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KENO CAPITALISM ? THE SPATIAL CO-LOCATION OF ACTIVITIES IN EIGHT CANADIAN CITIES

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The Spatial Co-Location of Activities in Eight Canadian Cities

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Abstract / Résumé

There are currently two somewhat contradictory approaches to the study of the spatial economies of cities. On the one hand, some researchers have claimed that Keno capitalism – the increasingly random distribution of activities across space – is on the rise (Dear and Flusty, 2001). Others have observed that employment is scattering across space (Gordon and Richardson, 1996), or locating in formless, “edgeless”, cities (Lang, 2003). But on the other hand much work is being performed on spatial structures, specifically on the spatial clustering of sectors or firms (Hutton, 2004 ; Britton, 2003) and activities (Garreau, 1991 ; Shearmur and Coffey, 2002a) at the intra-metropolitan level. This type of work draws upon ideas developed in the literature on networks, innovation and local agglomeration economies : the spatial clustering of sectors is seen as a possible indicator of interdependencies between them. In this paper we seek to explore, at the metropolitan scale, the extent to which broad economic sectors co-locate. Two questions are asked : first, within the eight largest Canadian metropolitan areas, do the same types of sectors tend to co-locate ? Second, if similar sectors tend to co-locate, are these clusters similarly distributed over metropolitan space within each of the metropolitan areas ? We find that common clusters emerge across the metropolitan areas, and that these clusters are located similarly within each metropolitan area. We identify two different types of cluster, only one of which can be interpreted as a sign of interdependencies between sectors. Similar land use patterns and planning regulations are other factors that may explain the clustering of sectors : these explanations are unrelated to inter-sectoral dynamics. These spatial regularities are incompatible with the idea of Keno capitalism.

* * *

Il y a actuellement deux approches un peu contradictoires à l’analyse de l’économie spatiale des villes. D’une part, certains chercheurs prétendent que le ‘Keno capitalism’ – une distribution plus ou moins aléatoire des activités dans l’espace – se manifeste de plus en plus (Dear and Flusty, 2001). Certains ont observé que l’emploi s’éparpille dans l’espace métropolitain (Gordon and Richardson, 1996), ou se localise dans des “edgeless city” sans forme (Lang, 2003). Mais, d’autre part, il se fait beaucoup de recherche sur la structure spatiale des villes, et plus précisément sur l’agglomération spatiale de secteurs, d’entreprises (Hutton, 2004 ; Britton, 2003) ou d’activités (Garreau, 1991 ; Shearmur and Coffey, 2002a) à l’échelle intramétropolitaine. Ce type de travail s’inspire d’idées promues dans les écrits sur le réseautage, l’innovation et les économies d’agglomération locales : le regroupement spatial de ces activités est perçu comme un indicateur d’interdépendance entre elles. Deux questions sont posées dans cet article :

d’abord, au sein des huit plus grandes agglomérations canadiennes, est-ce que ce sont les mêmes secteurs qui, systématiquement, se regroupent ? Ensuite, si ce sont les mêmes secteurs qui se regroupent, ces regroupements se retrouvent-ils aux mêmes endroits au sein des métropoles ? Nous trouvons que des regroupements communs existent dans les huit villes, et qu’ils se localisent de manière semblable par rapport à l’espace métropolitain. Nous identifions deux types de regroupement, dont un seulement pourrait être interprété comme signe d’interdépendances. Il est plus plausible d’attribuer l’autre type de regroupement à l’utilisation du sol (qui se ressemble entre secteurs) et aux règlements d’urbanisme : ces explications ne relèvent pas des dynamiques intersectorielles. Néanmoins, toutes ces régularités sont incompatibles avec l’idée du ‘Keno capitalism’.

Introduction

There are many approaches to the study of urban areas, but two stand out as being at opposite ends of a spectrum. On the one hand, regularities, structures and general processes can be explored, producing knowledge that may be applicable to groups of cities, or, in some cases, to all urban agglomerations. On the other hand, specificities, unique features, local interpretations of the city can be explored – thereby highlighting the features which make each city, and each interpretation of the city, unique.

The study of spatial urban economies has tended to favour the first approach, but some have argued that the search for structures is less relevant today than it used to be (Dear and Flusty, 2001 ; Soja,. 2000). This is partly due to disaffection with structures and meta-narratives at a philosophical level, and partly due to empirical observations which have sometimes been interpreted as showing that the urban economy is increasingly shapeless and haphazard (Gordon and Richardson, 1996 ; Lang, 2003).

However, at the same time that the search for patterns was abandoned by some, and that patterns seemed to be dissolving for others, other researchers in economic geography were searching for – and sometimes finding – clear patterns in the spatial location of firms. Work on clusters, networks and innovative milieux (Porter, 1990 ; Maillat and Kébir, 1999, 1992 ; Brenner, 2000 ; Shearmur and Coffey, 2002a ; Britton, 2003 ; Hutton, 2004) has revealed that firms tend to co-locate both at the regional and at the intra-metropolitan level, and current work is seeking to understand why this clustering occurs : the idea that clustering is *necessarily* linked with milieu type inter-linkages[1] is no longer adhered to (Suarez-Villa and Walrod, 1997 ; Simmie, 1998), but other factors such as proximity to labour, access to clients and suppliers, infrastructure and land-use are put forward to complement the milieu-type approach.

In this paper we seek to make a connection between, on the one hand, the literature on urban form, and on the other hand, the literature on innovation, spatialised clusters and networks of firms. We proceed in two stages. First, we explore whether the same sectors cluster across all metropolitan areas : we search for regularities in the way economic sectors locate relative to each other. Second, if clusters common to all metropolitan areas exist, we explore the spatial distribution of these clusters within each of the eight metropolitan areas under study : we search for regularities in the way clusters of sectors locate within metropolitan space. We then seek to interpret the nature of these clusters :

[1] Milieu-type interlinkages are synergistic and cooperative relationships between firms and other local actors and institutions, of the type first described by Piore and Sabel (1984) in the third Italy.

specifically, we will attempt to corroborate the idea that the sectors that systematically cluster within cities are inter-linked.

The paper is organized as follows. In the next section we briefly summarise the literature on urban form and spatial clustering. We also review the writings on milieux and inter-firm linkages as they pertain to cities in order to establish some links between the two bodies of work. We then describe our data and methodology. The results are presented in three sections : some brief information on each of the eight cities analysed, a description of the clusters of sectors, and analysis of the location in space of these clusters. We conclude by returning to a more general discussion of the relevance of these results to the study of the urban space-economy and the relevance of inter-sectoral linkages for understanding spatial clusters.

The distribution of economic activity in metropolitan areas

The distribution of economic activity, and specifically employment, within metropolitan areas is in a constant state of flux, and at different periods different spatial patterns have been identified : but often, these patterns are related to general processes such as the need for accessibility to infrastructure, to workforce, to related industries, and to amenities such as available land, no pollution, and good image. Depending on the internal organization of an industry, on available technology, on relevant infrastructure, and on the strength of social (e.g. planning) regulation, these general processes can lead to very different spatial outcomes.

It is possible to review the evolution of the spatial economy of cities from the sole perspectives of accessibility and amenity[2]. This approach is deceptively simple since the difficult question is not whether these two building blocks are fundamental, but rather how decisions made by individuals and society on the basis of these two motivations lead to ever-changing spatial patterns. Nevertheless, the twin ideas – and associated processes – of accessibility and amenity will serve to guide this brief review.

During the industrial revolution, the creation of large factories led to the concentration of employment, first in the centre of cities (accessible to transport infrastructure such as railway stations and ports), then increasingly towards the suburbs as space requirements (for both factories and workers' lodgings) grew (Lewis, 2000). The move of

[2] The argument that the search for accessibility and amenity are two fundamental processes that organize urban space is not new : Alonso (1964) describes the interplay between distance from the CBD (accessibility) and consumption of space (amenity), and develops his urban model on this premise. However, as the number of factors to which access is desired increases, and as the number of amenity considerations also grows, then the Alonso-type model becomes intractable. The fact that evolutions in preferences, transport and communications technology and lifestyles affect the type of access and amenity required adds further complexity, but also explains why the same fundamental processes (search for access and search for amenity) can lead to very different spatial outcomes in different places and at different times.

manufacturing out of the centre towards the periphery of urban areas continued during the twentieth century – for reasons of space, pollution, and accessibility to workforce (Lewis, 2000 ; Yeates, 1998). Especially since the Second World War, and under the impetus of an increasingly suburbanised and motorized population, new retail development tended to occur out of the centre as well (Yeates, 1998). A self-reinforcing pattern of suburbanization emerged : as population moved to the suburbs, so did related services. The presence of services attracted more people. In addition, as the good manufacturing jobs moved further out – for reasons of land availability, access to highways, and access to labourforce – this too attracted population, which in turn led to the development of more suburban services. Physical decay and social problems in or around many CBDs only exacerbated this trend (Bourne, 1992).

Notwithstanding these important changes in the spatial distribution of employment and population, the spatial pattern of the economy still seemed to reflect patterns described by earlier generations of urban analysts (Harris and Ullman, 1945) : the CBD continued to structure the metropolitan economy because it remained the point of highest accessibility. High-order services located there to have maximum access both to clients and to the metropolitan-wide qualified labour-force. The affluent day-time population of the CBD, and the CBD's high accessibility to the whole population, ensured continued service employment (retail, entertainment, but also medical and other) in the centre.

