THE GREAT URBAN TECHNO SHIFT: ARE CENTRAL NEIGHBORHOODS THE NEXT SILICON VALLEYS? EVIDENCE FROM THREE CANADIAN METROPOLITAN AREAS

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Abstract

A growing literature suggests that inner city economies are changing as abandoned factories are replaced by techno start-ups. Much of the evidence so far is anecdotal. The paper examines the spatial dynamics (1996-2011) of "New Economy" (NE) employment in Canada's three largest metropolises using GIS and econometric techniques. The evidence is consistent with a shift to central neighborhoods. The share of NE employment in central neighborhoods grew and average distances to the central business district fell. The econometric results point to the increasing weight of central city attributes and decreasing role of suburban attributes as predictors of NE employment location.

Key Words:
New Economy; Intra-metropolitan Distribution of Employment; Cities; Canada

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Résumé

Plusieurs études récentes suggèrent que les quartiers centraux des grandes villes sont en train de se métamorphoser, à mesure que des start-up innovantes réinvestissent d'anciens entrepôts industriels désaffectés. A ce jour, la plupart des travaux demeurent cependant des cas d'études. Ce travail analyse l'évolution de la localisation de l'emploi dans le secteur de la "Nouvelle Economie" (NE) entre 1996 et 2011 dans les trois plus grandes métropoles canadiennes, à l'aide de techniques de SIG et économétriques. Nos résultats indiquent que la NE s'est centralisée depuis le milieu des années 1990. Ainsi, au sein des régions métropolitaines, les quartiers centraux regroupent un part croissante de l'emploi dans la NE et la distance moyenne au centre-ville de l'emploi dans la NE a progressivement diminué. Les résultats économétriques révèlent qu'une partie des facteurs de localisation de la NE a changé au cours du temps, les caractéristiques propres aux quartiers centraux (et notamment la présence importante d'artistes parmi les résidents) jouant un rôle croissant.

Mots clés :
Nouvelle économie; Distribution intra-métropolitaine de l'emploi; Villes; Canada

INTRODUCTION

Are central neighborhoods about to replace the Silicon Valleys of this world as the new techno stars of the digital era? That is the question driving this paper.

Several authors (Foord, 2013; Hutton, 2004; 2006; 2009; Indergaard, 2003; 2009; 2013; Polèse, 2014; Pratt, 2009; Rantisi and Leslie, 2010) have argued that the economies of inner neighborhoods, notably in the major cities of the Western World, are undergoing a change as factories and warehouses are abandoned, replaced by refurbished workspaces for young computer geeks and techno start-ups. From a more interventionist perspective, Katz and Bradley (2013) and Katz and Wagner (2014) have coined the concept of "innovation districts", the new foci they argue of the rising digital economy. The popular press is replete with examples (and associated hype) of urban techno clusters with appropriately named *Silicon Alley* in Manahan and *Silicon Roundabout* in London among the featured stars (Biddulph, 2012; Wainright, 2012; Wortham, 2010). Kendall Square in Boston and SoMa in San Francisco are other examples, the latter it seems challenging Silicon Valley on its home turf (*The Economist*, 2016; Nieva, 2014; Weinberg, 2015). Facebook's new campus is located in Menlo Park in the Valley, but Twitter, Uber, and Airbnb have chosen downtown San Francisco.

How much of this is an optical illusion? Much of the evidence so far has been anecdotal or based on case studies. The emergence of new techno neighborhoods is undeniable, but suburban techno clusters may still be growing faster. This paper examines the location of "New Economy" employment over a fifteen year period in Canada's three largest metropolitan areas, taking a quantitative approach using an industry-based definition of "New Economy" focused on computer and IT-based services (definition issues are discussed below) as distinct from "creative" industries with a high arts content. The distinction matters for two reasons. Creative industries are not necessarily "new"; actors, musicians, artists, writers, and other cultural workers predate the digital era[1]. More to the point, the "creative" arts-based milieu is historically associated with central neighborhoods, be it Paris' Left Bank, London's West End or Greenwich Village in New York. The inclusion of such creative workers would have biased the proposed analysis towards central neighborhoods, at the heart of the question addressed in this paper.

The paper uses descriptive data and GIS and econometric techniques to examine the spatial dynamics of New Economy (henceforth, NE) employment in Toronto, Montreal, and Vancouver (populations 2011, respectively, 5.5, 3.8, and 2.3 million) using micro-data from the 1996, 2001, and 2006 Canadian censuses and 2011 National Household Survey. An econometric model is estimated to examine whether the location determinants of NE employment have changed over

[1] See also figure 1. Typical of an emerging industry, NE employment has grown much faster than other high-order services, including arts-based "creative" industries

time. Results are generally consistent with the thesis of a shift to central locations and increasing weight of attributes associated with central neighborhoods and decreasing role of attributes associated with suburban techno parks as predictors of NE employment location.

The paper is structured as follows. A first section considers the possible factors driving the shift of NE activity to central neighborhoods, followed by a discussion of data and definitional issues. Methods and models used are presented in a third section, followed by the presentation of results and conclusions.

EXPLAINING THE SHIFT TO CENTRAL NEIGHBORHOODS

The intra-metropolitan location of computer services and related high-order services has been abundantly studied, but studies examining location over time are few. Those that have are generally dated, using fairly broad spatial classes, with computer services often one class within a wider business services class. Grimes et al. (2007) and Nunn and Warren (2000), using county data for U.S. metro areas, look respectively at 1990-1997 and 1982-1993, and find that computer services dispersed, suggesting that the shift to central neighborhoods is a recent phenomenon. However, the use of county data in which the central city is often a single observation makes it difficult to draw general conclusions at the neighborhood level. Coffey and Shearmur (2002) look at Montreal from 1981 to 1996, the fifteen years preceding the period examined here. They also find that computer service employment dispersed, non-CBD census tracts capturing the greater share of employment growth. However, Coffey and Shearmur's (2002) strict definition of the central business district (CBD) means that census tracts close to the CBD, often among the most dynamic neighborhoods (as we shall discover), are classified in a 'rest-of-metropolis' class, again making comparisons difficult.

Central neighborhoods have not traditionally been the focus of the high-tech literature. An important literature exists on knowledge spillovers, research parks, universities, and the spatial dynamics of innovation, going back to the classic writings Anselin et al. (1997) and Audretsch and Feldman (1996). Moretti (2012) in his study of the "new" geography of jobs points to "the great divergence" between places (in the U.S.) that have the right attributes and those that do not, implicitly suggesting a shift to favored cities. Moretti (2012), as others before him, focuses on determinants such as human capital, good universities, and entrepreneurship. These remain valid for cross-city comparisons, but are not terribly useful for understanding the location dynamics of jobs within cities. Hutton (2004; 2006; 2009) whose case studies of the new economy of inner-cities are arguably the most exhaustive (covering London, San Francisco, Singapore, and Vancouver) stresses the role of "space and place": the quality of the social and built environment and access to typically central urban functions (finance, entertainment…). However, this does not fully answer the question of why now and not before.

The literature (plus the authors' intuitions) suggest a combination of reasons: a) changes in workforce lifestyle preferences; b) changes in the nature of the computer service industry, increasingly wedded to content, less to containers; c) miniaturisation of computer hardware and parallel fall in prices and entry costs; d) growth of start-ups (in part a corollary of (c)) and consequent need for proximity to potential investors; e) new availability of commercial space in central areas, often aided by public policies aiming at revitalizing abandoned neighborhoods.

The driver for (a) is the residence-workplace nexus: the lifestyle choices of NE workers, a recurrent theme in the creative district literature (Hutton, 2006; Indergaard, 2009; Foord, 2013). Workers and entrepreneurs will normally seek to minimize the distance between workplace and residence. Katz and Bradley (2014) argue that the lifestyle preferences of younger, educated, workers have undergone a fundamental change over the last two decades with new cohorts less car-oriented and increasingly attuned to city life. Citing data from the American Community Survey for the 51 largest metropolitan areas (Cortright, 2014), they note that the share of college-educated 24-35 year-olds living within three miles of the CBD increased by 26% between 2000 and 2009, double the rate for the same cohort as whole.

A second change (b), we suggest, drawing NE firms to the centre is the growing emphasis on digital *content* (music, images, information, news…). Indergaard (2013) coins the term "digitalisation of culture" to characterize the growing symbiosis between the arts and technology, reinforcing the supplier-customer relationships with entertainment and broadcasting, generally located in central districts. The link with the residential/workplace choices (a) of NE workers is fairly self-evident, in part at the root of the overlap between the "creative" and "innovative" district literature. The arts-technology symbiosis should for example influence the neighborhood choices of software publishers of computer graphics and special effects, to take two examples. An important computer gaming industry has emerged in Montreal since the late 1990s, most major studios, to our knowledge, located within a short distance of the CBD (see also Rantisi and Leslie, 2010).

A third reason for the spatial shift is, we suggest, the progressive miniaturization of computer devices noted by Polèse (2014), and concomitant fall in prices. Scale economies and barriers to entry have become less important. The miniaturization of computer hardware means that NE firms are starting to resemble financial and other high-order services, able to generate high income streams with relatively little floor space, making it possible to afford the high real estate costs typical of central locations. For firms with high hardware and data storage costs, suburban campuses may still be more cost-effective; but, for many start-ups space requirements are minimal: a few laptops plus a lot imagination and determination. Interaction with financial institutions (d), traditionally concentrated in the CBD, can act as an additional centralizing factor for start-ups in search of venture capitalists and other investors. The fifth possible factor (e) favoring centralization is the new availability, where at hand, of comparatively inexpensive commercial space near the centre as factories and warehouses close.

Not all of these factors are new. Access to investors always mattered, although demand for venture capital has probably increased as start-ups multiply. The de-industrialisation of central neighbourhoods began several decades ago in most areas; but the conversion of industrial neighbourhoods is often a drawn-out process with serviceable commercial spaces and urban amenities only available recently, the public sector often being a key catalyst. Examples in Canada are the Design Exchange in Toronto, the *Cité du Multimédia* in Montreal, and False Creek Flats in Vancouver (Hutton, 2004).

Finally, taking a broader perspective, the shift to the center (if confirmed) of innovation-driven techno firms is perhaps but one facet of a wider phenomenon of return to urban life (Ehrenhalt, 2012; Glaeser and Gottlieb, 2006), specifically for better educated populations and budding entrepreneurs. By the same token, are we perhaps witnessing (if confirmed) a return to urban normality, so to speak, the intra-urban face of Duranton and Puga's (2001) nursery cities hypothesis, as central areas take back their historic function as birthplaces to the newest economic sectors of each generation?

