitan areas is once again evident. No CMAs are found in Groups 2 (blue collar), 3 (sales & service, blue collar), and 6 (education & health, sales & service), while only one (Sherbrooke) is found in Group 4 (education & health plus sales & service or blue collar). On the other hand, 13 CMAs (out of a total of 25) are found in Group 5 (diversified), while four of the seven elements of Group 7 (HKC) are CMAs. The metropolitan versus non-metropolitan distinction is the fuzziest within Group 1 (sales & service, education & health), where seven of 43 urban areas are CMAs, but these tend to be the smallest CMAs. Second, there also appears to be a certain regional logic underlying the occupational clustering. Groups 4, 5, and 1 (subgroups 1A and 1C, in particular) contain urban areas that are mostly located East of the Prairies, while Group 3 urban areas are mainly found West of Ontario. Groups 2, 6, and 7 have elements that are distributed relatively evenly across the country.

Note that as the occupational structure of certain urban areas evolves over time, these places are able to shift from one group to another. In fact, only 75 of the 152 urban areas — slightly less than one-half of the elements of the urban system — remained in the same group in 1971, 1981 and 1991. The HKC group (Group 7) has been relatively stable, with only two of the seven urban areas found there in 1991 having shifted over from other groups. In-migrants include Québec, which belonged to Group 7 in 1971 and 1991, having made a detour by Group 5 (diversified) in 1981, and Whitehorse, which shifted over from Group 1 in 1981. Finally, only one urban area, Montréal, left the HKC group over the period; it shifted into the diversified group (Group 5) in 1981, during the decade of its major economic transformation.

CONCLUSION

In this study, we have argued that, in spite of its wide usage, the term "high technology" presents considerable drawbacks for researchers. An alternative notion, that of "high knowledge content", appears to be both conceptually less ambiguous and operationally more useful. This approach, implemented in the present study using occupational rather than sectoral structure, accurately reflects the fact that innovative activity, in the largest sense of the term, is not restricted to a small, predefined set of economic sectors. Thus, in this manner, many leading-edge activities which otherwise would continue to be hidden in "low tech" economic sectors are able to be identified. In a regional development context, this distinction is particularly important, especially in the case of smaller communities in peripheral regions whose economic bases are highly dependent upon natural resources and traditional manufacturing activities. Indeed, with such an approach it will be possible to better identify the development potential of these "problem" communities.

Empirically, our analysis has shown that, over the period 1971-1991, HKC activities have been the most rapidly growing element of employment in the Canadian urban system, accounting for over 25 percent of total net employment growth. With growth rates of 174.4 and 172.1 percent, respectively, the managerial

& administrative and science & engineering groups increased much more rapidly than all other occupational categories. These activities tend to be concentrated in a small number of large urban areas, largely in response to the advantages of agglomeration and urbanization economies. In both 1971 and 1991, slightly more than one-half of all HKC employment was located in the set of five largest CMAs, a level of concentration that is approximately 10 percentage points higher than that for total employment. Nevertheless, the remainder of HKC employment is relatively evenly spread across the rest of the urban system, and the overall level of spatial concentration across the entire system is diminishing over time.

In order to identify sets of urban areas that are most similar in terms of their occupational profiles, *cluster analysis* was performed. A group consisting of seven urban areas that are highly specialized in both elements of the high knowledge content activities stood out: four CMAs — Québec, Ottawa-Hull, Toronto, and Calgary — and three provincial/territorial administrative centres — Fredericton, Whitehorse, and Yellowknife. In general, the clustering of occupational groups appears to reflect at least two types of influences. First, there is an obvious distinction between metropolitan and non-metropolitan areas. Second, there also appears to be a certain regional logic underlying the occupational clustering.

In our view, the high knowledge content approach is one that justifies further exploration. On the one hand, it appears to be a useful complement to the high technology approach — both in light of its own intrinsic advantages and in light of the lack of progress by researchers in satisfactorily defining the concept of high technology. On the other hand, it also appears to have considerable utility in helping researchers to more accurately identify the economic structure and potential of urban areas and regions.

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NOTES

1 See, for example, the comprehensive review of locational factors pertaining to high technology activities carried out by Delaplace (1993).
2 Some authors speak of high technology activity as if it were the type of economic activity with the highest knowledge content. This view appears limited in regard to the innovation process, specifically its trial-error character, and the procedural rationality from which it is drawn (Perrin, 1991).
3 The latter approach may be a source of bias. For example, in Québec, half of all engineers are employed in managerial or administrative positions (Godin and Trépanier, 1995), meaning they do not participate directly in the R&D process, as usually defined.
4 Major Group 11 of Canada's 1971 Standard Occupational Classification.
5 Major Groups 21 and 23 of Canada's 1971 Standard Occupational Classification.
6 Figures concerning the percentage of "high knowledge content" workers have been calculated using the data described in section 4.

7 In fact, this set of places includes two Census Agglomerations (see below) whose population slipped slightly below the threshold value of 10 thousand inhabitants between 1981 and 1991: Selkirk, Manitoba (9.8 thousand) and Weyburn, Saskatchewan (9.7 thousand).