Since the late 1980s it has been suggested that this essentially monocentric description of metropolitan areas is no longer valid (Hartshorn and Muller, 1989 ; Stanback, 1991 ; Garreau, 1991). Of course, ever since Harris and Ullman (1945) it has been recognized that polynucleation occurs within metropolitan areas, but it has been assumed that suburban employment poles are smaller than, and secondary to, the CBD. Furthermore, the CBD's dominance in terms of high-order services and speciality retailing was not questioned. However, a 'new suburbanization' was detected in the 1980s : Stanback (1991) and Garreau (1991) showed that suburban employment poles were diversifying and growing to such an extent that they formed alternatives to the CBD. 'Edge cities' – the term coined by Garreau (1991) to describe these suburban downtowns – provided all the accessibility advantages of the CBD : they are located at major highway intersections, include retail and high-order service activities, and are situated close to a middle-class workforce. They also do not suffer from the disamenities of old CBDs (decaying infrastructure, social tensions…).

During the 1990s empirical research emanating from US cities (Ingram, 1998 ; Harrington and Campbell, 1997 ; McMillen and McDonald, 1998 ; McDonald and Prather, 1994 ; Giuliano and Small, 1991) has tended to confirm the relative decline of the CBD and the rise in suburban employment – particularly in high-order service

employment. However, research from other countries only partly corroborates the US findings : in Canada, CBDs retain their dominant position, notwithstanding increased polynucleation, which is occurring particularly in Toronto and Vancouver (Shearmur and Coffey, 2002b ; Gad, 1999 ; Gad and Matthew, 2000). Other studies from Australia (Pfister *et al.*, 2000) and Paris (Shearmur and Alvergne, 2003 ; Bekouche and Vire, 1998) tend to show that suburban employment growth has not necessarily led to a weak CBD (though if trends are extrapolated such weakening would eventually occur).

All this research has in common the underlying idea that economic activity will tend to cluster spatially (whether in the CBD or in multiple suburban nuclei), and that this clustering could at least partly be explained by the need for economic actors to optimise their accessibility to a variety of factors. As accessibility to a widening variety of factors develops in suburban locations, so clusters occur there.

The most important challenge to the idea that employment is clustering in suburban edge cities comes from work by Gordon and Richardson (1996), Pfister *et al.* (2000), and most recently Lang (2003). Gordon and Richardson (1996) and Pfister *et al.* (2000) suggest that nucleation – in the CBD or in edge cities – is decreasing in relevance as employment scatters across the metropolitan landscape : with the advent of widespread automobile use and freeways, accessibility to a variety of factors can be ensured without the need for spatial clustering. Their empirical evidence shows that, in Los Angeles and Sydney respectively, employment growth is occurring outside employment poles rather than within them. Another type of evidence also appears to support this finding : Suarez-Villa and Walrod (1997), Gordon and McCann (2000), Doloreux (2001) show that agglomeration economies at the intra-metropolitan level are negligible : whether firms cluster together or not seems to have no effect on their economic performance or on the spatial extent of their interaction with other firms within a metropolitan area. However, indirect interaction by way of shared labourforce has been documented (Simmie, 1998), and it is probable that the degree of direct interaction between firms differs between sectors (Carrincazeaux, 2000 ; Simmie *et al.*, 2002). In sum, whilst it is not *necessary* for firms to concentrate geographically at an intra-metropolitan scale in order to benefit from agglomeration economies and interaction (which operate at the scale of the metropolitan area) in some cases such considerations may contribute to spatial clustering.

Lang (2003) and Barbonne *et al.* (2003) present a vision which is complementary to the view that agglomeration does not necessarily operate at the intra-metropolitan scale : they observe that employment is ceasing to nucleate, and is increasingly strung out along highways and roads. Lang (2003) points to new office space which is filling

interstices of the urban fabric in the USA. Barbonne *et al*. (2003) show that in Quebec City economic activity is organized along the trans-metropolitan route of the region's rapid transit system.

In the light of this recent research it is difficult to make any definitive claims about the distribution of employment within western metropolitan areas or on the need for economic actors to share proximity within a metropolitan area in order to derive positive externalities. There are quite clearly a number of different patterns, which have in common only the fact that employment is growing faster in suburban locations than in the CBD. Empirical observations differ as to whether there is absolute, or only relative, decline of the CBD ; as to whether employment is suburbanizing in a polynucleated, a scattered, or a linear way ; and as to whether suburban nuclei are really acting as suburban downtowns.

However, the number of patterns described is not infinite, and researchers have put forward a limited number of alternatives which, if mixed and matched, seem to account for most spatial-economic configurations. Furthermore, each pattern remains consistent with the fact that firms are constantly balancing cost, land-use, and accessibility to clients, workforce and other inputs when making location decisions. Thus, even if empirical outcomes differ owing to local factors and to changes in technology and preferences over time, the principle underlying processes are understood and have not fundamentally changed. These processes, particularly the interplay between amenity and accessibility, provide the common thread which links the variety of observations and conclusions outlined above.

New approaches to understanding the urban spatial economy : inter- firms dynamics

In the midst of this empirical research on the spatial economy of metropolitan areas, two other important streams of geographic research have contributed to the interpretation of processes and patterns observed at the intra-metropolitan level : research on inter-firm dynamics within clusters of related firms, and abstract work on post-modern urban space.

Research on the spatial clustering of economic activities has already been alluded to (see Suarez-Villa and Walrod, 1997 and Gordon and McCann, 2000) : but an important distinction must be made between two different usages of the word 'cluster'. In the literature on intra-metropolitan patterns of employment distribution, a 'cluster' is a large number of jobs located in the same place : it is used interchangeably with the word 'pole', and is an employment 'nucleus' in a polynuclear metropolitan area. However, in

the literature dealing with inter-firm dynamics and growth, a ‘cluster’ is a group of related firms or industries located close to one another : there is no absolute size connotation. Suarez-Villa and Walrod (1997), Gordon and McCann (2000) and Doloreux (2001) are interested in this type of cluster. Hutton (2004) and Britton (2003) study the clustering of new-economy firms and electronic firms in Vancouver and Toronto respectively : they are not concerned with whether these clusters form an employment pole at the metropolitan level, but with how the spatial proximity of firms within these sectors affects interactions between firms. This approach to the study of intra-metropolitan spatial economy leads to new empirical questions. In particular, at the metropolitan level it suggests that another type of spatial structure can be examined (other than the distribution of employment) : irrespective of the absolute distribution of employment over space, and of whether or not employment is growing in central or suburban locations, the question arises as to whether certain firms and sectors *systematically* tend to locate in proximity to one another. Shearmur and Coffey (2002a) perform a factorial ecology of employment in Montreal, and note regularities in the sectors which co-locate : in fact, they conclude that in Montreal there is an almost seamless link between the co-location of economic sectors and similarities between activities performed in these sectors. However, they do not extend their study beyond Montreal, and suggest that further research could explore whether similar clusters (in the sense of co-located economic sectors) are apparent in other cities.

The second stream of work which can be brought to bear on the empirical study of urban form is the post-modern approach. Dear and Flusty (2001) have suggested that urban space can be understood as a “keno economy”– a space over which activities are randomly distributed under the influence of extraneous global forces. Soja (2000) puts forward similar arguments, and states that even if empirical regularities are found, they are misleading and a-theoretical. These authors seem to reject the notion that spatial patterns and processes are relevant, and this is in keeping with wider ideas emanating from post-modern thinkers. From an empirical perspective, the work of Gordon and Richardson (1996), Lang (2003) and Barbonne *et al.* (2003) could be taken as confirmation of the post-modern argument : scattered employment and office buildings set within interstices of the urban fabric seem to support Dear and Flusty’s (2001) contention that “keno capitalism” is now the organizing (or dis-organising) principle of urban spatial economies. However, the authors of empirical work cited above do not themselves claim that there are no organizing processes behind the patterns they observe : the new patterns are interpreted as new spatial manifestations of well understood spatial economic processes (Lang, 2003 : 25-26). Furthermore, we have just argued that other types of pattern and organizing principle – specifically the *relative* location of economic sectors – may also be relevant to understanding the metropolitan

space economy. So even if there is apparent disorder, organizing principles – such as the tendency for similar sectors to co-locate – may be observable, although not if standard methods of analysis are used (Shearmur and Coffey, 2002a).

From very different perspectives, these two new approaches to understanding intra-metropolitan economies lie behind the empirical study in this paper. In a direct way, interest in clustering (from an inter-firm perspective) leads to questions regarding the co-location of economic sectors within metropolitan economies. Clustering, which has usually been studied at a case by case or industry by industry scale, can also be studied in a systematic way at the metropolitan level (Shearmur and Coffey, 2002a) : we propose to extend this systematic approach to the comparison of clustering in eight different metropolitan areas.

In an indirect way, the contention that the spatial economy is not structured by at least some general processes also motivates this work. If it can be shown that similar patterns of clustering are observed in eight different metropolitan areas, this is evidence of general processes at work, even if we are unable to fully understand the processes from statistical evidence alone. It is detailed survey work of the sort performed Doloreux, (1999), Britton (2003) and Hutton (2004) which may point to some of the reasons behind clustering. In this paper we are merely seeking to explore whether or not the intra-metropolitan clustering of economic sectors occurs in a systematic way.