DATA AND DEFINITIONS

There is no universally agreed-upon definition of New Economy. Some definitions encompass the entire information and communications technology (ICT) sector as defined by the OECD, including manufacturing, wholesaling, and services, but with no necessary common location-specific attributes (Holm and Østergaard, 2015; Lasagni, 2011; Maurseth and Frank, 2009). For others closer to the creative district literature, New Economy includes activities such as design and architecture which may involve the use of computer technologies (Foord, 2013; Hutton, 2004; Pratt, 2009) but, as noted earlier, are not really "new". Others have defined more homogeneous classes focusing on computer and internet-based activities (Arai et al., 2004; Grimes et al., 2007; Moriset, 2003), which is also the path chosen here, using Statistics Canada industry classes.

All data are based on Statistics Canada micro-data drawn from the 1996, 2001 and 2006 censuses, and the National Household Survey for 2011. Micro-data for employed persons were aggregated at the census tract level by place of work. The micro data contain information on individual employment by industry (at the 4-digit level), that is, the industry of the establishment in which the individual works. Statistics Canada changed classification schemes in 1997. Industries prior to 1997 are based on SIC codes (Standard Industrial Classification) and on NAICS codes (North American Industry Classification System) thereafter, periodically updated. To construct a consistent definition over time, concordance tables provided by Statistics Canada were applied[2]. Codes and descriptions for each census year are given on Table 1.

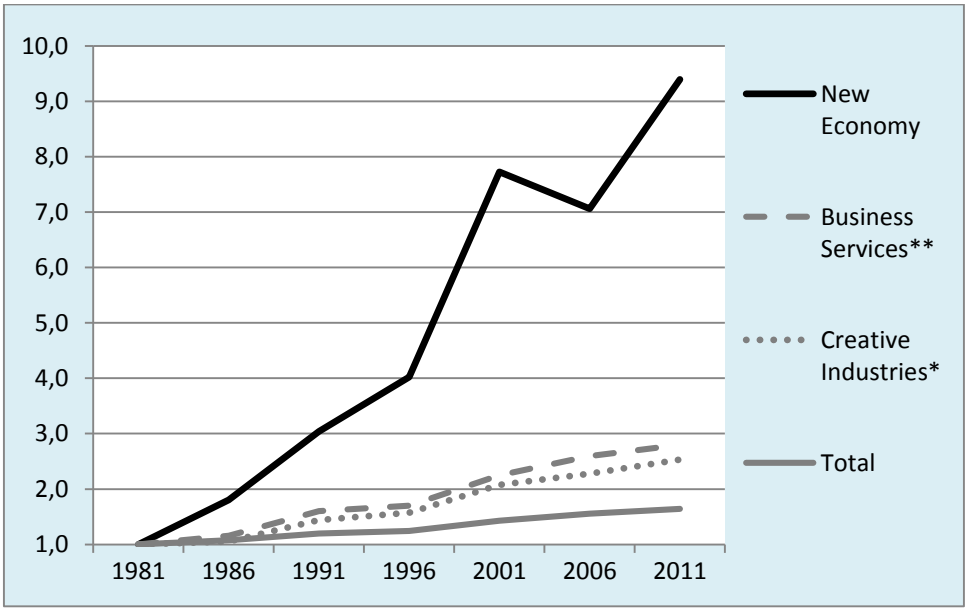
[2] Tables available at: http://www.statcan.gc.ca/eng/concepts/concordances-classifications

Table 1: New Economy - Definition and Employment: Three Metropolitan Areas (1996-2011)

Year	Classification	Codes	Industry Class	Montreal	Toronto	Vancouver
1996	SIC 1980	M772	Computer Services	21,715 (1.30)	42,265 (1.83)	12,380 (1.32)
2001	SIC 1980	M772	Computer Services	49,715 (2.72)	95,535 (3.59)	31,900 (3.10)
	NAICS 1997	5112	Software Publishers	41,895 (2.30)	75,595 (2.84)	26,220 (2.55)
		5142	Data Processing Services			
		5415	Computer Systems Design and Related Services			
2006	NAICS 2002	5112	Software Publishers	45,310 (2.32)	73,895 (2.61)	27,490 (2.48)
		5182	Data Processing, Hosting, and Related Services			
		5415	Computer Systems Design and Related Services			
2011	NAICS 2007	5112	Software Publishers	49,955 (2.49)	76,305 (2.59)	29,605 (2.54)
		5182	Data Processing, Hosting, and Related Services			
		5415	Computer Systems Design and Related Services			

Note: Share of New Economy jobs in total metropolitan employment in brackets.

Fortunately, the 2001 Census, provides industry data by both SIC and NAICS codes, allowing us to compare the impact of the two classifications on results. Table 1 shows NE employment for the three metropolitan areas for each year. For 2001, the number of NE jobs based on SIC is higher than for NAICS, explained by the SIC "Computer Services" class, which not only includes the three industry classes in the NAICS-based definition (5112; 5142; 5415), but also parts of two industry groups (5111: Directory and Mailing List Publishers; 5324: Office Machinery and Equipment Rental and Leasing). However, what matters is whether the exclusion of these activities significantly alters the intra-metropolitan distribution of NE employment. A dissimilarity index[3] was calculated for each metropolitan area in 2001, comparing the two classification schemes; it was respectively 0.090 for Montreal, 0.089 for Toronto, and 0.079 for Vancouver, indicating a close fit between the two distributions. In the rest of the paper, NE employment for 2001 is only given according to the NAICS definition.



*Broadcasting, Telecommunications, Motion Picture & Sound Studios, Performing Arts, Advertising, Architects
**Accounting, Legal Services, Management & Technical Consultancies, Other Business Services
Source: Canadian censuses (1981; 1986; 1991; 1996; 2001; 2006) and 2011 National Household Survey, Statistics Canada.

Figure 1: Growth (1981 =1.00) Total Employment and Three Industry Groupings. Toronto, Montreal, and Vancouver

[3] The Duncan and Duncan (1955) dissimilarity index is calculated as follows:

$$DI = \frac{1}{2}\sum_{i=1}^{n}\left|\frac{x_i}{X} - \frac{y_i}{Y}\right|$$

Where x_i refers to the number of SIC-based NE jobs in census tracts i; X the number of SIC-based NE jobs in the metropolitan area; y_i the number of NAICS-based NE jobs in census tracts i; Y the number of NAICS-based NE jobs in the metropolitan area; and n the number of census tracts in the metropolitan area. The index ranges from 0 (perfectly equal distribution) to 1 (perfectly unequal).

Figure 1 shows growth in total employment and in NE and two related industry classes for the three metro areas (1981-2011). Three points are worth noting: 1) the difference in employment growth between New Economy and two sister high-order services. Creative and business service jobs grew faster than employment as a whole (respectively, by factors of 2.5 and 2.8), but nothing compared to NE employment which registered almost tenfold growth; 2) the acceleration of NE growth[4] after 1995 roughly the point at which the Internet arrived and the generalization of laptops; 3) the bust in 2000-2001 of the techno bubble, but finally only a blimp in the ascending growth path of New Economy employment.

Finally, all spatial boundaries were standardized over time for 1996-2011. Census Metropolitan Areas (CMAs) boundaries were reconstructed to their 1996 geographies and census tracts split between 1996 and 2011 were re-aggregated. The number of census tracts in each CMA is respectively 798, 753, and 283 for Toronto, Montreal, and Vancouver. The three Canadian CMAs are depicted in the Supplementary Appendix A.1.

METHODS AND MODELS

Empirical analysis is carried out in two stages: a) descriptive analysis of the spatial dynamics of NE employment; b) estimation of an econometric model to examine whether the location determinants of NE employment have changed over time.

Descriptive Analysis

The weighted average distance of NE employment from the CBD is used to provide a first indicator of the evolution of the intra-metropolitan distributions. For each year, the index is calculated as:

$$Decentralization_t = \sum_{i=1}^{n} \frac{e_{i,t}}{E_t} \cdot Dist_i \qquad (1)$$

Where $\frac{e_{i,t}}{E_t}$ is the share of metropolitan New Economy employment in census tract *i* in year *t*, $Dist_i$ the distance between census tract *i* and the CBD[5], and *n* the number of census tracts in the metropolitan area.

The next step involved the identification of NE employment concentrations (also called NE clusters or poles), allowing us to map NE poles at different points in time to asses which grew and which shrank between 1996 and 2011.

[4] Figure 1 underestimates the acceleration because of the shift from SIC to NAICS codes after 1996. As noted above, SIC-based estimates are higher than for NAICS meaning that the 1996 figure is an "overestimate" when compared to later dates. See also footnote 16.

[5] Geo-coded street data was used to compute the shortest road network distance between each census tract and the CBD.

Different methodologies exist to identify employment concentrations: threshold methodologies (Giuliano and Small, 1991; Bogart and Ferry, 1999; Anderson and Bogart, 2001; Coffey et al., 2000; Shearmur and Coffey, 2002; Muñiz et al., 2008; Garcia-López and Muniz, 2010); non parametric methods (Craig and Ng, 2001; McMillen, 2001; Redfearn, 2007); exploratory spatial data analysis (Baumont et al., 2004; Guillain et al., 2006). Threshold methodologies, the most widely used, have advantages to study the evolution of urban form for a single city (McMillen and Lester, 2003). However, the method relies on arbitrary cut-offs points. Moreover, this method can lead to an "inflation" in the number of employment centers over time when analysis is carried out over a period of strong employment growth or, as is the case here, for rapidly growing industries. Muniz et al. (2008) propose using "statistical" (or relative) thresholds instead of "numerical" (or absolute) thresholds. Thus, following Muniz et al. (2008), NE employment concentrations are defined here as census tracts with both a high NE employment density (i.e. a high number of NE jobs per km²) and a high level of NE employment, using statistical thresholds[6]. For each metro area, NE employment concentrations are identified for 1996, 2001, 2006 and 2011 as census tracts with a NE employment density ($D_{i,t}$) greater than or equal to the third quartile of NE employment density of the metro area ($D_{q3,t}$), and with NE employment ($E_{i,t}$) greater than or equal to the third quartile of NE employment ($E_{q3,t}$) of the metro area:

$$D_{i,t} \geq D_{q3,t} \qquad (2)$$

$$E_{i,t} \geq E_{q3,t} \qquad (3)$$

For each of the three CMAs, once census tracts with both a high density and employment levels are identified, contiguous census tracts are grouped into four spatial classes: New Economy Central Districts (including the CBD and adjoining central neighborhoods); Major Suburban NE Poles; Other NE Poles; Rest of the CMA. The share of metropolitan NE employment in each area in 1996, 2001, 2006 and 2011 is computed, to assess relative growth (or shrinkage) over time[7].

[6] Since census tracts are larger in suburban areas, using employment density per km² entails the risk of underestimating the weight of outlying suburbs. The potential bias is, however, largely mitigated here given that we are analyzing the *evolution* of NE employment concentrations over time. Also, parallel mapping analyses were carried out using NE employment density per capita and NE employment location quotients, showing similar results; available upon request.