8 As indicated in the previous footnote, Statistics Canada continues to classify two small urban agglomerations as CAs even though they slipped below the threshold value of 10 thousand inhabitants in 1991.

9 The blue collar group actually suffered an absolute decline in the 1980s, with a loss of 181.6 thousand jobs (a rate of change of -7.2 percent).

10 The location quotient is defined as $((e_{im}/E_m) / (e_{in}/E_n)) \times 100$,
where: e_i = employment in a given occupation, i
E = total employment across all occupations
m = a given urban area
n = the nation.

11 The industrial concentration index (here referred to as the "occupational concentration index") for a given occupation is calculated in the following manner. First, the percentage of total urban system employment in that occupation falling within a given urban area is calculated. Second, the percentage of total employment in the urban system falling within that urban area is calculated. Third, the figure derived in step 2 is subtracted from that derived in step 1. Fourth, these steps are repeated for each urban area. Fifth, all positive values (or, alternatively, all negative values) are summed. The resulting value can vary between a minimum of 0 (an even distribution of employment in a given occupation across all urban areas) and 100 (all employment in that occupation is concentrated in a single urban area).

REFERENCES

AYDALOT, P. and KEEBLE, D. (1988) High Technology Industry and Innovative Environments in Europe: An Overview. In P. Aydalot and D. Keeble (eds.) *High Technology Industry and Innovative Environments: the European Experience*, London, Routledge, pp. 1-21.

BATAÏNI, S.-H., MARTINEAU, Y. and TRÉPANIER, M. (1997) *Le secteur biopharmaceutique québécois et les investissements directs étrangers: dynamique et impacts des activités de R-D.* Sainte-Foy, Gouvernement du Québec, Conseil de la science et de la technologie.

BEYERS, W. B. (1989) *The Producer Service and Economic Development in the United States: The Last Decade.* Washington, U. S. Department of Commerce, Economic Development Administration.

BOISVERT, E. (1992) L'industrie manufacturière de haute technologie dans la région de Montréal: tendances spatiales et facteurs de localisation. In F. Remiggi and G. Sénécal (eds.) *Montréal: Tableaux d'un espace en transformation*, Montréal, ACFAS, "Les Cahiers Scientifiques", 76: 127-139.

BRITTON, J. N. H. (1987) High Technology Industry in Canada: Locational and Policy Issues of the Technology Gap. In M. J. Breheny and R. McQuaid (eds.) *The Development of High Technology Industries: an International Survey*, London, Croom Helm, pp. 143-191.

CASTELLS, M. (1985) High Technology, Economic Restructuring and the Urban-Regional Process in the United States. In M. Castells (ed.) *High Technology, Space and Society*, London, Sage, pp. 11-39.

COFFEY, W. J. (1990) Panacea or Problem? The Role of Services and High Technology in Regional Development. *Revue d'économie régionale et urbaine*, 5: 715-730.

COFFEY, W. J., FULLUM, R. and POLÈSE, M. (1987) *La restructuration de l'économie canadienne, 1971-1981: une nouvelle dynamique régionale?* Moncton, Institut canadien de recherche sur le développement régional.

COFFEY, W. J. and POLÈSE, M. (1987) The Distribution of High Technology Manufacturing and Services in the Canadian Urban System. *Revue d'économie régionale et urbaine*, 2: 279-299.

DELAPLACE, M. (1993) *High Tech* et facteurs de localisation: une revue de la littérature. *Revue d'économie régionale et urbaine*, 4: 679-704.

GODIN, B. and TRÉPANIER, M. (1995) La politique scientifique et technologique québécoise: la mise en place d'un nouveau système national d'innovation. *Recherches sociographiques*, 36: 445-477.

KLINE, S. J. and ROSENBERG, N. (1986) An Overview of Innovation. In R. Landau and N. Risenberg (eds) *The Positive Sum Strategy*, National Academy Press, pp. 275-305.

MALECKI, E. J. (1984) High Technology and Local economic Development. *Journal of the American Planning Association*, 50: 262-269.

MARTIN, B. R. and IRVINE, J. (1983) Assessing Basic Research. Some Partial Indicators of Scientific Progress in Radio Astronomy. *Research Policy*, 12: 61-90.

NOYELLE, T. J. and STANBACK, T. M. (1984) *The Economic Transformation of American Cities*. Totawa (New Jersey), Rowman & Allanheld.

PERRIN, J.-C. (1991) Réseaux d'innovation - milieux innovateurs - développement territorial. *Revue d'économie régionale et urbaine*, 3/4: 343-374.

PLANQUE, B. (1985) Le développement par les activités à haute technologie et ses répercussions spatiales. L'exemple de la Silicon Valley. *Revue d'économie régionale et urbaine*, 5: 911-941.

REICH, R. B. (1992) *The Work of Nations*. New York, Vintage Books.

SCOTT, A. J. and STORPER, M. (1987) Industries de haute technologie et développement régional: revue critique et reformulation théorique. *Revue Internationale des Sciences Sociales*, 112: 237-256.

TRÉPANIER, M. and BATAÏNI, S.-H. (1996) *Évaluation des retombées socio-économiques et technologiques du Centre canadien de fusion magnétique (CCFM)*. Montréal, INRS-Urbanisation, 80 pages.