Data and methodology

Data : The data used to study the clustering of economic sectors are 1996 place of work data at the census tract level for Montreal, Toronto, Vancouver, Ottawa-Hull, Calgary, Edmonton, Quebec city and Winnipeg. Employment is divided into 32 sectors based upon aggregated SIC codes. The sectors are listed in annex 1. These data, though not the most recent, are unique to the extent that they provide comparable place of work data for a large number of economic sectors across eight different metropolitan areas at a given point in time.

These data present two problems. First, they are at the census tract level, and census tract boundaries are not designed to distinguish between economic areas within a city : although we are interested in analyzing sectors that co-locate within a metropolitan area, we do not wish to erroneously exclude sectors which co-locate but which tend to be on different sides of arbitrary census tract boundaries. We have therefore, following Shearmur and Coffey (2002a), transformed the employment data into employment potential using the formula.

$$P_c^s = \sum_{i=1}^{n} E_i \Big/ (d_{ic})^2$$

where
P_c^s = potential of sector s in census tract c.
n = number of census tracts in the metropolitan area.
E_i = employment of sector s in census tract i.
d_{ic}= distance from centroid of census tract i to centroid of census tract c.

if $d_{ic} = 0$, then $d_{ic} = 0.5\sqrt{a_c / \pi}$ where a_c = area of census tract c.

The effect of using employment potential is to blur the edges of the census tracts so that employment in surrounding tracts has some influence on the indicator of employment within tract c. The use of a standard gravity model (with distance squared) ensures rapid distance decay so that only closely neighboring tracts can significantly influence the employment indicator of tract c.

The second problem to be addressed is the difference in absolute employment levels in each city. To control for differences in total employment in each city and in each sector, a location quotient has been calculated as follows :

$$LQ^s_c = \frac{P_c^s \Big/ \sum_{i=1}^{32} P_c^i}{\sum_{j=1}^{n} P_j^s \Big/ \sum_{i=1,}^{32} \sum_{j=1}^{n} P_j^i}$$

Where LQ^s_c = location quotient of sector s in tract c, n the number of census tracts and 32 the number of sectors.

Although the location quotient is calculated on potentials and not on straightforward employment figures, it can be interpreted in the same way. If LQ^s_c approaches zero, there is very little sector s employment either in or near tract c. If LQ^s_c equals one, then the amount of sector s employment in or around tract c is equivalent to the amount of s employment in the metropolitan area as a whole. If LQ^s_c is greater than one, then there is proportionally more sector s employment in or around the tract than in the metropolitan area as a whole.

These transformations do not modify the spatial distribution of employment at the metropolitan level. They serve to blur the tract boundaries to take into account their artificial nature, and to standardize the data to make it comparable between cities and sectors.

Methodology : The traditional approach to studying employment poles in cities is to identify areas of high employment density or high absolute employment, then study the sectors that locate within them. Such an approach is useful for studying urban form, but not as powerful for discovering which sectors systematically co-locate. Shearmur and Coffey (2002a) present a method for identifying the spatial correlation of employment in different sectors that relies upon factor analysis of employment potentials for the sectors studied. Their approach is basically a spatialised factorial ecology of economic sectors. In this paper we adapt their method : the main difference is that we use cluster analysis instead of factor analysis : this provides us with a discrete and non-overlapping typology of census tracts based upon the sectors that co-locate there.

To explore whether the intra-metropolitan clustering of economic sectors occurs in a systematic way across these eight metropolitan areas, two stages of analysis are necessary. The first stage consists of answering the following question : do the same economic sectors cluster in each metropolitan area ? The transformed (spatialised and standardised) data are pooled, and hierarchical cluster analysis is applied using the Ward method and Euclidian distance. In this way the 2062 tracts are grouped, not according to their metropolitan area of origin but according to the mix of sectors found within and around them. In order to allow different clusters to emerge for different metropolitan areas, twenty one clusters have been retained : such a large number of clusters should allow tracts belonging to each of the eight cities to emerge as independent clusters if each city does indeed harbour unique combinations of sectors.

After the first stage, each tract in each city has been assigned to a cluster, and each cluster is defined according to the mix of sectors within and around its member tracts. The second stage of analysis consists in exploring the spatial distribution of cluster members within each city in order to answer the following question : do clusters which are common to all cities have a similar spatial distribution ? Two types of question are asked : first, is there spatial auto-correlation between cluster members ? Second, do cluster members tend to locate within the same concentric rings around each city’s CBD ?

To answer the first question a simple measure of spatial autocorrelation between categorical variables has been developed. The formula is as follows :

$$A_c = \frac{\sum_{i=1}^{n} n_i^{ac}}{\sum_{i=1}^{n} n_i^{a}} \times \frac{N}{n}$$

where

A_c = measure of autocorrelation for members of cluster c.
n^{ac}_i = for tracts in cluster c, number of tracts adjacent to tract i which are in cluster c.
n^{a}_i = for tracts in cluster c, number of tracts adjacent to tract i.
n = number of tracts in cluster c.
N = total number of tracts.

This indicator, which is based on the joint-count statistic described in Fortin *et al.* (2001), measures the number of tracts in a given cluster which are adjacent to tracts of the same cluster, controlling for the probability of a tract being a member of the cluster. It varies from zero (total dispersion – no tracts of the cluster are adjacent to each other), through 1 (neither dispersed or concentrated – the number of adjacent tracts in the same cluster is in accord with what would be expected if neighbours were randomly assigned) to values above 1 (indicating spatial concentration – the number of adjacent tracts in the same cluster is greater than what would be expected if neighbours were randomly assigned)[3].

To answer the second question the tracts are divided into quintiles based on distance from the CBD (defined as the census tract with the highest total employment potential, which in all cases is also the tract with the highest employment). Frequency distribution of cluster members in each of the quintiles is examined to determine if clusters tend to be closer or further from the CBD.

We now turn to the results.

A brief portrait of the eight cities

The eight metropolitan areas analysed in this paper are diverse, and it is not our intention to describe their differences in detail. In this section a few basic statistics are presented in order to provide background information.

All eight cities are located in Canada. All except Montréal, Ottawa-Hull and Calgary are the capital cities of their respective provinces, and Ottawa-Hull is the capital of Canada.

[3] The indicator has been interpreted in the following way on the basis of observing the patterns associated with different values of the indicator : 0 to 1, dispersed ; 1 to 1,5, neither dispersed nor concentrated ; 1,5 to 2 moderate concentration ; 2 to 4, high concentration ; above 4, very high concentration.

Québec city and Montréal are cities which were founded over 400 years ago, and Montréal was the centre of Canada's industrial revolution. Toronto and Ottawa emerged as important centres in the nineteenth century. The western cities, Winnipeg, Calgary, Edmonton and Vancouver developed as major centres during the course of the twentieth century. Until 1996 British Columbia (Vancouver) and Alberta (Calgary and Edmonton) were the fastest growing provinces in Canada. Winnipeg (Manitoba) is in the Prairies, a region which has suffered from population stagnation since the 1950s. Quebec, Toronto, Ottawa and Montreal, located in the most densely populated part of Canada, are in a region which has been growing moderately over the years leading up to 1996.

The cities range in size from 650 000 to 4 200 000 people (table 1). Population growth over the 25 year period preceding the analysis ranges from 16 % to 95 %, and employment growth from 41 % to 183 %. The economic structure of the cities is also diverse : Calgary has 6,5 % of its workforce in the primary sector against 0,7 % in Montreal. 16,4 % of Montreal's workforce is in the manufacturing sector, and only 8,1 % of Quebec's. Business services comprise a high percentage of employment in Calgary, Ottawa and Toronto, but very little in Winnipeg and Quebec.

Table 1 : Population, employment and economic structure, eight metropolitan areas

	Population		Employment		% of jobs in each sector, 1996			
	Growth 71-96	Population in 1996	Growth 71-96	Employment in 1996	Primary	Manufact--uring	Business services	Other (residual)
Quebec	31%	663 885	89%	314 535	1,3%	8,1%	5,2%	85,4%
Montreal	16%	3 195 165	53%	1 460 725	0,7%	16,4%	6,4%	76,5%
OttawaHull	53%	977 630	95%	489 160	1,0%	6,0%	7,9%	85,1%
Toronto	57%	4 226 220	77%	2 055 915	0,7%	15,6%	7,9%	75,8%
Winnipeg	17%	651 205	41%	319 370	1,1%	12,8%	4,1%	81,9%
Calgary	95%	815 985	183%	440 830	6,5%	9,2%	9,1%	75,2%
Edmonton	61%	853 010	106%	432 660	3,9%	9,5%	5,6%	81,0%
Vancouver	68%	1 813 890	115%	906 885	1,8%	9,6%	7,5%	81,1%

Note: The growth columns indicate % growth in population/employment between 1971 and 1996.

These numbers are not intended to provide comprehensive information on the economies of each city[4]. They do, however, underscore the major differences in size, economic structure and growth which exist between the cities. In particular, the different growth rates suggest that, if the nature of the metropolitan space economy has been evolving over the last 25 years then it should be evident in the faster growing cities, particularly the western ones. However, the differences in city size, economic structure and history also mean that different configurations of the space economy are to be expected. Thus, if similarities are found they will be significant because they will

[4] A comprehensive analysis of the economies of these metropolitan areas can be found in Coffey *et al.*, 2000.

indicate that there are general processes and patterns in the space economy which transcend the differences just described.