[7] Shares of metropolitan employment are computed using *constant geographies (invariant New Economy employment poles over time)* where poles comprise all census tracts part of a NE pole in either1996 or 2011. Similar results were obtained using separate 1996 and 2011 geographies (available upon request).

Table 2: New Economy Location Determinants over Time

Variable	Excepted Impact	Rationale
Neighborhood Structure		
Creative Industries (LQ)	Increasing	Changes in the nature of output, more wedded to content: sound; graphics; news; entertainment.
Financial Institutions (LQ)	Increasing	Miniaturization => deceasing barriers to entry => start-ups => demand for venture capital.
Computer Manufacturing (LQ)	Decreasing	Decreasing link with hardware, more with design and development.
Accessibility		
Proximity Airport	Decreasing	Airports generally suburban.
Proximity Highways	Decreasing	Changing workforce lifestyle preferences: new cohorts less car-oriented.
Proximity Subway	Increasing	Changing workforce lifestyle preferences.
Neighborhood Environment		
Average Housing Rent	Indeterminate	Three opposing effects: - Miniaturization => decreasing expulsive effect of high rents. - More start-ups => sensitive to costs => increasing expulsive effect of high values. - Changing workforce lifestyle preferences => amenities capitalized in rental values => values have an increasingly positive effect.
Distance to CBD	Increasing	Miniaturization => decreasing space requirements.
Students in Computer Sciences (Relative presence)	Increasing	Young start-ups may often start in (or near) place of residence; miniaturization makes this easier.
University Faculty in Computer Sciences (Workplace)	Indeterminate	Indicator of access to university resources (i.e. knowledge); no *a priori* reason why should be more or less important now.
Performers, Writers & Other Arts-related Professions (Relative presence)	Increasing	Indirect indicator of cool neighborhoods attractive to "creative" types. Changing workforce lifestyle preferences and growing links with creative industries should favor such neighborhoods.

Econometric Model: Location Determinants over Time

Several factors may explain why NE firms are shifting to central neighborhoods. Following from the discussion in section 1, Table 2 summarizes possible variables and associated expectations. These in turn lay the foundations for the base econometric model, estimated separately for each metropolitan area at the census tract (CT) level. The model reads as follows:

$$Y_i = \alpha + \sum_{k=1}^{3} \beta_k \cdot Empl + \sum_{l=1}^{5} \gamma_l \cdot Env_{l,i} + \sum_{m=1}^{3} \delta_m \cdot Access_{m,i} + \varepsilon_i \qquad (4)$$

Where $Empl_{k,i}$, $Env_{l,i}$ and $Access_{m,i}$ respectively identify sets of attributes describing CT employment mix, neighborhood environment, and measures of relative accessibility.

For *employment mix*, three industry variables were created: *Creative industries*, as identified on figure 1; *financial institutions*, banks and other credit intermediaries which include venture capital societies, but nonetheless an admittedly imperfect proxy for the availability of potential investors; c*omputer manufacturing*, which refers to a single industry class. Location quotients per census tract were calculated for each to measure concentrations. The first two variables are expected to increasingly affect the location of NE employment over time. The third is included as an indicator of (generally) suburban techno parks[8], whose relative importance as NE location determinant we would thus expect to decline.

Five variables were created for *neighborhood environment*. The first, *Rent*, measures average housing rent by room, a proxy for general real estate values. Rental values can exert opposing impacts. High rental values will naturally exert a negative price effect. However, Arai et al. (2004) and Moriset (2003) found that real estate costs had little impact on location choices. Moreover, as posited above, we would expect NE firms to be increasingly capable of bearing high costs thanks to miniaturization. High rental values may also have a positive effect where they reflect amenities (cafés, good restaurants, parks…) or better quality buildings, capitalized in housing prices. As the weight of amenities increases, we might expect NE employment to exhibit a growing positive relationship. The second neighborhood variable (*Distance to CBD*) should capture the need to interact with downtown players; which we would expect to play an increasing role in determining the location of NE employment. Geo-coded street data was used to compute the shortest road network distance between each census tract and the CBD (accessibility measures using network distances are generally preferable to Cartesian distances; Apparicio et al., 2008). A third neighborhood variable (*Students in Computer Sciences*) measures the number of graduate (M. Sci. or Ph.D. level) students in computer sciences and related fields as a share of the resident population. We might reasonably expect many young start-ups to begin in their neighborhood of residence, often in their residence. A note of caution: this variable is not necessarily related to the presence of

[8] The variable was mapped for the metro areas; visual inspection confirmed that the principal concentrations were suburban, generally clustered around identifiable office parks.

universities, the purpose of the next variable, *University Faculty in Computer Sciences*, which measures the number of faculty (professor level) with degrees in computer sciences and related fields employed in a census tract and five closest CTs[9]. The two "university" variables are only weakly correlated[10], suggesting that the student variable is closer to a life-style indicator, students choosing particular neighborhoods[11]. The fifth neighborhood variable (*Arts-related Population*) measures the number of person in arts-related occupations as a share of the resident population. The exact list of occupations is given in Supplementary Appendix A.2. This variable is similar to Florida's (2002) Bohemian Index although not an exact clone as Canadian occupational classes differ from those used in the U.S. census. It comes closest, arguably, to identifying neighborhoods that typify the so-called creative class or, to use other favored adjectives, cool, trendy neighborhoods, favored by artsy types.

Accessibility is measured via three variables: *Inv. Distance Airport, Highway, Subway*: respectively the inverted distance to the airport, the nearest highway entrance, and the nearest subway station. Accessibility is again based on the shortest road network distance. The inverted distance (rather than direct distance) was calculated as suggested by McDonald and Prather (1994). We thus implicitly posit that the three distance effects are lower than for access to the CBD. Using the inverted distance also has the advantage of reducing possible multicollinearity between accessibility measures. We expect proximity to subway to increasingly affect NE employment (due to changing workforce lifestyle preferences) but proximity to the airport and to highway to have a decreasing effect.

Two econometric models were estimated. First, a binomial logistic model is estimated to identify the general determinants of location of NE employment over the whole period (1996-2011). To do so, a dichotomous dependent variable was created, equal to 1 if the census tract is part of a NE pole for any of the four census years (hereafter "attractive census tracts"), and 0 otherwise (hereafter "unattractive census tracts").

Second, to examine if and how location determinants have changed over time, a multinomial logit model[12] was estimated, distinguishing between three classes of census tracts: "unattractive census tracts" ($y=0$), "attractive but declining NE census tracts" ($y=1$) and "attractive and growing NE census tracts" ($y=2$). "Attractive but declining NE census tracts" are defined as attractive census tracts (i.e. located in a NE pole for any of the four census years) whose shares of total metropolitan NE employment declined between 1996 and 2011. "Attractive and growing NE census tracts" refer

[9] The five census-tract criterion was introduced for three reasons: a) university campuses can encompass an entire CT making associations with other employment impossible; b) without this, many CTs would register zero faculty employment; c) large university campuses can cross several CTs.

[10] Correlation coefficient between the two variables = 0.142 (three CMAs merged).

[11] Graduate students only were included to minimize the impact of younger students, possibly still living with their parents.

[12] Since the analysis is carried out for a period of continuing centralization of New Economy employment, estimating growth models over different sub-periods (e.g. 1996-2001 versus 2006-2011) is inappropriate for determining whether location factors have changed over time.

to attractive census tracts whose shares grew between 1996 and 2011[13]. The Supplementary Appendix A.3 gives information on the temporal and spatial distribution of growing and declining NE tracts. Thus, tracts that emerged as poles only in 2011 accounted for some 39% of growing poles but less than 1% for declining NE tracts. Inversely, for declining tracts, 47% were poles in 1996 only against 1% for growing NE tracts. As a result, variables associated with declining poles will, as a rule, identify past (pre-1996) determinants with the opposite holding true for growing NE tracts.

As noted earlier, using employment density per km² entails the risk of overestimating the weight of central neighborhoods since census tracts are smaller in central areas. While this is not a serious issue when examining the *evolution* of NE employment poles (figures 4, 5 and 6), it can lead to an overestimation of the weight of central city attributes in econometric analyses. Thus, the econometric model is estimated using three different definitions of NE employment poles: (i) NE employment density per km2 and NE employment (see equations 2 and 3); (ii) NE employment density per capita and NE employment; (iii) NE employment location quotients and NE employment.

Finally, the dependent variable was created from the 1996, 2001, 2006 and 2011 censuses whereas independent variables were built using the 1996 census to minimize possible endogeneity. If for example we find that NE jobs are concentrated in census tracts with high relative concentrations of creative industries, we might reasonably question whether the estimated impact truly reflects the fact that NE start-ups choose to locate near creative industry firms, or whether the estimated effect arises from creative industries choosing to locate near NE firms. Given that NE employment accounted everywhere for less than 2% of employment in 1996 (table 1), measuring independent variables in 1996 mitigates potential reverse causality problems. It is highly unlikely that NE employment, such as there was in 1996, affected the location of creative industries at the time. However, endogeneity issues may remain for accessibility variables even when using lagged explanatory variables (Redding and Turner, 2015), but minor here since almost all the infrastructures were in place well before 1996.

RESULTS

Descriptive and mapping results are presented first, followed by the econometric models.

[13] A second multinomial logistic regression was carried out in which decline and growth were defined in terms of employment numbers not shares. The results were very similar, available upon request.

Evolution of New Economy Employment: Montreal; Toronto; Vancouver

Figure 2 illustrates the growth of total and of New Economy employment between 1996 and 2011 in Montreal, Toronto, and Vancouver. As in figure 1, employment is set to 1.0 for the initial year. In all three, NE employment exploded during the techno 1996-2001 boom[14], only to abruptly stall when the bubble burst. The impact was most severe in Toronto where NE employment barely grew after 2001. In Montreal and Vancouver, growth picked up again, growing at comparable rates between 2001 and 2011.