The clustering of census tracts according to employment profile

The first stage of this empirical analysis revolves around classifying the types of sectoral mix found at the census tract level within Canadian cities. Not only is it useful to identify which of the 32 economic sectors (see annex 1) tend to co-locate, but of maybe more relevance is finding out if the same sectors tend to co-locate in all eight metropolitan areas.

Twenty one different types of sectoral mix (henceforth called classes[5]) are identified. This number is arbitrary to the extent that it is the researcher who specifies the desired number of classes. A large number of classes have been retained[6] because it was felt that by constraining the classification a limit would be put on the possibility for the particularities of each city to emerge. The name, identifier, and basic characteristics of each class are shown in table 2, and the manner in which they merge as one moves from 21 to 1 class is indicated in figure 1.

The principal result is that the 32 economic sectors under study tend to co-locate in the same way in each of the eight metropolitan areas. Except for Calgary, most of the 21 classes are present to a similar degree in all cities. There is no major class type[7] that is not present in all eight cities. Furthermore, except for classes 219 and 44 (which only have 3 and 6 members respectively), there is no class type that is not present in at least 6 of the eight metropolitan areas. Thus, although there are clearly differences in the prevalence of each class within each city, it is the similarity in the way that the 32 sectors co-locate which is overriding.

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[5] We call each sectoral mix a class, and not a cluster, to avoid confusion with the idea of clusters exposed in the literature review. In a class which exhibits particularly high concentrations of two or more sectors we will say that these sectors 'cluster' : however, we will not say that sectors cluster in a class in which there are only average location quotients.

[6] The specific number 21 was chosen because there is jump in the total variance explained by the classification as one moves from 20 to 21 clusters, but not as one moves from 21 to 22. Other breaks occur at 4, 7, 8, 18 and 25 clusters. The principal breaks are at 4, 8 and 21.

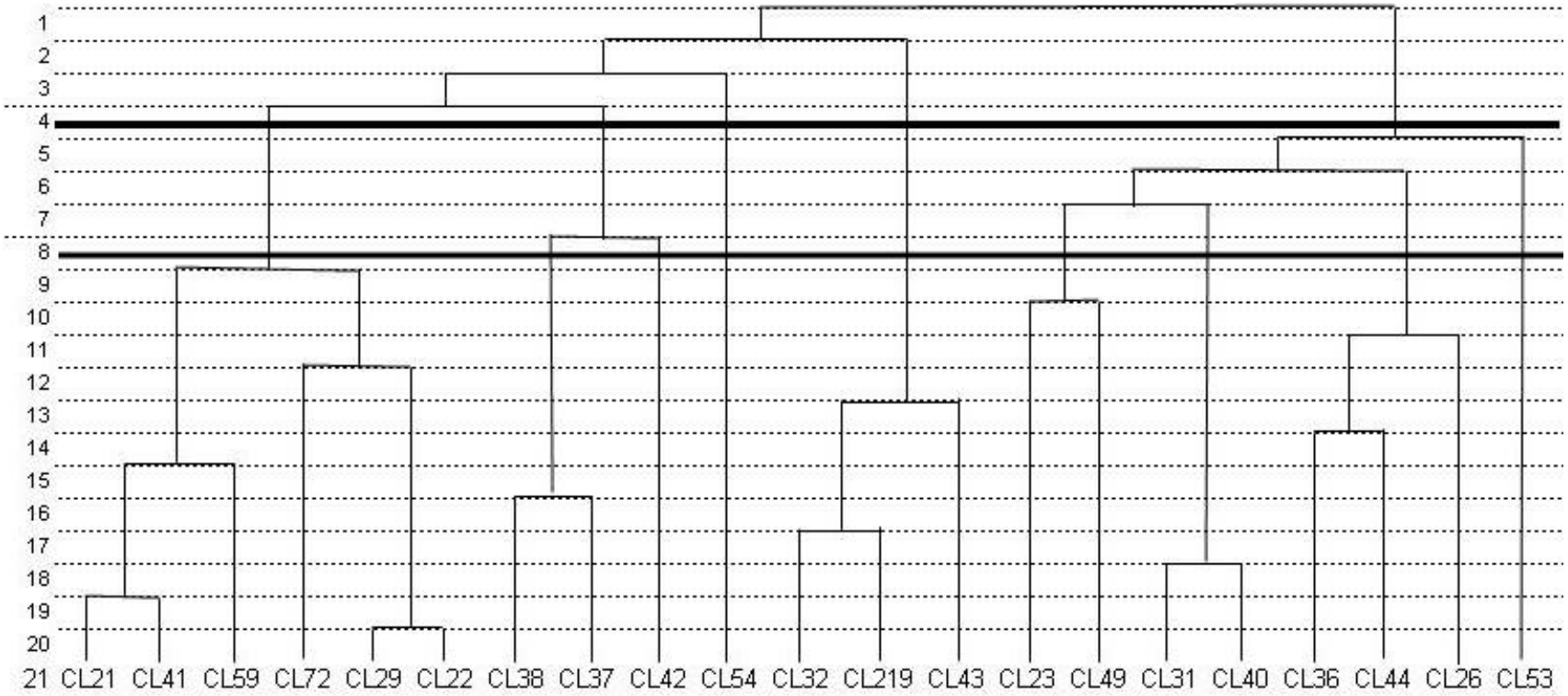
[7] We define a major class type as one which gathers over 32 tracts (1.6% of all tracts under study).

Table 2: Class description and percentage of tracts per class in each CMA, 1996

name	n	General description	Calgary	Edmonton	Montreal	Ottawa	Quebec	Toronto	Vancouver	Winnipeg
CL21	790	Average	**62%**	**40%**	**35%**	**28%**	**20%**	**43%**	**44%**	**30%**
CL219	3	Temping agencies			0%		1%			
CL22	36	High-order services and high-tech	1%	2%	1%	**4%**	**6%**	1%	1%	3%
CL23	132	Manufacturing, warehousing and wholesale	2%	**7%**	**5%**	3%	3%	**10%**	**8%**	**7%**
CL26	32	High-tech, warehousing and wholesale			2%	**4%**	3%	2%	1%	1%
CL29	107	High-order services and consumer services	2%	**10%**	**6%**	**4%**	**8%**	3%	2%	**9%**
CL31	295	General manufacturing and retail	3%	**7%**	**15%**	**12%**	**25%**	**18%**	**12%**	**14%**
CL32	81	All high-order services and FIRE	**8%**	**6%**	**4%**	**4%**	**5%**	3%	3%	3%
CL36	9	Doctors and high-tech		1%	1%	1%	1%		1%	
CL37	37	Transport	1%	2%	1%	2%	3%	2%	3%	2%
CL38	56	Public administration	3%	2%	3%	**6%**	3%	2%	2%	2%
CL40	104	Primary, construction and warehousing		**9%**	**9%**	**8%**	**5%**	1%	0%	**8%**
CL41	81	Education	**7%**	1%	3%	**4%**	**4%**	**4%**	**7%**	**5%**
CL42	23	Communication		1%	1%	1%	1%	1%	**4%**	1%
CL43	19	FIRE and high-tech			0%	1%	2%	2%	1%	1%
CL44	6	Engineering consultants, warehousing			0%		2%	0%		
CL49	40	Warehousing, high-tech and general manufacturing		2%	3%	2%	3%	2%	1%	
CL53	15	Utilities			0%	2%	3%	0%	0%	2%
CL54	67	Hospitals, doctors and laboratories	3%	2%	3%	5%	2%	3%	5%	3%
CL59	105	Retail, primary and transport	3%	**7%**	**6%**	**7%**	3%	**4%**	3%	**7%**
CL72	24	Leisure and doctors	3%	1%	0%	3%	1%	1%	1%	1%
	2062	TOTAL:	122	161	613	161	126	533	214	138

note: n is the number of census tracts in each class (total across the eight CMAs).

Figure 1: Tree diagram indicating manner in which classes would merge



note: Significant breaks in terms of the variance explained by each additional class occur as one moves from 21 to 20 classes, 8 to 7 classes and 4 to 3 classes.

The classes will not be discussed here at length (full details of the 32 sector profile of each class can be found in annex 2). However, some remarks will be made about the major classes. The most prevalent type is the 'average' class (21), comprising over 20 % of census tracts in all cities : the sectoral mix in this class is average, with no type of economic activity predominating. Bearing in mind the nature of location quotients (bounded by 0 at the low end but with no upper limit), such a profile should not be interpreted as meaning that all sectors are present in this class : rather, it means that there are no sectors which are present at above average levels, and many may be almost absent. Cities which have a lower percentage of CL21, the eastern cities, tend to have a higher percentage of CL31, the next most prevalent class. In many ways this class is similar to CL21 except that it includes slightly above average concentrations of manufacturing : given the fact that the principal manufacturing centres in Canada are in these Eastern cities, it is probable that CL31 reflects this.

Amongst the other classes, it can be noted that there is a strong tendency for manufacturing, warehouse and wholesale activities to cluster (23, 26 and 49[8]), for high-order services to either cluster together (32) or with consumer services (29), and for a variety of other related sectors to be located together – public administration (38), medical (54), primary, construction and warehousing (40). Also of interest is the fact that some classes include high-tech manufacturing and high-order services (22, 43 and 44). On the whole, these results are similar to Shearmur and Coffey (2002a), who note that in Montreal there is a strong tendency for sectors to cluster spatially along lines which are consistent either with expected interactions amongst sectors or with similar requirements in terms of accessibility to infrastructure, land use and so on.