Figure 2: Growth (1996=1.0) Total and New Economy Employment: Three Metropolitan Areas

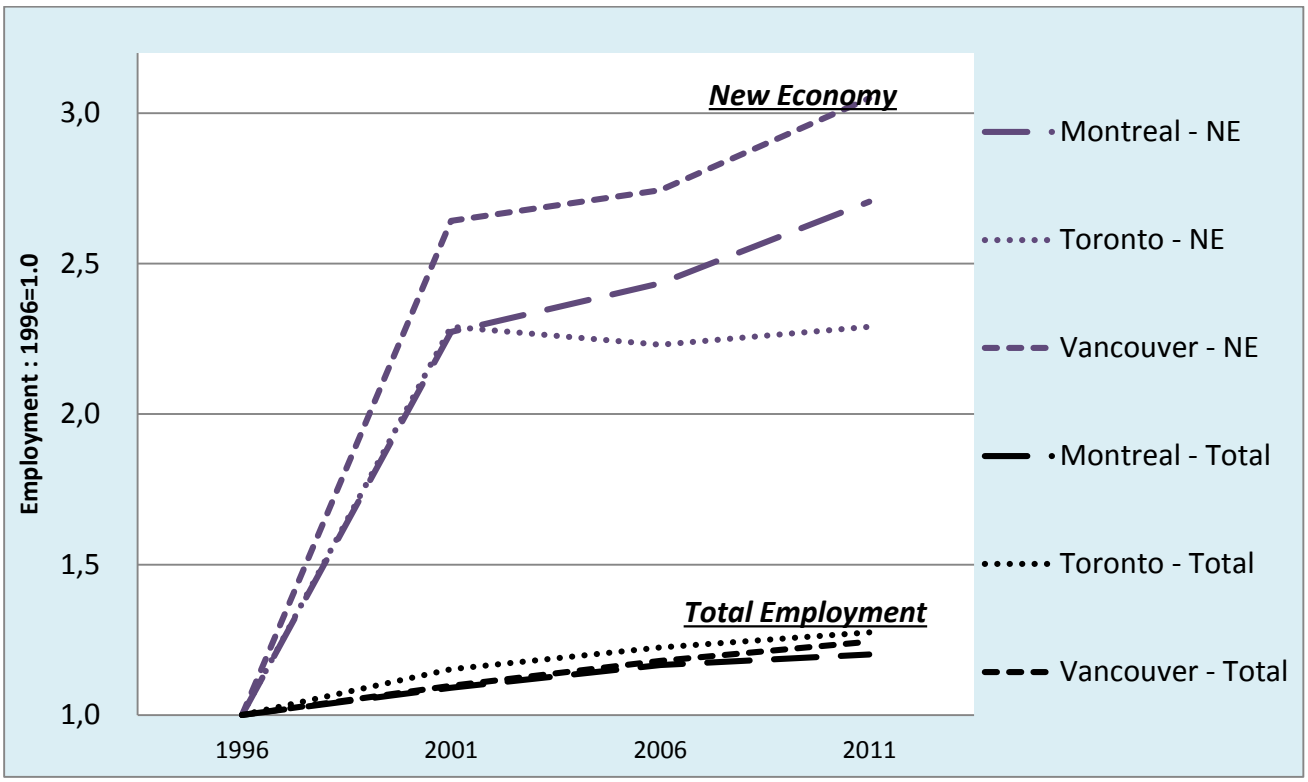
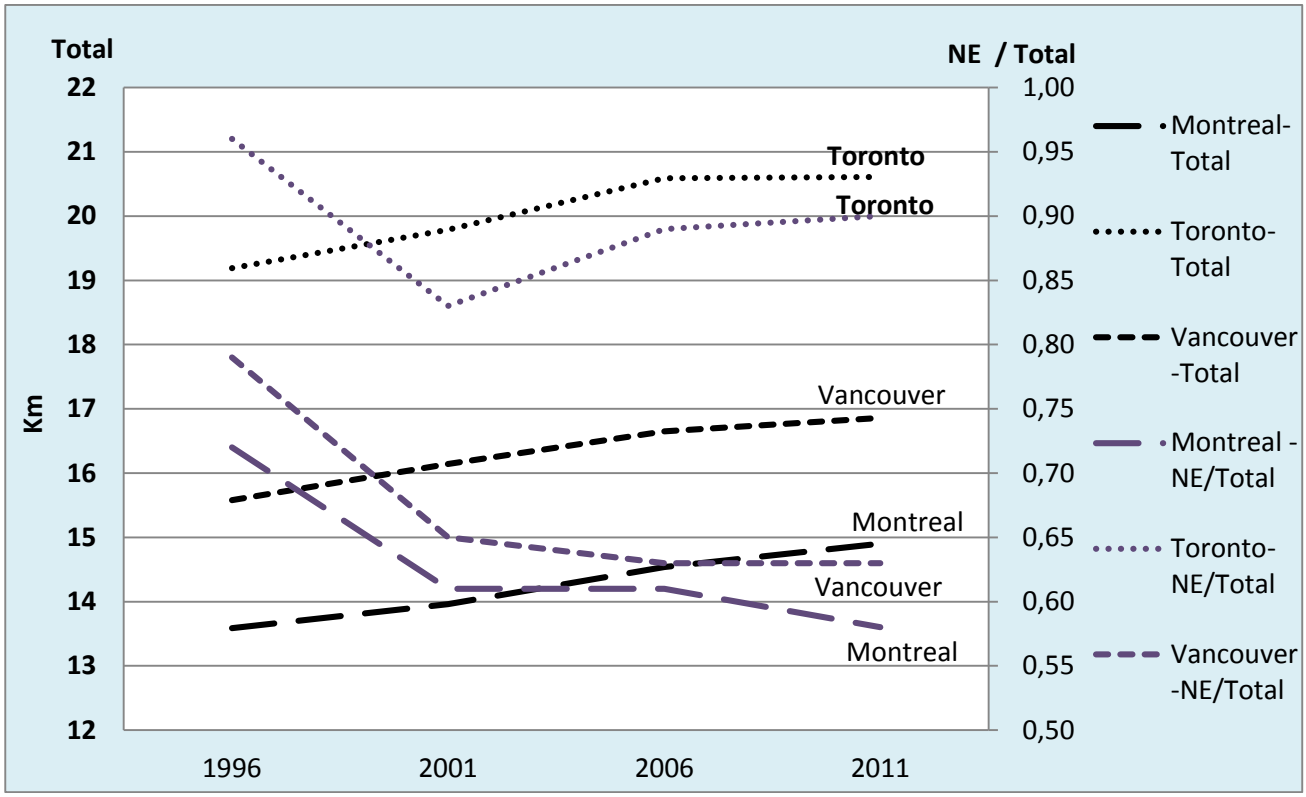


Figure 3 shows the evolution of average distances from the CBD (in kilometers) of total employment and of NE employment for the three metro areas. For total employment corresponding distances are indicated on the left-hand axis. NE employment distances are given as a proportion of total employment distances with corresponding shares indicated on the right-hand axis. Thus, for the Montreal metropolitan area in 2011 the average distance for NE employment was less than 60% for employment as a whole.

[14] To adjust for the post-1996 industry code change, NE employment figures for 1996 were adjusted downward using the NAICS-SIC difference in 2001 as benchmark.

Figure 3: Average Distance from the CBD (km). Three Metro Areas 1996-2011



The results reveal three different urban structures. Montreal, the oldest city, exhibits the most concentrated urban structure with distances for total employment systematically below that of its two sisters. At the other end, Toronto displays the most "sprawled" structure with the highest average distances, a reflection both of its greater size and generally unconstrained geography. In all three metro areas, employment continues to expand spatially with average distances growing over time, although at a decelerating rate in Toronto. The overall trend is towards increasing distances, a predictable outcome of the growth in employment and expanding metropolis, consistent with the literature on Canadian metropolitan areas (Shearmur et al., 2007; Shearmur and Hutton, 2014).

The picture for NE employment is very different, but with Toronto again the odd-man out. In Montreal and Vancouver, NE employment was both initially more concentrated in and near the CBD (relatively shorter distances) in 1996, but also progressively becoming more centre-oriented over time compared to total employment. In both cities, the fall in relative distances was particularly sharp during the 1996-2001 techno boom, suggesting that many of the dot com start-ups of the time sprung up in central locations, consistent with the incubator vision of central districts. Toronto, however, projects a different geography of NE employment. First, average distances for NE economy employment are consistently close to the metro norm, 0.96 in 1996 and

0.90 in 2011, suggesting a fairly dispensed spatial distribution. Second, unlike Vancouver and Montreal, relative distances have gone up since 2001, suggesting a New Economy with a comparatively strong base in suburban locations and more fragile foundations in central neighborhoods, hard hit by the 2001 techno bust (figures 2, 4 and 5).

Figure 4: New Economy Employment by Location (Constant Geography): % Distribution 1996-2011

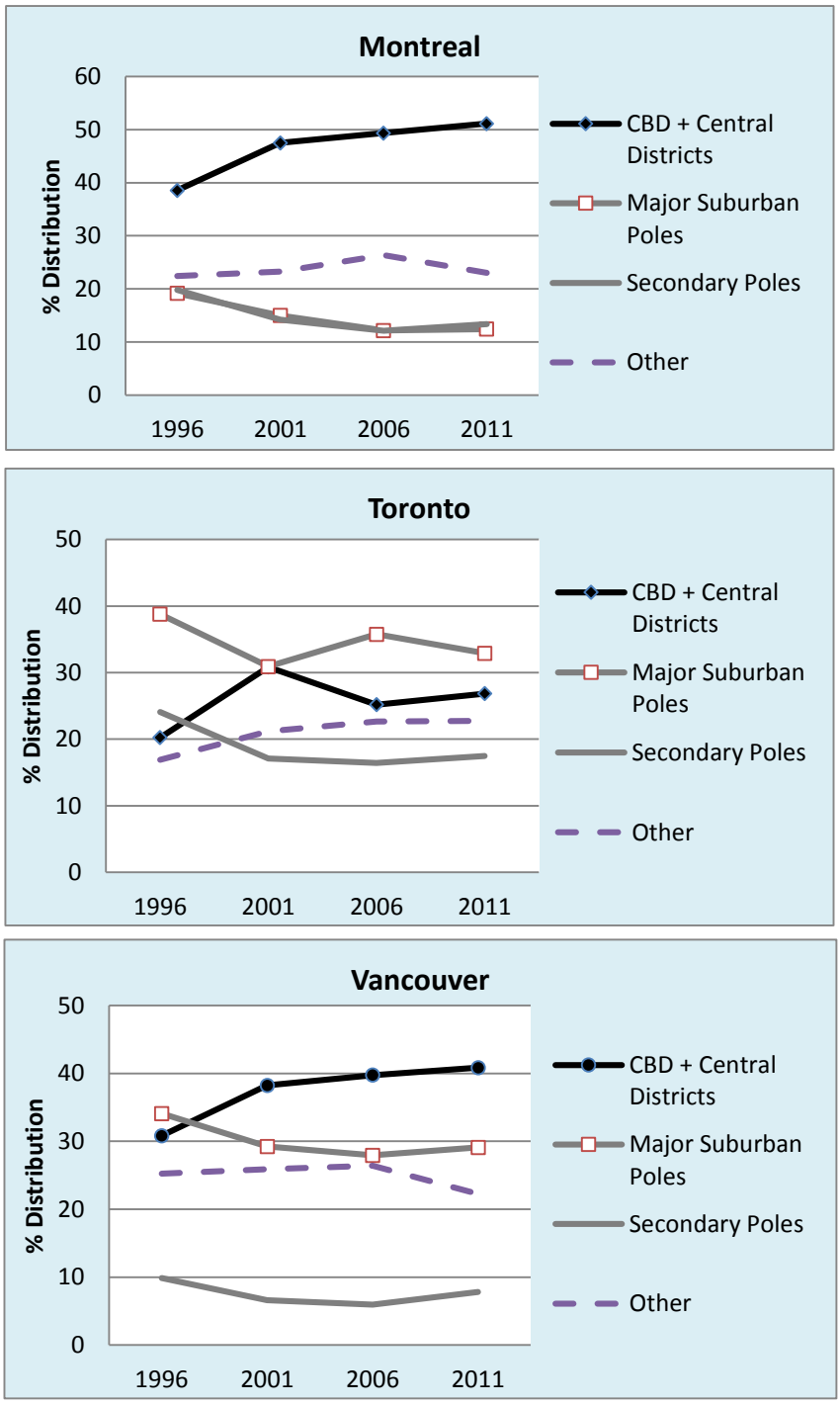
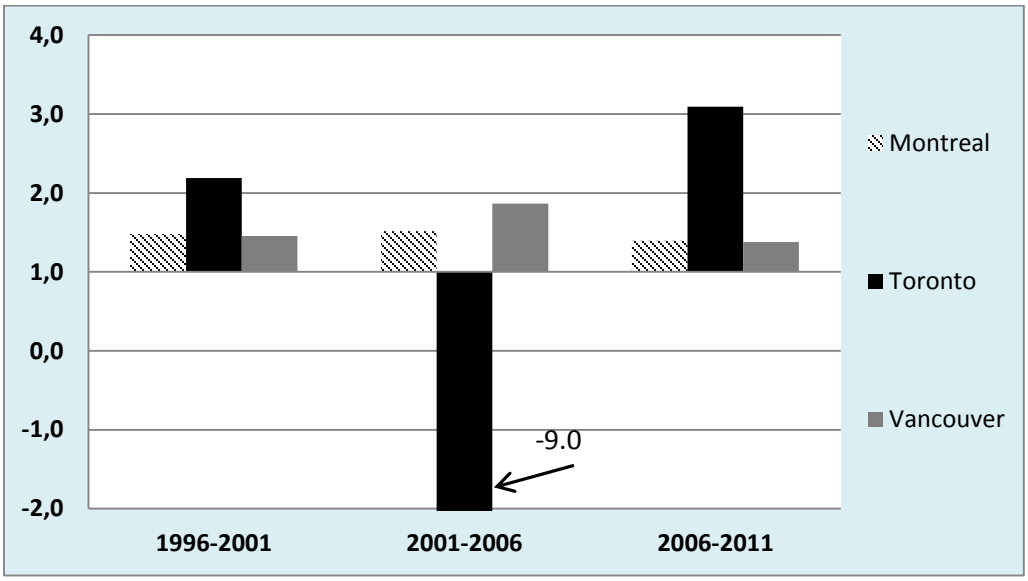


Figure 5: NE Employment Growth in Central Districts Relative to Initial Share (Constant Geography)



*Index= % metropolitan NE employment growth captured by central districts for a given 5-year period / % metropolitan NE employment in central districts at the beginning of each 5-year period (i.e. 1996, 2001, 2006).

Figure 4, 5 and 6 complete the picture, illustrating the redistribution of employment among NE poles (constant geographies are used for figures 4 and 5). NE economy poles, recall, group census tracts in the top quartile in terms both of NE jobs per km² and numbers per tract in 1996 and/or 2011.

The portrait for Montreal is unambiguous. Central districts not only capture the largest share of NE employment but their share is steadily increasing (figure 4). The share of NE employment growth captured by central districts in each five-year period is systematically above initial NE shares (figure 5), a sign of continuing concentration. The slowdown after 2001 in relative average distances (figure 3) and in the growth of the share of central districts (figure 4) is, in other words, largely the product of slower NE employment growth (figure 2) rather than a slowing of concentration. A comparison of the two maps on figure 6 (1996 and 2011) reveals the steady consolidation of Montreal's New Economy central neighbourhoods with expansions westward along the Lachine Canal, an old industrial area, and northwards along St. Lawrence Boulevard and Mile-End neighbourhood, formally home to the garment industry. The other major concentration is around the airport (Dorval) whose relative weight declined between 1996 and 2006, steadying since (figure 4).

Figure 6: Shares of Metropolitan Employment by Pole: NE Economy and Total (1)

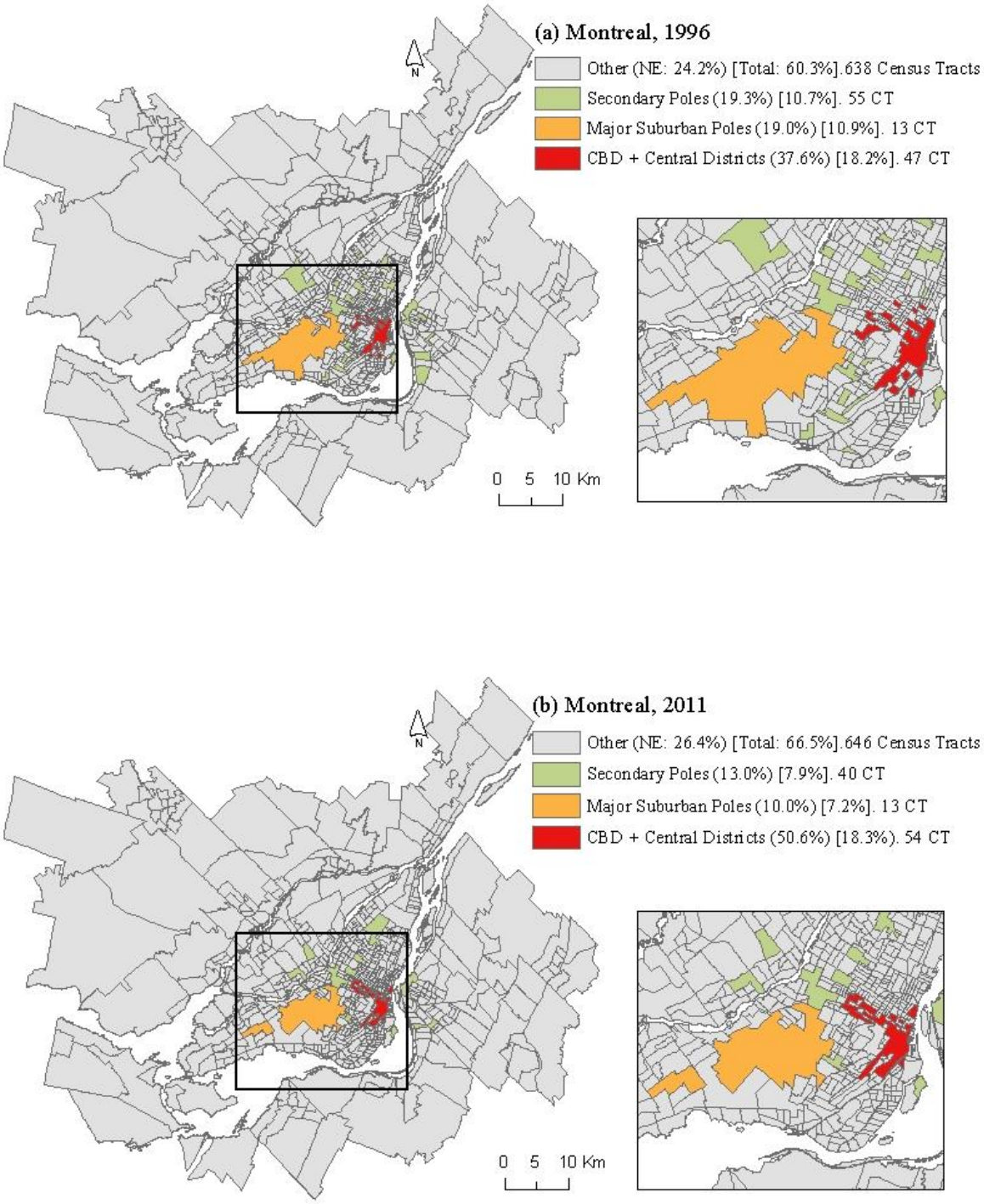


Figure 6: Shares of Metropolitan Employment by Pole: NE Economy and Total (2)