The next section will explore whether the spatial distribution of these classes within cities – in other words the urban form associated with these classes – is similar across the eight cities.

The intra-metropolitan spatial distribution of clustered sectors

Two dimensions of the spatial distribution of classes are explored. First, a measure of spatial auto-correlation is presented in order to assess the extent to which tracts with a similar mix of sectors tend to concentrate in space. If they turn out to be concentrated (high auto-correlation) this may merely mean that the particular class spreads out over a number of contiguous tracts : however, if each class displays similar auto-correlation within each of the eight metropolitan areas, then this indicates a similarity in spatial pattern – however the pattern is interpreted.

[8] In order to simplify the text we will refer to each class by its number, and will omit 'CL'.

The second dimension explored is concentricity : we have seen that a number of empirical studies suggest that the monocentric vision of the city is no longer valid[9]. The type of evidence brought to bear upon this question usually deals with the spatial distribution of total employment, or with the location of high-order services. In this paper, we examine whether particular *combinations* of sectors are distributed concentrically around the CBD – the underlying idea being that even if the CBD is losing its absolute weight, it may be retaining a specific function linked to a particular sector-mix.

The spatial auto-correlation of classes

Since many classes are only present in small numbers in any given city, the measure of auto-correlation must be interpreted cautiously. In particular, inconsistencies should be noted but will not be interpreted as invalidating more general observations.

Five out of the 21 classes (40, 32, 31, 41 and 21, representing 65 % of all tracts), are both present in at least 7 metropolitan areas and have similar auto-correlation in all (or all but one) of the metropolitan areas where they are present. Classes 72, 29 and 26 also tend to have similar auto-correlation, although they are present in fewer cities and there are more exceptions particularly in cases where n (number of tracts in the class) is small. These three classes represent a further 8 % of all tracts. Thus, 8 classes, representing about three quarters of all tracts, tend to display similar spatial patterns across the metropolitan areas under study. Not surprisingly, it is classes which gather a small number of tracts – and which are either not present in a number if cities or only there in small numbers – which tend to display the most inconsistent auto-correlation values : as with all statistical measures, values tend to be more robust and consistent the higher the number of observations.

[9] In Canada the monocentric city still seems to exist (Shearmur and Coffey, 2002b), but whilst it is strongly evident in Montreal and Ottawa, there are signs that Vancouver and particularly Toronto are developing a polynuclear urban structure. However, Villeneuve *et al.* (2003) suggest that Quebec city is evolving along the lines described by Lang (2003) and Gordon and Richardson (1996) – dispersion and development along linear routes.

Table 3: A measure of the spatial auto-correlation of classes in eight Canadian cities, 1996

	Calgary	*n*	Edmonton	*n*	Montreal	*n*	Ottawa	*n*	Quebec	*n*	Toronto	*n*	Vancouver	*n*	Winnipeg	*n*	Average
CL40	-	*0*	6.25	*14*	5.19	*55*	6.05	*13*	0.00	*6*	61.50	*4*	**0.00**	***1***	4.26	*11*	11.89
CL32	6.97	*10*	5.37	*9*	13.77	*24*	8.94	*6*	3.24	*6*	10.27	*15*	5.24	*7*	10.35	*4*	8.02
CL72	2.10	*4*	**0.00**	***2***	**0.00**	***2***	8.78	*5*	**0.00**	***1***	22.84	*5*	**0.00**	***3***	**0.00**	***2***	4.22
CL29	**0.00**	***3***	1.92	*16*	3.84	*37*	1.77	*7*	1.00	*10*	5.59	*18*	10.19	*4*	2.05	*12*	3.29
CL26	-	*0*	-	*0*	7.32	*10*	4.72	*7*	**4.21**	***3***	1.85	*9*	**0.00**	***2***	**0.00**	***1***	3.02
CL38	11.09	*4*	0.00	*4*	1.40	*20*	2.17	*9*	**0.00**	***3***	1.79	*9*	0.00	*4*	**4.38**	***3***	2.60
CL31	1.74	*4*	3.21	*11*	1.86	*91*	1.95	*20*	1.69	*30*	1.74	*94*	1.61	*25*	2.10	*20*	1.99
CL41	2.71	*8*	**0.00**	***2***	1.57	*19*	2.90	*6*	1.92	*5*	1.37	*20*	2.35	*14*	1.36	*7*	1.77
CL43	-	*0*	-	*0*	**0.00**	***3***	**0.00**	***1***	**0.00**	***2***	2.90	*8*	**0.00**	***3***	**7.67**	***2***	1.76
CL23	**0.00**	***3***	2.93	*11*	3.61	*32*	0.00	*5*	**0.00**	***3***	2.77	*51*	1.92	*18*	1.53	*9*	1.59
CL37	**0.00**	***1***	7.79	*4*	3.50	*7*	**0.00**	***3***	**0.00**	***3***	1.42	*10*	0.00	*6*	**0.00**	***3***	1.59
CL49	-	*0*	0.00	*3*	3.10	*16*	**3.98**	***3***	**0.00**	***3***	2.05	*13*	**0.00**	***2***	-	*0*	1.52
CL22	**0.00**	***1***	0.00	*4*	3.98	*7*	3.93	*6*	3.81	*7*	0.00	*5*	**0.00**	***2***	0.00	*4*	1.46
CL42	-	*0*	**0.00**	***1***	2.60	*8*	**0.00**	***1***	**0.00**	***1***	**0.00**	***3***	6.55	*8*	**0.00**	***1***	1.31
CL59	0.00	*4*	1.63	*11*	1.21	*38*	1.30	*12*	**0.00**	***3***	0.79	*21*	2.04	*6*	3.12	*10*	1.26
CL21	1.13	*76*	1.13	*65*	1.32	*214*	1.37	*45*	0.96	*24*	1.33	*229*	1.34	*95*	1.19	*42*	1.22
CL53	-	*0*	-	*0*	**0.00**	***2***	**0.00**	***3***	1.82	*4*	**0.00**	***2***	**0.00**	***1***	**5.11**	***3***	1.15
CL54	0.00	*4*	**0.00**	***3***	2.06	*20*	1.87	*8*	**0.00**	***2***	0.85	*15*	2.68	*11*	0.00	*4*	0.93
CL36	-	*0*	**0.00**	***1***	0.00	*4*	**0.00**	***1***	**0.00**	***1***	-	*0*	**0.00**	*2*	-	*0*	0.00
CL44	-	*0*	-	*0*	**0.00**	***2***	-	*0*	**0.00**	***2***	**0.00**	***2***	-		-	*0*	0.00
CL219	-	*0*	-	*0*	**0.00**	***2***	-	*0*	**0.00**	***1***	-	*0*	-		-	*0*	0.00

note:
- n is the number of census tracts in each city in each of the classes (e.g. there are 13 tracts in class 40 in Ottawa).
- A value below 1 indicates spatial dispersion, 1 no spatial dispersion or auto-correlation, and above 1 auto-correlation.
- As a guide to interpreting the indicator, 0 to 1 indicates dispersion; 1 to 1,5 neither dispersion nor auto-correlation; 1,5 to 2 moderate auto-correlation; 2 to 4 high auto-correlation; and above 4 very high auto-correlation.
- Note that a value of zero, in a case where there is only one cluster member, is ambiguous. In all other cases this means that no members of this cluster are adjacent to one another.
- Classes with similar values across the CMAs are highlighted in grey. Exceptions are framed and the cells are in white. Exceptions are only noted if n is greater than 3. Values for which n is 3 or less are in bold.

The class with the greatest spatial auto-correlation (40) is characterized by high levels of primary sector employment, medium presence of high-tech and construction, and the further presence of warehousing, wholesale, retail, transport and other manufacturing. The next most auto-correlated class (32), present in all cities and with no evidence of dispersal in any of them, gathers all high-order services and FIRE. Classes 72 and 29, also highly concentrated, are leisure and consumer service oriented.

Class 31, which is moderately auto-correlated in all cities, gathers all manner of manufacturing, construction, warehousing and retail, whilst class 41 gathers tracts which specialize in education combined with a moderate presence of construction.

Finally, class 21, which is consistently dispersed in all metropolitan areas, gathers tracts which have no specialization in any sector.

As we have pointed out, these results are difficult to interpret in isolation : the spatial units analysed are arbitrary, and the mere subdivision of one tract into many could change the value of the auto-correlation measure. That being said, and if we only pay attention to the results where n is high, it is clear that the general patterns of spatial concentration and dispersal of the identified classes are similar across these different metropolitan areas.

There are also differences between cities. Edmonton and Calgary stand out as having less variety of classes than most other cities. The eastern cities – Montréal, Québec, Ottawa and Toronto – have more tracts with a manufacturing bias. Québec city stands out because for classes 40 and 29 it has a high n (a large number of tracts in each class) yet each class is more spatially dispersed than in other cities. Similarly, although class 21 is dispersed in every city, it is most dispersed in Quebec. This suggests that the spatial clustering of economic activity in Québec City is more dispersed than in other Canadian metropolitan areas : even if economic sectors tend to co-locate similarly within census tracts, the spatial distribution of tracts with a particular sector mix is more dispersed in Québec.