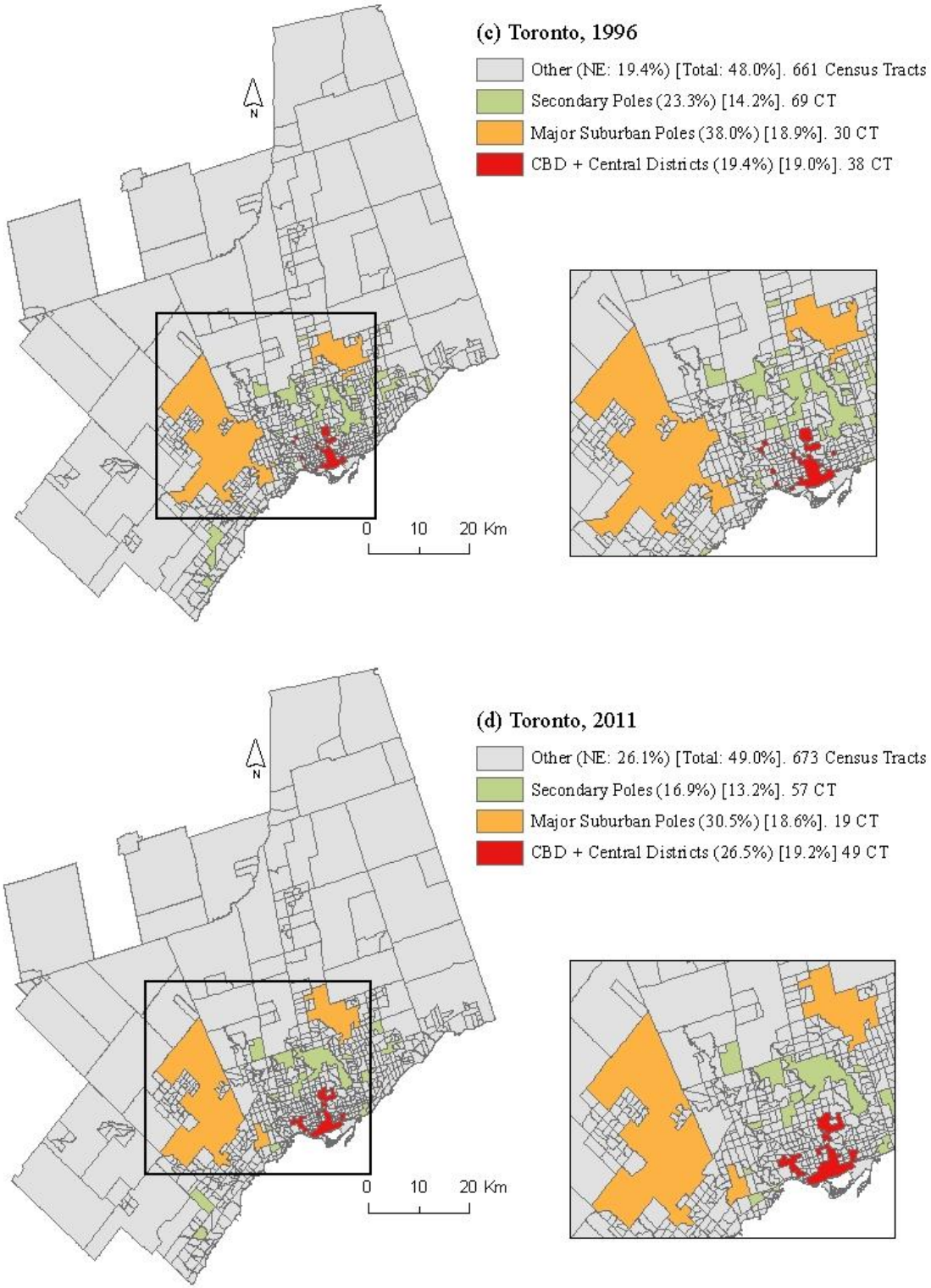
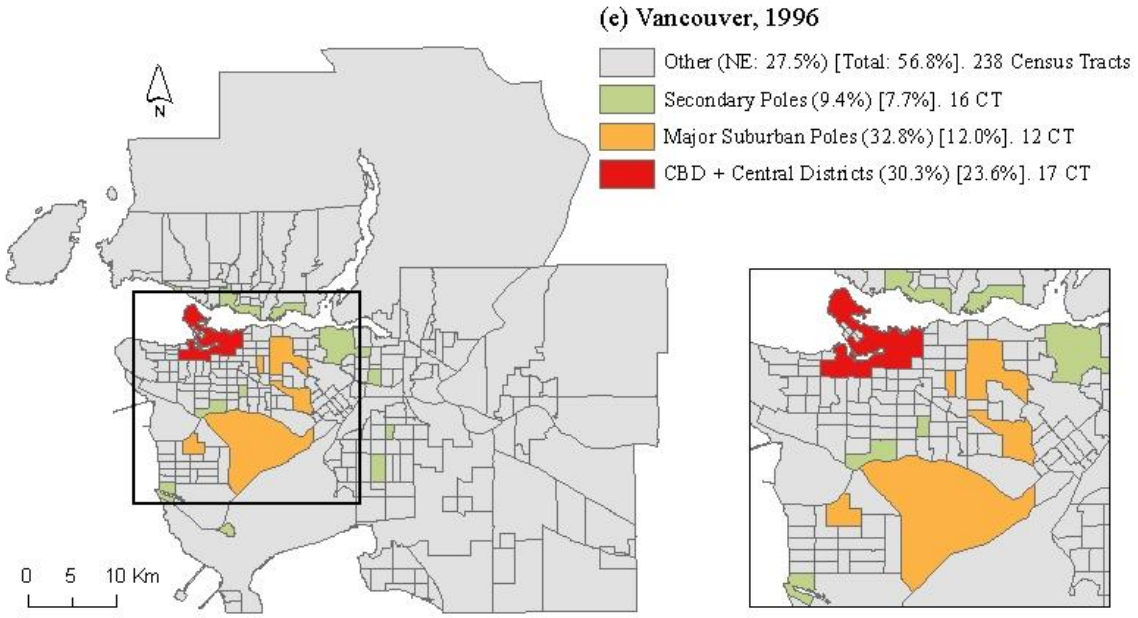
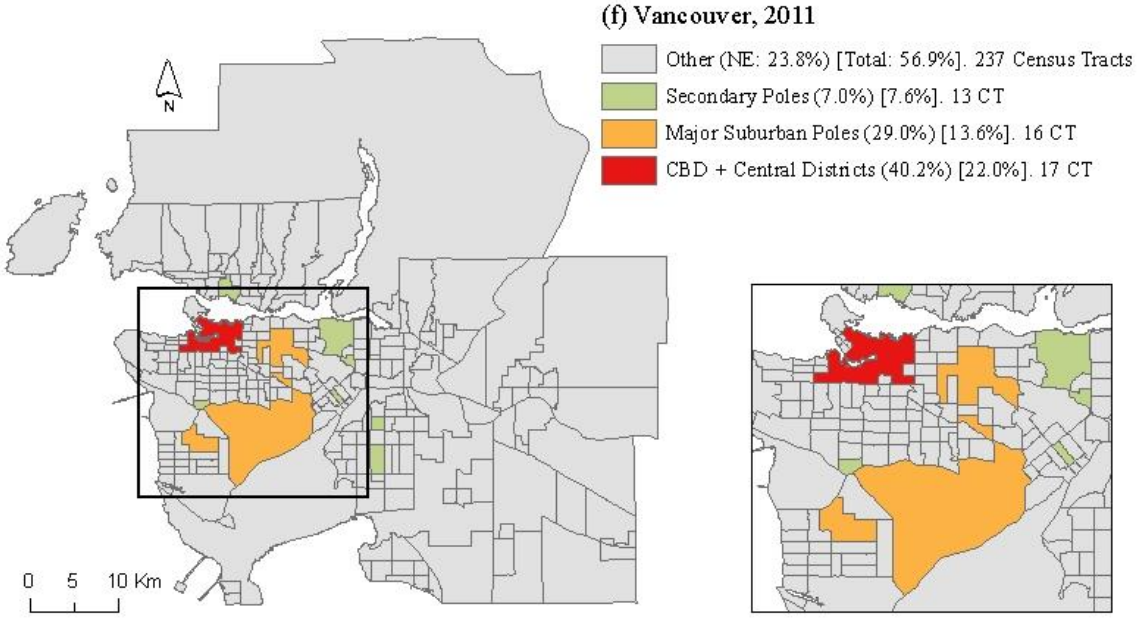


Figure 6: Shares of Metropolitan Employment by Pole: NE Economy and Total (3)





The results for Vancouver confirm the similarities with Montreal. Central neighborhoods continued to gain ground (figure 4) with the weight of suburban poles declining until 2006 with a slight upturn since. As in Montreal, central districts continue to capture a steady above-average share of NE employment growth over all three periods (figure 5). The principal change in Vancouver's central NE cluster has been a southward shift across False Creek (maps 6e and 6f), below the downtown core. Yaletown¸ the neighborhood studied by Hutton (2004) and Barnes and Hutton (2009) is north of False Creek and remained fairly stable (i.e. same number of census tracts).

Toronto is again the odd-man out. Major suburban poles capture the largest share of NE employment with fluctuating shares over time (figure 4). Figure 5 confirms the devastating impact of the 2001 techno bust on central NE employment, but with a sharp upturn since. There is no obvious reason why central NE firms should have been especially hard hit in Toronto. One possible explanation, but for which we have no hard evidence, is the possible customer relationship with the corporate and financial sectors, the core of the downtown economy. Toronto is Canada's principal corporate centre, particularly hard hit by the 2001-2002 downturn. The post-2001 downturn suggests, in short, that downtown NE firms were heavily dependent on servicing local customers, contrasting with Montreal and Vancouver more specialized in visual effects and computer gaming, largely destined for outside markets. Unfortunately, industry classifications do not allow us to identify industries by markets[15].

However, the maps (figure 6) paint a more centre-focused picture for Toronto. Toronto's central NE cluster appears to be expanding and consolidating very much like Montreal with an extension north along one of the main transit lines and towards the northwest along an old rail line and former industrial districts, the latter encompassing Toronto's trendy Junction neighbourhood, typical of the kind of neighborhood cited in the creative industry and innovative districts literature. In 2009, Ubisoft, a major player in the computer gaming industry, already present in Montreal's Mile End neighbourhood, opened a studio (350 jobs) in the Junction neighborhood in a former GE plant (Hartley, 2012).

Summarizing, the descriptive and mapping results reveal a mixed picture but nonetheless largely consistent with the proposition of the growing weight of central neighborhoods in the New Economy. Central neighborhoods are the dominant NE employment poles in Vancouver and Montreal, their shares increasing over time. NE employment is increasingly centre-oriented as measured by comparatively shorter (average) distances from the CBD with central districts consistently capturing above-average shares of NE employment growth. Toronto presents a less clear-cut picture. Central districts suffered major NE employment losses during the 2001 techno bust, but resumed growth since with expanding central NE poles similar to the pattern observed for Montreal. However, average distances for NE employment are similar to those for total employment with strong suburban NE poles.

[15] Thus, the generic class "Software Publishers" does not distinguish between the development of customized software for local banks and the production of block-buster computer games for global markets.

Table 3: Binomial Logistic Regression Results

	(1) Montreal			(2) Toronto			(3) Vancouver		
	Def. 1	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**
Employment Structure									
Creative Industries (LQ)	0.105	0.097	0.183	0.583***	0.468***	0.546***	0.149	0.473**	0.65***
	(0.104)	(0.089)	(0.122)	(0.128)	(0.113)	(0.122)	(0.198)	(0.202)	(0.200)
Computer Manufacturing (LQ)	0.022	0.030	0.040	0.316***	0.429***	0.225***	0.523***	0.624***	0.154*
	(0.023)	(0.025)	(0.032)	(0.108)	(0.162)	(0.081)	(0.154)	(0.223)	(0.094)
Financial Institutions (LQ)	0.060*	0.041	0.006	0.118*	0.099*	0.146*	0.057	0.047	0.033
	(0.033)	(0.025)	(0.025)	(0.070)	(0.060)	(0.082)	(0.046)	(0.045)	(0.048)
Accessibility									
Inv. Dist. Airport	23.805***	8.953**	10.068**	0.304	-3.801	-1.171	2.393	3.009	0.601
	(4.588)	(4.249)	(4.183)	(5.094)	(4.744)	(5.116)	(6.229)	(6.273)	(5.891)
Inv. Dist. Highway	0.073	0.102	-0.010	0.597***	0.533**	0.393***	0.572	0.771	0.161
	(0.064)	(0.066)	(0.017)	(0.212)	(0.211)	(0.146)	(0.690)	(0.768)	(0.445)
Inv. Dist. Subway	0.140**	0.143**	0.204***	0.062	0.078	-0.214	0.456	0.214	-0.087
	(0.063)	(0.061)	(0.072)	(0.176)	(0.162)	(0.187)	(0.288)	(0.260)	(0.256)
Neighborhood Environment									
Rent	0.001*	0.002***	0.002***	0.003***	0.002***	0.002***	0.001	0.001	0.0004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance to CBD	-0.107***	-0.008	0.015	-0.021**	0.011	0.011	-0.060**	0.007	-0.014
	(0.020)	(0.010)	(0.010)	(0.010)	(0.007)	(0.007)	(0.026)	(0.019)	(0.020)
University Faculty in Computer Sciences	0.063	0.073	-0.022	0.006	0.021	-0.009	-0.076	-0.046	-0.014
	(0.049)	(0.049)	(0.032)	(0.033)	(0.039)	(0.026)	(0.062)	(0.091)	(0.086)
Students in Computer Sciences	-0.037	-0.068	0.000	0.153*	0.053	0.004	0.086	0.109	0.087
	(0.070)	(0.064)	(0.068)	(0.087)	(0.075)	(0.077)	(0.141)	(0.147)	(0.144)
Arts-related Population	0.012*	0.017**	0.018**	0.019*	0.028***	0.015*	0.031*	0.059***	0.021
	(0.007)	(0.007)	(0.007)	(0.011)	(0.010)	(0.009)	(0.018)	(0.020)	(0.020)
Constant	-2.584***	-2.824***	-3.308***	-4.512***	-3.614***	-4.412***	-2.352*	-3.331***	-2.240*
	(0.566)	(0.521)	(0.537)	(0.749)	(0.652)	(0.690)	(1.365)	(1.192)	(1.179)
N	753	753	753	798	798	798	283	283	283
Pseudo R^2	0.2619	0.1108	0.0863	0.2232	0.1375	0.1243	0.2441	0.1791	0.1073
% Correctly Classified	79.42%	71.58%	71.05%	77.82%	72.18%	74.56%	79.86%	73.85%	77.03%