The concentric distribution of classes. All metropolitan areas

In order to more fully understand how different classes of activity are distributed over space, we now turn to an examination of their distribution in concentric rings around the CBD. From table 3 it can be seen that most classes are not distributed evenly over space. They can broadly be classified into four groups.

First are the classes which tend to be located close to or in the CBD (group A) : they are classes 219, 29, 32, 38, 43 and 54. Together they comprise high-order services, medical facilities consumer services and public administration (see table 2 and annex 2). The most highly central class, which is also the second most spatially auto-correlated (class 32 – table 2), is defined by the co-location of *all* producer services and FIRE sectors. Although it comes as no surprise that the CBD is characterized by this sector mix, it is more interesting to note that such a sector mix is almost entirely absent from any other location within Canadian metropolitan areas.

A second type of spatial configuration is presence in the outer rings (group B). Only two classes, 40 and 44, are located exclusively in the outer rings. Most other classes in this category are dispersed across all rings but with a growing presence as one moves towards the outer suburbs (clusters 23, 26, 31, 41, 59). Class 40 is defined by strong presence of the primary sector, and corresponds to the sector mix found in rural or semi-rural outer reaches of metropolitan areas. Class 44, with only six members, has a sector mix which may correspond to mixed suburban employment poles. Classes 23, 26 and 31 all have sector mixes heavily biased towards manufacturing : of these it is the high-tech manufacturing class (26) which is most present in the outer rings. Classes 23 and 31, which comprise more traditional industries, have some residual presence in the inner rings. Class 59 is dominated by retail : it is only in the outer rings that one finds tracts within which this sector is separated from other economic activities.

A third type of spatial configuration is presence in the middle rings, with lower presence both towards the CBD and towards the outer rings (group C). Classes 36, 37, 42 and 53 reflect this. These small classes (the largest has 37 members) are all extremely specialized in public service-like sectors : doctors (with high-tech manufacturing), transport, communication and utilities respectively.

A final configuration is a fairly even spread across all rings (group D). Classes 21, 22 and 49 reflect this configuration. Class 21, which specializes in no particular sector, acts as a default or background : it is dispersed (table 2) and present in all rings. Class 22, on the other hand, comprises a wide mix of sectors, particularly high order services and high-end manufacturing : this class seems to represent the sector mix which may be found in suburban employment centres : less specialized than the CBD (class 32), it gathers local producer services and some of their clients. Class 49 is specialized in warehousing, with a mixture of light industrial and transport related sectors also present : this sector mix may correspond to distribution hubs, which are located throughout the metropolitan area.

Table 4 : The location of classes relative to the CBD, all metropolitan areas, 1996

cluster	n	CBD	ring 2	ring 3	ring 4	outer ring	comments
CL219	3	67%	33%				very central
CL29	107	52%	18%	12%	13%	5%	very central
CL32	81	83%	7%	5%	4%	1%	hyper central
CL38	56	38%	27%	20%	9%	7%	central
CL43	19	53%	5%	11%	21%	11%	central
CL54	67	34%	21%	13%	18%	13%	central
CL23	132	11%	15%	20%	30%	24%	outer rings
CL26	32		9%	28%	28%	34%	outer rings
CL31	295	3%	15%	24%	26%	33%	outer rings
CL40	104		2%		5%	93%	hyper peripheral
CL41	81	14%	17%	20%	23%	26%	outer rings
CL44	6			17%	33%	50%	outer rings
CL59	105	6%	16%	32%	23%	23%	outer rings
CL36	9	11%	33%	22%	22%	11%	middle rings
CL37	37	16%	32%	22%	22%	8%	middle rings
CL42	23	17%	26%	35%	17%	4%	middle rings
CL53	15	20%	13%	40%	20%	7%	middle rings
CL21	790	20%	26%	22%	21%	10%	even distribution
CL22	36	14%	25%	28%	19%	14%	even distribution
CL49	40	15%	25%	15%	23%	23%	even disribution
CL72	24	33%	8%	8%	21%	29%	centre and outer rings

notes:
– n is the number of census tracts in each class (total across the eight CMAs).
– Census tracts have been ranked by quintile using distance from the CBD. Each cell shows the percentage of class members within each concentric ring. Even distribution relative to the CBD would imply a value of 20% in each cell.
– Percentages above 25% have been highlighted in grey.

Class 72, with high concentrations of leisure related activities, is the only one that does not fall into this classification : its 24 members are either downtown or in the distant suburbs. This spatial configuration may be picking up one of the traditional CBD roles, leisure activities, that is increasingly present in the suburbs (e.g. : suburban cineplexes).

Are these patterns replicated within each metropolitan area ?

Although table 4 reveals interesting patterns, it does not allow the comparison of the eight metropolitan areas. The last question we will address is therefore whether these concentric spatial configurations are replicated in the eight metropolitan areas under study. In order to make this comparison, only twelve classes have been analysed[10] : all

[10] Full results are available upon request. It is felt, however, that presenting full results for eight metropolitan areas and 21 clusters would overburden the article.

those with over 40 members, to which class 26 (32 members – high-tech manufacturing) has been added (table 5).

Table 5 : The location of classes relative to the CBD, by metropolitan area, 1996

	CL21: Average						CL23: Manufacturing						CL26: High-tech					
	n	CBD				outer	*n*	CBD				outer	*n*	CBD				outer
Quebec	*24*	25	25	33	8	8	*3*	-	33	33	-	33	*3*	-	33	67	-	-
Montreal	*214*	19	30	25	20	7	*32*	6	9	22	50	13	*10*	-	-	30	40	30
Ottawa	*45*	16	38	27	9	11	*5*	20	-	20	40	20	*7*	-	-	14	29	57
Toronto	*229*	26	25	20	21	7	*51*	12	18	10	25	35	*9*	-	11	33	22	33
Winnipeg	*42*	17	31	24	19	10	*9*	22	22	33	22	-	*1*	-	-	-	-	100
Calgary	*76*	9	14	22	26	28	*3*	33	-	33	33	-						
Edmonton	*65*	22	15	18	32	12	*11*	9	36	36	-	18						
Vancouver	*95*	22	32	17	19	11	*18*	6	6	28	28	33	*2*	-	50	-	50	-
	CL29: All services						**CL31: Manuf. & retail**						**CL32: Producer serv. & FIRE**					
	n	CBD				outer	*n*	CBD				outer	*n*	CBD				outer
Quebec	*10*	50	20	30	-	-	*30*	3	10	13	27	47	*6*	67	17	17	-	-
Montreal	*37*	68	14	-	14	5	*91*	1	16	24	29	30	*24*	92	8	-	-	-
Ottawa	*7*	71	29	-	-	-	*20*	-	5	25	40	30	*6*	83	-	17	-	-
Toronto	*18*	50	28	17	6	-	*94*	1	12	29	22	36	*15*	53	20	13	13	-
Winnipeg	*12*	25	8	25	25	17	*20*	10	30	10	45	5	*4*	100	-	-	-	-
Calgary	*3*	67	33	-	-	-	*4*	-	50	25	-	25	*10*	100	-	-	-	-
Edmonton	*16*	25	19	19	31	6	*11*	9	36	18	9	27	*9*	89	-	-	-	11
Vancouver	*4*	75	-	25	-	-	*25*	8	8	32	12	40	*7*	86	-	-	14	-
	CL38: Administration						**CL40: Primary**						**CL41: Education**					
	n	CBD				outer	*n*	CBD				outer	*n*	CBD				outer
Quebec	*3*	33	-	-	33	33	*6*	-	-	-	17	83	*5*	-	40	20	40	-
Montreal	*20*	40	25	15	15	5	*55*	-	2	-	7	91	*19*	16	21	32	21	11
Ottawa	*9*	56	44	-	-	-	*13*	-	-	-	-	100	*6*	33	17	17	33	-
Toronto	*9*	44	11	33	11	-	*4*	-	-	-	-	100	*20*	20	10	15	20	35
Winnipeg	*3*	33	-	67	-	-	*11*	-	9	-	-	91	*7*	-	29	-	14	57
Calgary	*4*	-	75	25	-	-							*8*	13	38	25	-	25
Edmonton	*4*	25	25	50	-	-	*14*	-	-	-	-	100	*2*	-	-	50	50	-
Vancouver	*4*	25	25	-	-	50	*1*	-	-	-	-	100	*14*	7	-	14	36	43
	CL49: Warehousing						**CL54: Medical**						**CL59: Retail**					
	n	CBD				outer	*n*	CBD				outer	*n*	CBD				outer
Quebec	*3*	33	33	-	33	-	*2*	-	100	-	-	-	*3*	33	33	-	33	-
Montreal	*16*	25	19	6	31	19	*20*	20	25	30	25	-	*38*	8	13	32	16	32
Ottawa	*3*	-	-	67	33	-	*8*	38	25	-	25	13	*12*	-	17	50	25	8
Toronto	*13*	8	31	15	8	38	*15*	27	27	7	7	33	*21*	10	5	29	24	33
Winnipeg							*4*	75	-	25	-	-	*10*	-	10	40	30	20
Calgary							*4*	75	-	25	-	-	*4*	-	50	-	50	-
Edmonton	*3*	-	33	33	-	33	*2*	67	-	-	33	-	*11*	-	36	36	18	9
Vancouver	*2*	-	50	-	50	-	*11*	36	9	-	27	27	*6*	-	17	33	33	17

notes: - This table is constructed along the same lines as table 3, except that percentages of over 30% are highlighted.

– n is the number of census tracts in each class.