Note: "Def. 1": NE employment poles are defined according to NE employment density per km2 and NE employment; "Def. 2": NE employment poles are defined according to NE employment density per capita and NE employment; "Def. 3": NE employment poles are defined according to NE employment location quotients and NE employment. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

ECONOMETRIC RESULTS: THE EVOLVING DETERMINANTS OF NE EMPLOYMENT LOCATION

Econometric results are presented in two stages beginning with the binomial logistic regression of the determinants of the location of NE employment over the whole period (1996-2011) followed by a multinomial logistic regression to ascertain how those determinants have changed over time. The models are applied separately to the three metropolitan areas.

Table 3 shows the binomial regression results for three definitions of NE employment concentration. The explanatory power of the model is generally satisfactory with a pseudo-R^2 always near 0.25 for the first indicator, but lower for the other two (recall that the Pseudo-R^2 is mechanically lower than the R^2; see Mc Fadden, 1979). The predictive power of the model is also acceptable with 70% to 80% of census tracts correctly classified (predicted probabilities) depending on the metro area.

For Montreal and Toronto, significant coefficients tend to be so across all three definitions of NE employment poles with only minor exceptions, indicating fairly robust relationships. The exception common to both (and also Vancouver) is proximity to the CBD, significant only for NE employment density per km2, not entirely surprising given the natural tendency for densities to increase near the center. Staying with Montreal and Toronto, the two variables common to both (significant across all three indicators) are "Rent" and "Arts-related Population". The chances, in other words, of a CT for being in a NE pole for any of the four censuses years is positively associated with higher housing prices and artsy, "cool", neighborhoods. The arts variable is also significant for two out of three indicators in Vancouver, the most consistent variable across all three cities.

Montreal comes closest to the image of city in which NE jobs are primarily drawn towards central-type neighborhoods with only the airport variable pointing in the opposite direction, the strong subway variable also pointing to non-suburban locations. The results for Toronto and Vancouver reveal a more mixed picture, especially the former (also the largest metropolis), suggesting a bi-polar spatial structure in which suburban poles remain strong magnets, as witnessed by the positive coefficients for "Computer Manufacturing" in both cities and "Highways" in Toronto. The consistent significance of "Finance" and "Creative Industries" in Toronto also suggests a more complex geography within central and proximate areas, going beyond a simple centre/suburb dichotomy (recall figure 6). However these results do not tell us whether the relative weight of these determinants has increased or decreased over time.

Table 4: Multinomial Logistic Regression Results

	(1) Montreal			(2) Toronto			(3) Vanvouver		
	Def. 1	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**
				(A) Declining Poles					
Employment Structure									
Creative Industries (LQ)	0.127	0.118	0.211	0.606***	0.499***	0.597***	0.151	0.557**	0.659***
	(0.112)	(0.095)	(0.131)	(0.148)	(0.132)	(0.143)	(0.237)	(0.228)	(0.245)
Computer Manufacturing (LQ)	0.048**	0.044*	0.051	0.384***	0.483***	0.296***	0.486***	0.603***	0.157
	(0.021)	(0.026)	(0.033)	(0.111)	(0.165)	(0.090)	(0.157)	(0.227)	(0.104)
Financial Institutions (LQ)	0.053	0.036	0.016	0.160*	0.136*	0.185*	0.067	0.069	0.065
	(0.037)	(0.028)	(0.028)	(0.094)	(0.076)	(0.105)	(0.044)	(0.043)	(0.046)
Accessibility									
Inv. Dist. Airport	27.109***	14.690***	13.806***	-1.038	-2.603	-4.155	3.846	5.239	-0.917
	(5.612)	(5.126)	(5.087)	(5.989)	(4.911)	(6.697)	(7.960)	(7.882)	(7.274)
Inv. Dist. Highway	0.101	0.115*	-0.010	0.584***	0.543**	0.342**	0.637	0.826	0.160
	(0.075)	(0.067)	(0.017)	(0.217)	(0.218)	(0.151)	(0.725)	(0.793)	(0.577)
Inv. Dist. Subway	0.120	0.123*	0.200**	0.160	0.192	-0.022	0.522	0.245	-0.353
	(0.079)	(0.074)	(0.085)	(0.182)	(0.176)	(0.193)	(0.329)	(0.302)	(0.329)
Neighborhood Environment									
Rent	0.001**	0.002**	0.002***	0.003***	0.002***	0.003***	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance to CBD	-0.122***	-0.022	0.015	-0.015	0.014	0.005	-0.056	0.020	-0.005
	(0.024)	(0.015)	(0.013)	(0.012)	(0.009)	(0.010)	(0.035)	(0.022)	(0.024)
University Faculty in Computer Sciences	0.055	0.072	-0.098**	0.025	0.031	0.014	-0.073	-0.099	-0.089
	(0.052)	(0.052)	(0.042)	(0.034)	(0.039)	(0.034)	(0.087)	(0.099)	(0.096)
Students in Computer Sciences	-0.105	-0.142*	-0.052	0.237**	0.133	0.000	-0.100	-0.068	-0.092
	(0.089)	(0.082)	(0.086)	(0.095)	(0.087)	(0.113)	(0.184)	(0.182)	(0.189)
Arts-related Population	0.006	0.014*	0.015**	0.001	0.013	-0.009	0.041*	0.062**	0.015
	(0.008)	(0.008)	(0.008)	(0.013)	(0.011)	(0.011)	(0.024)	(0.024)	(0.025)
Constant	*-3.321****	*-3.553****	*-4.321****	*-5.527****	*-4.880****	*-5.207****	*-3.127**	*-4.669****	*-3.566***
	(0.647)	*(0.610)*	*(0.641)*	*(0.877)*	*(0.741)*	*(0.882)*	*(1.703)*	*(1.387)*	*(1.474)*

	(1) Montreal			(2) Toronto			(3) Vanvouver		
	Def. 1	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**	**Def. 1**	**Def. 2**	**Def. 3**
				(B) Growing Poles					
Employment Structure									
Creative Industries (LQ)	0.083	0.077	0.152	0.570***	0.447***	0.515***	0.151	0.369	0.664***
	(0.108)	(0.092)	(0.122)	(0.132)	(0.118)	(0.125)	(0.265)	(0.262)	(0.243)
Computer Manufacturing (LQ)	-0.147	0.006	0.010	0.221	0.375**	0.145	0.557***	0.657***	0.152
	(0.092)	(0.042)	(0.050)	(0.135)	(0.170)	(0.107)	(0.158)	(0.228)	(0.107)
Financial Institutions (LQ)	0.067*	0.046	-0.012	0.053	0.043	0.102	0.043	0.007	-0.049
	(0.036)	(0.033)	(0.033)	(0.077)	(0.066)	(0.080)	(0.071)	(0.073)	(0.082)
Accessibility									
Inv. Dist. Airport	20.426***	1.799	5.158	1.532	-4.866	0.846	0.969	0.020	2.969
	(6.181)	(5.383)	(5.847)	(7.319)	(7.482)	(6.442)	(7.565)	(7.417)	(8.516)
Inv. Dist. Highway	0.022	0.088	-0.009	0.602***	0.521**	0.427***	0.513	0.691	0.129
	(0.080)	(0.069)	(0.020)	(0.215)	(0.213)	(0.153)	(0.761)	(0.829)	(0.524)
Inv. Dist. Subway	0.153**	0.156**	0.217***	0.0003	-0.011	-0.359	0.381	0.173	0.246
	(0.065)	(0.065)	(0.076)	(0.212)	(0.198)	(0.228)	(0.334)	(0.343)	(0.340)
Neighborhood Environment									
Rent	0.001	0.002***	0.001**	0.002***	0.001**	0.002***	0.001	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance to CBD	-0.093***	-0.001	0.015	-0.027*	0.009	0.015*	-0.064**	-0.013	-0.032
	(0.028)	(0.012)	(0.012)	(0.014)	(0.009)	(0.009)	(0.028)	(0.029)	(0.031)
University Faculty in Computer Sciences	0.071	0.071	0.012	-0.006	0.013	-0.024	-0.077	-0.010	0.037
	(0.051)	(0.051)	(0.034)	(0.041)	(0.046)	(0.040)	(0.083)	(0.107)	(0.099)
Students in Computer Sciences	0.015	-0.011	0.043	0.073	-0.027	0.006	0.233	0.254	0.258
	(0.077)	(0.071)	(0.074)	(0.101)	(0.092)	(0.089)	(0.170)	(0.169)	(0.169)
Arts-related Population	0.017**	0.020**	0.020***	0.028**	0.038***	0.028***	0.020	0.055**	0.029
	(0.008)	(0.008)	(0.008)	(0.012)	(0.011)	(0.011)	(0.024)	(0.026)	(0.027)
Constant	*-3.216****	*-3.372****	*-3.606****	*4.901****	*3.817****	*-4.978****	*-2.940***	*-3.066***	*-1.734*
	(0.737)	*(0.624)*	*(0.657)*	*(0.925)*	*(0.833)*	*(0.801)*	*(1.529)*	*(1.526)*	*(1.636)*
N	753	753	753	798	798	798	283	283	283
Pseudo R^2	0.2079	0.0895	0.0723	0.1874	0.1135	0.1096	0.1918	0.1425	0.1046
% Correctly Classified	75.03%	66.93%	67.99%	76.06%	67.29%	73.43%	74.56%	67.84%	71.73%

Note: "Def. 1": NE employment poles are defined according to NE employment density per km2 and NE employment; "Def. 2": NE employment poles are defined according to NE employment density per capita and NE employment; "Def. 3": NE employment poles are defined according to NE employment location quotients and NE employment. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Associated with growing and declining CTs	Only in growing CTs	Only in declining CTs

Table 4 shows multinomial logistic regression results for the three cities with, respectively, the determinants of *declining* NE and of *growing* NE census tracts located in NE employment poles, the former where shares of metropolitan NE employment declined and the latter where shares grew between 1996 and 2011. Again, the results are shown for three definitions of the dependant variable. To facilitate the reading of table 4, significant coefficients (0.10 + level) are coded according to three classes: *a*) determinants associated with *both* declining and growing CTs (in light grey); *b*) determinants associated only with *growing* CTs (in brown); *c*) determinants associated only with *declining* CTs (in dark grey). The first class essentially identifies determinants whose predictive power has not changed between 1996 and 2011, while the second (*b*) identifies determinants whose explanatory power has grown (with the inverse for *c*).