– Numbers in the columns 'CBD' to 'outer' are the percentage of all tracts in each cocnentric ring.

A more detailed look at the spatial distribution of classes reveals similarities and differences between metropolitan areas. The most striking result concerns class 32 : in each of the eight metropolitan areas the CBD has a unique sectoral mix. Only in Toronto, Montreal and Quebec is more than one member of class 32 found outside the inner ring. In Edmonton and Vancouver one member is found outside the inner ring. Since this sectoral mix clearly characterizes the downtown CBD, then its presence outside the CBD may be evidence of the appearance of edge cities or suburban downtowns. This analysis is only concerned with the economic function of census tracts, and not with the absolute number of jobs, so the appearance of CBD-type functions outside of the CBD does not necessarily mean that high levels of employment are associated with them.

The central rings are also characterized in all cities by the strong presence of class 29 (a variety of consumer and business services – except for Edmonton and Winnipeg) and class 54 (the medical cluster – except for Montreal and Toronto). Public administration (class 38), however, characterizes the CBD of eastern cities and the inner or outer suburbs of western ones.

All three of the manufacturing classes (23, 26 and 31) tend to be located in the three outer rings, except in Calgary and Edmonton. This being said, there is no absolute segregation between rings, and – except for high-tech manufacturing (cluster 26) – members of manufacturing classes are found in all rings.

Warehousing (class 49), retail (class 59) and education (class 41) are distributed across the four outer rings, but tend to be absent from the CBD.

The background class (cluster 21) is evenly distributed across the rings in all metropolitan areas, and the primary cluster (cluster 40) is heavily concentrated in the outer ring in all metropolitan areas.

In sum, despite some differences the distribution of classes is similar in all of the metropolitan areas studied. Some of the differences in distribution seem to be between the eastern and the western cities. In particular Calgary and Edmonton are characterized by higher presence in the suburbs of classes 29 and 38 (all services and public administration), and higher presence in the more central rings of manufacturing (clusters 23 and 31). Despite its small size (600 000 people) economic functions in Quebec City are more dispersed over the five rings than they are in other cities. This is particularly evident for class 32 (there are CBD functions outside of the CBD), and in classes 49 and 59 (warehousing and retail) for which some members are in the inner ring.

Discussion and conclusion. The empirical results

In this study the distribution over intra-metropolitan space of economic functions – census tracts with similar economic profiles – has been studied in a systematic way in order to address two questions.

The first question concerns whether or not similar spatial groupings of economic sectors are found in all metropolitan areas. Our results show that this is the case, since there is no tendency for census tracts to group together by metropolitan area. On the contrary, tracts have group in classes by broad economic function, and these economic functions are the same in all cities. The main difference between cities is that some of the smaller ones – in particular Calgary, Edmonton and Winnipeg – have a smaller variety of functions. This does not necessarily mean that the functions (sector mixes) are absent from these cities : the result could either indicate that the sectors co-locate at a scale beneath that of the census tract, or could indicate that economic sectors are more evenly distributed over space and do not co-locate in quite the same way as they do in larger cities.

The second question concerns how economic functions occupy intra-metropolitan space. Here too, it is found that the way in which economic functions occupy space within metropolitan areas is similar in the eight metropolitan areas. In fact some functions fully characterize the space they occupy : the mix of all high-order services and FIRE sectors characterizes the CBD, and displays high levels of spatial auto-correlation ; the mix of primary and manufacturing characterizes the outer reaches of metropolitan areas, and is also highly auto-correlated ; and the absence of specialization characterizes many spaces across all of the metropolitan are. This function (or lack of function) is highly dispersed. Other functions are spread across the various concentric rings in metropolitan areas, but nevertheless tend to locate in similar areas, be it close to the CBD, in middle rings or towards the outer regions.

These results demonstrate that there are strong regularities in the type of economic sector that cluster within census tracts, and in the way these clusters (or economic functions) occupy intra-metropolitan space. However, care should be taken not to over-interpret the results : census tract level data have been analysed, so nothing can be said about how sectors occupy space at a smaller scale. Similarly, by aggregating tracts it is possible that different sector combinations would have been found : however, it is unlikely that aggregating tracts would fundamentally modify the results. The main consequence of aggregation would be loss of precision – and, ultimately, loss of all spatial discrimination. Research is currently being performed at the dissemination area

level in order to test the robustness of these results to analysis at a smaller scale. Similarly, combining this cross-sectional approach with an analysis of changes over time would enable us to better understand the spatial dynamics of sector clustering : data for 2001 is currently being compiled to explore changes over the 1996 to 2001 period.

Another important point to emphasise is that these results describe the distribution of economic functions, not of employment : this is an important distinction. We have shown, for instance, that the CBD has a unique economic function (sector mix) in all cities studied. We have not shown that the CBD carries a similar weight (in terms of the percentage of total employment it gathers) in all metropolitan areas. Indeed, Shearmur and Coffey (2002b) clearly show that the weight of the CBD and of the various suburban rings differs between the four largest Canadian metropolitan areas.

Does spatial clustering reveal inter-sector dynamics ?

In a more general way, our results demonstrate that similar spatial patterns are found in eight quite different metropolitan areas. The similarity in patterns may be due to chance : but it is difficult not to conclude that these similarities are the outcome of general processes at work in cities. The sectors which cluster together tend to have similar requirements in terms of accessibility and amenity. For instance manufacturing, warehousing and wholesale, which are found together in clusters 23, 26, 31, 44 and 49, all require large parcels of land, easily accessible by highway : from a planning perspective these uses are often similarly zoned. However such clustering is not necessarily an indicator of inter-sector linkages.

High-order service sectors require accessibility to clients throughout the metropolitan area, to other high-order services, and to national and international networks : the CBD remains a point of high accessibility and their preferred location. Specialised consumer services and major health facilities must also be accessible to the metropolitan population as a whole, and therefore also tend to locate close to the centre of the metropolitan area, though price and land requirements (amenity) prevent them from always locating in the most central locations. Although there is little doubt that a CBD location can be very important for face-to-face interactions, the mere fact that high-order services, health facilities and consumer services cluster can not be taken as indication that there are inter-sector linkages.

The processes at work therefore seem to be twofold. On the one hand, the clustering of sectors may occur because firms in different sectors have similar requirements in terms of accessibility to infrastructure and labour, and have similar land-use (or amenity)

requirements. The clearest examples of this are the manufacturing, warehouse and wholesale clusters (clusters 23, 26, 31, 44 and 49). These clusters do not only gather the three sectors mentioned, but they variously gather retail (one supposes that the type of retail associated with these sectors is shopping malls or power-centres, which have similar land-use and accessibility requirements), construction, utilities, transport and the primary sector. Although this co-location may partly be explained by interactions between sectors (whether market or *milieu*-type), an explanation based on accessibility and amenity (land-use, infrastructure, labour) is more likely in many cases.

On the other hand, the clustering of sectors may occur because sectors interact with each other directly : some sectors (or rather some firms within sectors) require access to each other in order to function properly. This appears to be the case for some high-order services and high-tech manufacturing (class 22, 43 and 44), all three medical sectors (class 54) and high-order services (class 32). The rationale for this type of clustering may be that put forward by the literature on *milieux*, or, more prosaically, the need for proximity to clients and suppliers. These dynamics are being investigated at the firm level by researchers such as Hutton (2004) and Britton (2003).

The geographic approach to studying clusters within metropolitan areas suggests that there are a variety of reasons why sectors may cluster : inter-sectoral linkage is but one of many possible explanations for clustering. Such an explanation is more plausible for some clusters than for others. A number of researchers have questioned whether spatial proximity at the inter-metropolitan level is relevant with respect to inter-sector dynamics. This study can provide no clear answer, but it does suggest that the answer differs depending on the sectors studied and on the location constraints they face. It also reveals remarkable similarities in the types of cluster that form in different cities and in their general location within the agglomeration. From a geographic perspective, if not from the perspective of the study of networks and milieux, this is an important observation.

These conclusions are entirely consistent with traditional location theory (Dicken and Lloyd, 1990) and with the more recent work on interaction between firms. Their value lies in the fact that they are derived from the systematic analysis of eight cities : without denying that there are many facets of urban form and spatial economic organization that are context dependant and individual to each city, these results clearly corroborate the idea that some general processes, that are not context dependent, also serve to organize the spatial economy of cities. Although confusing at times, and despite changes in the spatial distribution of employment noted in many cities, the economic geography of metropolitan areas is not haphazard.

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ANNEX 1 : THE 32 SECTORS ANALYSED (1980 SIC CODES)

1 Primary sectors (1 to 9)
2 Traditional manufacturing industries (10 to 12, 15 to 19, 24 to 27, 29, 30, 35, 36)
3 Medium value added manufacturing (28, 31, 323 to 329, 331 to 334, 337 to 339, 371 to 373 375 to 379, 392, 393, 397, 399)
4 High-tech manufacturing (321, 335, 336, 374, 391)
5 Construction and public works (40, 41, 42, 44)
6 Transport (45, 46)
7 Utilities (49)
8 Communications (48)
9 Warehousing (47)
10 Wholesale (50 to 57, 59)
11 Retail (60 to 65, 69)
13 Financial institutions (70, 71, 72, 74)
14 Insurance (73)
15 Real estate managers (75)
16 Insurance and real estate agents (76)
18 Temporary work agencies (771)
19 Computer services (772)
20 Accounting (773)
21 Marketing and advertising (774)
22 Architects and engineering consultants (775)
23 Legal services (776)
24 Management consultants (777)
25 Various producer services (779)
26 Public administration and defense (81 to 84)
27 Education (85)
28 Medical services (861, 862, 863, 864, 869)
29 Doctors (865, 866, 867)
30 Laboratories (868)
31 Accommodation and restaurants (91, 92)
32 Leisure and entertainment (96)
33 Various consumer services (97, 99)
34 Cultural organizations (98)

Note that there are no sectors 12 and 17, which were sub-totals and have been excluded from the analysis to avoid double counting. In order to remain consistent throughout all of our databases and other analyses, the sectors have not been renumbered.

ANNEX 2 : FULL PROFILES OF THE 21 CLUSTERS (MEAN OF THE LOCATION QUOTIENTS OF MEMBER TRACTS) (SEE ANNEX 1 FOR SECTOR DEFINITIONS)

Annexe 2: Full profiles of the 21 clusters (mean of the location quotients of member tracts)

(see annex 1 for sector definitions)

CLUS	n	sector 1	sector 2	sector 3	sector 4	sector 5	sector 6	sector 7	sector 8	sector 9	sector 10	sector 11	sector 13	sector 14	sector 15	sector 16
CL21	790	1,16	1,03	1,01	1,16	**1,35**	0,91	0,67	0,75	0,96	1,15	1,28	0,75	0,62	1,05	1,09
CL219	3	0,64	1,01	**1,76**	0,62	1,14	0,80	0,43	0,69	1,09	**1,31**	**1,31**	1,10	0,67	0,63	1,21
CL22	36	1,21	0,76	0,92	**1,60**	**1,88**	0,72	**1,50**	0,72	0,55	1,25	1,23	0,82	0,84	**1,49**	**2,95**
CL23	132	1,24	**3,72**	**3,08**	**2,28**	**2,04**	**1,37**	0,82	0,63	**2,62**	**2,55**	1,08	0,41	0,32	0,51	0,51
CL26	32	**1,73**	**1,47**	**1,84**	**17,59**	**1,78**	1,25	0,80	0,74	**2,19**	**3,27**	1,05	0,44	0,38	0,63	0,94
CL29	107	1,15	0,72	0,97	0,77	1,04	0,74	0,65	0,66	0,57	0,84	1,16	0,80	0,61	**1,31**	1,05
CL31	295	**1,90**	**1,80**	**1,74**	**2,30**	**2,20**	1,21	1,23	0,74	**1,54**	**1,90**	**1,39**	0,66	0,47	0,71	0,83
CL32	81	1,03	0,49	0,88	0,51	0,69	1,04	0,97	1,28	0,86	0,66	0,71	**1,77**	**1,51**	1,27	**1,34**
CL36	9	**1,64**	0,75	0,98	**5,28**	0,90	0,65	0,44	0,85	1,26	1,18	0,89	0,58	0,69	0,59	1,02
CL37	37	1,22	**1,30**	1,19	0,86	**1,41**	**5,86**	0,88	0,71	1,26	1,26	1,16	0,63	0,42	0,62	0,90
CL38	56	0,95	1,20	0,81	0,99	0,84	0,90	0,90	0,80	0,71	0,84	0,86	0,59	0,55	0,67	0,70
CL40	104	**9,16**	**1,38**	1,42	**2,48**	**2,10**	**1,34**	1,03	0,62	**1,73**	**1,55**	**1,30**	0,72	0,56	0,64	0,94
CL41	81	1,24	0,99	0,99	1,22	**1,55**	0,80	0,67	0,54	1,14	1,09	1,10	0,58	0,44	0,81	0,87
CL42	23	0,86	0,86	0,65	1,12	1,10	1,11	1,07	**5,93**	0,77	1,00	0,92	0,61	0,61	1,23	0,97
CL43	19	0,51	0,83	1,02	**1,62**	0,74	0,63	0,49	1,12	0,45	**1,30**	0,88	0,71	**5,83**	0,87	**1,72**
CL44	6	**3,30**	0,87	1,17	**2,36**	**1,83**	**2,10**	0,54	0,67	**3,30**	**1,45**	0,96	0,55	0,24	0,79	**1,51**
CL49	40	**1,99**	**1,86**	**1,56**	**1,55**	**1,80**	**1,85**	**1,85**	0,77	**13,65**	2,00	1,17	0,60	0,54	0,69	0,84
CL53	15	0,92	**1,49**	**1,83**	**2,13**	**1,64**	**1,53**	**20,51**	0,84	1,19	**1,93**	1,28	0,63	0,69	0,62	1,18
CL54	67	0,78	0,68	0,75	0,69	0,85	0,57	0,48	0,42	0,60	0,72	0,72	0,46	0,35	0,59	0,56
CL59	105	**1,64**	0,85	0,93	1,24	**1,30**	0,73	0,69	0,54	0,80	1,14	**2,40**	0,78	0,47	0,87	1,01
CL72	24	1,21	1,12	0,98	0,97	1,17	0,65	0,60	0,58	1,16	0,82	1,26	0,62	0,38	0,90	1,27

CLUS	sector 18	sector 19	sector 20	sector 21	sector 22	sector 23	sector 24	sector 25	sector 26	sector 27	sector 28	sector 29	sector 30	sector 31	sector 32	sector 33	sector 34
CL21	0,81	0,83	0,94	0,86	0,91	0,63	0,96	0,84	0,77	**1,31**	0,98	1,01	**1,35**	0,96	1,04	1,27	1,03
CL219	**14,04**	0,63	0,77	**1,71**	0,94	**1,33**	0,78	0,97	0,79	0,74	0,56	0,35	**1,52**	0,72	1,06	**1,45**	0,84
CL22	0,61	**2,15**	**1,38**	**1,45**	**1,54**	0,86	**2,49**	1,15	0,54	1,10	0,71	0,96	1,26	0,95	0,94	**1,42**	0,92
CL23	0,72	0,58	0,50	0,51	0,88	0,27	0,47	0,69	0,49	0,77	0,49	0,65	0,58	0,61	0,65	0,80	0,54
CL26	0,67	**1,80**	0,78	0,63	**1,80**	0,34	0,85	0,79	0,44	0,73	0,51	1,13	0,65	0,71	0,79	0,78	0,51
CL29	0,85	0,86	0,83	**1,76**	1,24	0,76	1,07	1,30	0,77	0,97	0,91	0,81	**1,33**	**1,49**	**1,33**	**1,30**	**1,66**
CL31	0,66	0,78	0,74	0,73	0,88	0,43	0,70	0,78	0,65	1,10	0,71	0,68	0,91	0,83	0,79	1,05	0,71
CL32	**1,35**	**1,53**	**1,68**	**1,45**	**1,40**	**1,68**	**1,43**	**1,30**	1,23	0,78	0,64	0,98	0,84	1,04	1,04	0,90	1,11
CL36	0,47	1,30	0,54	0,58	**1,54**	0,48	0,77	0,90	0,90	**1,47**	1,25	**17,69**	0,86	0,69	0,69	0,88	0,75
CL37	0,63	0,63	0,54	0,55	0,71	0,49	0,49	0,69	0,99	0,92	0,67	0,75	0,97	0,82	0,88	1,03	0,73
CL38	0,69	0,69	0,56	0,66	0,61	0,58	0,69	0,78	**2,97**	1,01	0,83	0,68	0,86	0,69	0,88	0,80	0,78
CL40	0,66	0,71	0,85	0,75	0,91	0,57	0,79	0,77	0,73	1,00	0,77	0,76	0,98	0,91	0,97	1,03	0,60
CL41	0,53	0,70	0,67	0,58	0,80	0,43	0,64	0,66	0,66	**3,19**	0,90	0,88	1,08	0,79	0,82	0,98	0,79
CL42	1,02	1,03	0,79	0,69	0,60	0,44	0,70	0,89	0,80	0,99	0,62	0,74	0,84	0,78	0,94	0,88	1,02
CL43	0,96	1,00	**1,40**	0,80	1,20	0,69	0,99	1,04	0,95	1,01	0,63	1,03	1,12	0,79	0,74	0,79	0,95
CL44	0,70	**1,51**	0,59	0,50	**12,10**	0,57	1,06	1,21	0,48	1,18	0,65	**2,42**	1,18	0,91	0,77	0,92	0,55
CL49	0,70	0,72	0,69	0,78	1,00	0,51	0,80	1,00	0,73	0,99	0,69	0,60	0,95	0,82	0,83	0,97	0,62
CL53	0,85	0,98	0,74	0,88	**1,56**	0,53	0,92	0,80	0,44	0,82	0,72	0,64	0,77	0,75	0,79	0,85	0,67
CL54	0,70	0,54	0,51	0,49	0,55	0,34	0,53	0,55	0,53	1,03	**4,17**	**1,74**	**1,50**	0,57	0,61	0,70	0,81
CL59	0,45	0,61	0,71	0,62	0,65	0,48	0,56	0,65	0,60	0,97	0,71	0,54	1,15	**1,34**	0,94	1,16	0,64
CL72	0,46	0,59	0,73	0,75	0,73	0,50	0,83	0,62	0,81	1,23	0,81	**1,55**	1,21	1,22	**5,62**	1,12	0,89

note: high location (over 1,30) are in bold. Very high location quotients (over 2,00) are framed.