The overall picture mirrors table 3, which is as expected, with generally the same determinants highlighted. The principal variable (significant in Toronto and Vancouver) whose strength appears to have remained largely unchanged is proximity to "Creative Industries", although one result for Vancouver suggests a decline. In short, it is not the need to be close to creative industries that is driving spatial shifts one way or the other, at least in these two cities. The principal variable associated with declining NE poles is "Computer Manufacturing", specifically in Montreal and Toronto (associated only with declining CTs in 4 out 6 cases, and more significantly associated with declining CTs than with growing CTs in 5 out of 6 cases), suggesting that proximity to manufacturing is a decreasing location determinant for NE employment. For Montreal, the association (for declining CTs) with the "Airport" and, to a lesser extent "Highway", variables also points to the decreasing attractive power of suburban locations. The association of "Financial Institutions" with declining CTs, unique to Toronto, supports our earlier interpretation that the apparent decline in the city's downtown NE economy following the 2001 techno bust was in part driven by the slump in Toronto's financial sector.

The most frequent determinant driving growing NE employment poles is the "Arts" variable, specifically in Montreal and Toronto (associated only with growing CTs in 4 out 6 cases, and more powerfully associated with growing CTs than with declining CTs in 6 cases out of 6), as such largely consistent with the creative district literature. The comparison with the "Creative industries" variable (significant mainly in Toronto and stable over time) suggests that classical localicalization economies (i.e. interaction between the two industry classes) are not the principal drivers of NE neighborhood growth, but rather worker (and owner) life-style preferences for particular types of neighborhoods. The relatively weak although positive result for the "CBD" variable (for density per km2 in two cases) indicates that such growing neighborhoods are sometimes close to the CBD, but not necessarily so. The association of the "Subway" variable with growth, but only for Montreal (more powerfully associated with growing CTs than with declining CTs in 3 cases out of 3), suggests that accessibility may be as important as physical proximity. Finally, for Toronto, the

effect of the “Highway” variable has remained largely unchanged (even more powerfully associated with growing CTs in one case), a reminder that some non-central locations also continue to attract NE jobs.

CONCLUSION

The paper asks whether New Economy (henceforth, NE) jobs in cities are shifting to central neighborhoods. NE employment was defined using a strictly computer and IT service industry definition as distinct from arts-based "creative" industries. In search of an answer, the evolution of NE employment in Canada’s three largest metropolitan areas was examined between 1996 and 2011. The evidence largely supports the thesis of a shift to central neighborhoods. In all three metropolitan areas the share of NE employment in central neighborhoods grew between 1996 and 2011. In all three, average distances to the CBD fell between 1996 and 2011 in contrast to metropolitan employment as a whole which continued to expand outward.

The econometric results, specifically for Toronto and Montreal (the two largest metropolises) point to the increasing weight of neighborhood attributes, notably the presence of above-average (resident) populations in the arts and related “creative” occupations, as determinants of the location of NE employment, consistent in this respect with the more anecdotal and case study evidence in the creative district literature. The shift towards the center is, it seems, driven as much by life style choices as by classical localization economies focused on the interaction between firms or knowledge workers. The positive relationship with arts-based populations (a residential variable) is more systematic than with creative industry employment, a workplace variable. The presence of university faculty in NE-related fields (workplace) is never a significant variable. The econometric results also point to the decreasing importance of attributes associated with suburban locations, notably computer manufacturing, as location determinants of NE jobs. We have argued that the miniaturization of computer hardware and consequent reduction in NE firms space requirements and entry costs have introduced a new locational flexibility allowing firms to choose neighborhoods, including so-called “cool” central neighborhoods. This, however, must remain a hypothesis, not easily verifiable via statistical analysis with the data at hand.

The above conclusion does not negate the importance of localization economies and knowledge-sharing (or spillovers) in intra-metropolitan location choices. Rather the results point to an increasing interrelationship with life-style and residential choices. In this respect, the techno shift may mirror a broader social trend, notably among younger and better education populations, of a return to city living.

Does this mean the end of suburban research parks and the Silicon Valleys of this world? No. The evidence for Canada does not suggest that suburban techno clusters are about to die; rather that they are no longer the only (or chief) players in field. Toronto stands out in this respect. Major suburban NE poles continue to dominate its economic landscape, although with declining shares

since 2006. Average distances from the CDB have risen in recent years. Toronto's central New Economy districts (tracts with both high NE employment densities and totals) have nonetheless continued to expand in size, capturing above-acreage shares of NE employment growth in recent years. We are most probably heading to a world in which central and suburban techno employment concentrations are increasingly complements, successful New Economy cities housing both types, the former more often the setting for start-ups while larger more mature firms will seek out less dense settings.

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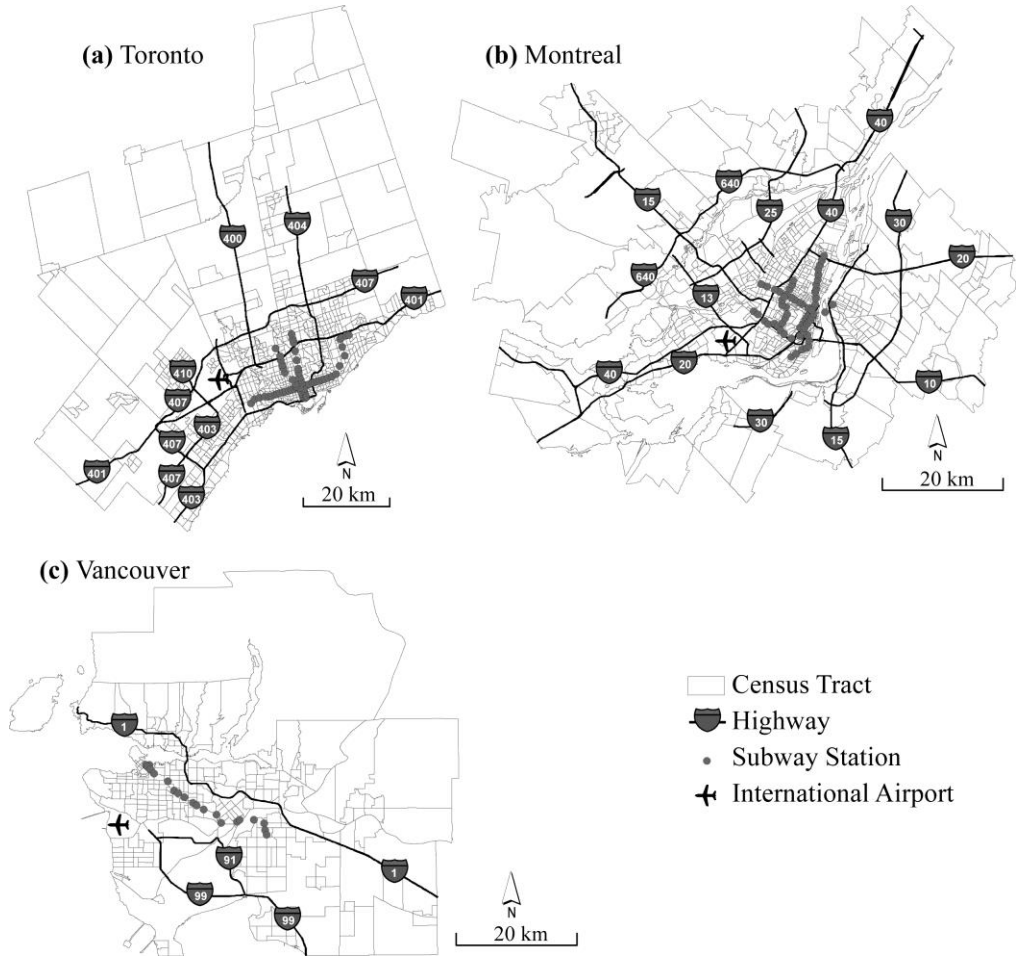
SUPPLEMENTARY APPENDIX

A.1: Toronto, Montreal and Vancouver Metropolitan Areas



A.2: Arts-related Occupations (Statistics Canada 1990 National Occupational Classification): NOC Codes and Description

5121 Writers
5131 Producers, Directors, Choreographers, and Related Occupations
5132 Conductors, Composers, and Arrangers
5133 Musicians and Singers
5134 Dancers
5135 Actors
5136 Painters, Sculptors, and Other Visual Artists
5232 Other Performers
5241 Graphic Designers and Illustrating Artists
5243 Theatre, Fashion, Exhibit, and Other Creative Designers
5212 Technical Occupations Related to Museums and Galleries
5222 Film and Video Camera Operators
5225 Audio and Video Recording Technicians
5226 Other Technical Occupations in Motion Pictures, Broadcasting, and the Performing Arts
5227 Support and Assisting Occupations in Motion Pictures, Broadcasting, and the Performing Arts

A.3: Distribution (by Type and Year) of Growing and Declining New Economy Employment Poles. Three Metropolitan Areas Combined.

	Declining	**Growing**
Census Tracts (Number)	260	267
Distribution per Year	%	%
Pole in 1996 only	47.3	1.1
Pole in 2011 only	0.8	38.6
In both 1996 and 2011	33.5	31.5
In 2001 and/ or 2006	18.5	28.8
Distribution by Pole Type	%	%
Central Districts	29.2	46.3
Major Suburban Pole	19.8	15.8
Secondary Pole	50.9	37.9
New Economy Employment		
1996	41,660	21,030
2001	55,945	62,740
2006	47,135	70,580
2011	39,750	84,335
Share (%) of New Economy Employment	%	%
1996	54.6	27.5
2001	38.9	43.7
2006	32.1	48.1
2011	25.5	54.1